nationalgrid

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 which 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. 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, 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. That is, market participants can 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. 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, which 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 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 urban areas close to customers (e.g. large industry) wishing to take the heat output.

Renewable generation technologies cover a wide range of energy sources including hydro, biofuels, wind, wave and solar. In output terms, the largest contributions presently come from hydro (particularly large scale hydro) and biofuels, which include landfill gas, waste combustion, sewage sludge digestion and coppice wood and straw burning. Figures for 2005 show wind accounted for 17% of renewable generation (up from 14% in 2004). Hydro held a 29% share in 2005 with biofuels (53%) accounting for most of the rest. Hydro and biofuels have together accounted for more than 80% of renewable output in recent years, with wind taking up most of the balance of around 15% and rising.

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 allowance 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 allowance 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 Table 4.1 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. For example, Craig windfarm (8MW), connected at Chapelcross and Hagshawhill extension (26MW), connected at Linnmill are not scheduled for connection until 2007. Both are located within the SP Distribution Network.

Unfortunately, updated information in respect of SP Manweb, EDF Energy (EPN), EDF Energy (SPN), Central Networks (East) and Central Networks (West) 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. In the coming months we shall endeavour to gather a more complete set of data for publication in the 2008 GB SYS. In the meantime, 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 was adopted to reduce the data collection burden on the distribution network operators (i.e. plant less than 5MW located in England and Wales was not included). The information relating to the Scottish distribution systems was provided to SHETL and SPT by the Scottish distribution network operators and 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. This information is summarised in Table 4.2 . Please note that the 'Zone Number', referred to in Table 4.2, is 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 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, some 695MW of the installed capacity of embedded Medium and Small generation is located in Scotland (zones 1 & 2), 2751MW is located in northern zones of England and Wales (zones 3, 4, 5 & 6) and 3291 MW is located in southern zones (zones 7 to 14).

Government Targets and Obligations

In 1993, as part of a programme to reduce carbon dioxide emissions, the government of the time set a target of increasing the electrical capacity of combined heat and power in the United Kingdom to 5GW by the year 2000. After taking office in 1997, the new government endorsed this target, which was reached during 2004. The government subsequently set a new target of 10GW of installed CHP capacity by 2010 as part of its Climate Change Programme to reduce carbon dioxide emissions in 2010 by 20% of their 1990 level.

In addition to the above CHP objectives, in 2002 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 (see below). Originally, a capacity target for the United Kingdom of 1.5GW on a declared net capability (DNC) basis, excluding large-scale hydro, was set for the end of 2000. (The term DNC takes the intermittent nature of the power output from some renewable sources into account. For wind this is 43% of its gross capacity.) The 1.5GW target was achieved during 2003.

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 2005-06.

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 and 2006. New Orders came into force on 1 April 2005 and 1 April 2006. These Orders place an obligation on licensed electricity suppliers in England and Wales, Scotland and Northern Ireland to source an increasing proportion of electricity from renewable sources. In 2005-06, this was 5.5% in England and Wales and Scotland and 2.5% in Northern Ireland. The size of these obligations increases year on year such that they reach 10% of electricity sales in 2010 and 15% of sales 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. In February this year, Ofgem published a buy-out price for the RO of £34.3 per megawatt hour for the period 1 April 2007 to 31 March 2008. 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 reduced significantly. In the 2005-06 obligation period 41 landfill gas generating stations were accredited. The most prevalent technology in the 2005-06 obligation period in terms of the number of stations and capacity was onshore wind with 63 stations (circa 640MW) being accredited.

Co-firing and onshore wind stations made up around 70% of the total renewable capacity installed and accredited under the RO in the 2005-06 obligation period. The total installed capacity of each technology is as follows: co-firing (3,312MW); onshore wind (1,584MW); landfill gas (771MW); small Hydro (i.e.<20MW) (583MW); offshore wind (304MW); biomass (205MW); sewage (75.8MW); micro hydro (15.1MW); biomass and waste using ACT-advanced conversion technology (1.9MW); waste using ACT (1.7MW); and photovoltaic (0.5MW).

Subject to Parliamentary approval, the legislation will change on 1 April 2007 when the renewables Obligation will be amended and new Orders for Scotland and Northern Ireland will come into force. Changes will include allowing ROCs to be issued for electricity consumed by the generator without the need for "sell-and-buy-back" contracts. Under such contracts , generators sell their electricity to a licensed supply and then purchase it back for their own consumption. Other changes under consideration for 2008 and beyond include extending obligation levels up to 20% and freezing the buy out price in 2015 by removing the annual increase in line with RPI.

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. At the time of writing the levy on electricity is 0.43p/kWh. However, this will increase with RPI from April 2007. 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 0.43p/kWh. As a result, developers of qualifying renewable schemes could receive a minimum support of 3.86p/kWh in 2006/07, (i.e. the buy-out price of 3.43p/kWh under the RO plus the 0.43p/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 that there is 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 various 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, which 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 2007/08 is some 1.8GW onshore and some 100MW offshore. Of this 76MW (onshore) is located in the SHETL area and 242MW (onshore) is located in the SPT area. The remainder (1.5GW onshore and 100MW offshore) is located in the NGET area. The broad disposition within the NGET area by distribution company is: Central Networks (East) 180MW; EdF (EPN) 295MW; SP Manweb 287MW; CE Electric (YEDL) 25MW; Western Power Distribution (South Wales) 66MW offshore; Western Power Distribution (South West) 38MW offshore; CE Electric (NEDL) 20MW; and United Utilities (Norweb) 680MW.

On the basis of the information contained in Table 3.5 , the installed capacity of wind farms, which are either classified as Large or are directly connected to the GB transmission system, grows from some 1.7GW in 2007/08 to 11GW by 2013/14. This is made up of a growth in offshore capacity from some 140MW in 2007/08 to 2.6GW by 2013/14. Onshore wind capacity is projected to grow from 1.6GW in 2007/08 to 8.4GW by 2013/14. 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 3.6GW in 2007/08 (244MW offshore and 3.4GW offshore) to 12.9GW by 2013/14 (2.7GW offshore and 10.2GW onshore). Around 6.5GW of this projected 9.3GW growth in wind farm capacity is located in Scotland.

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 years 2006/07 and 2012/13 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

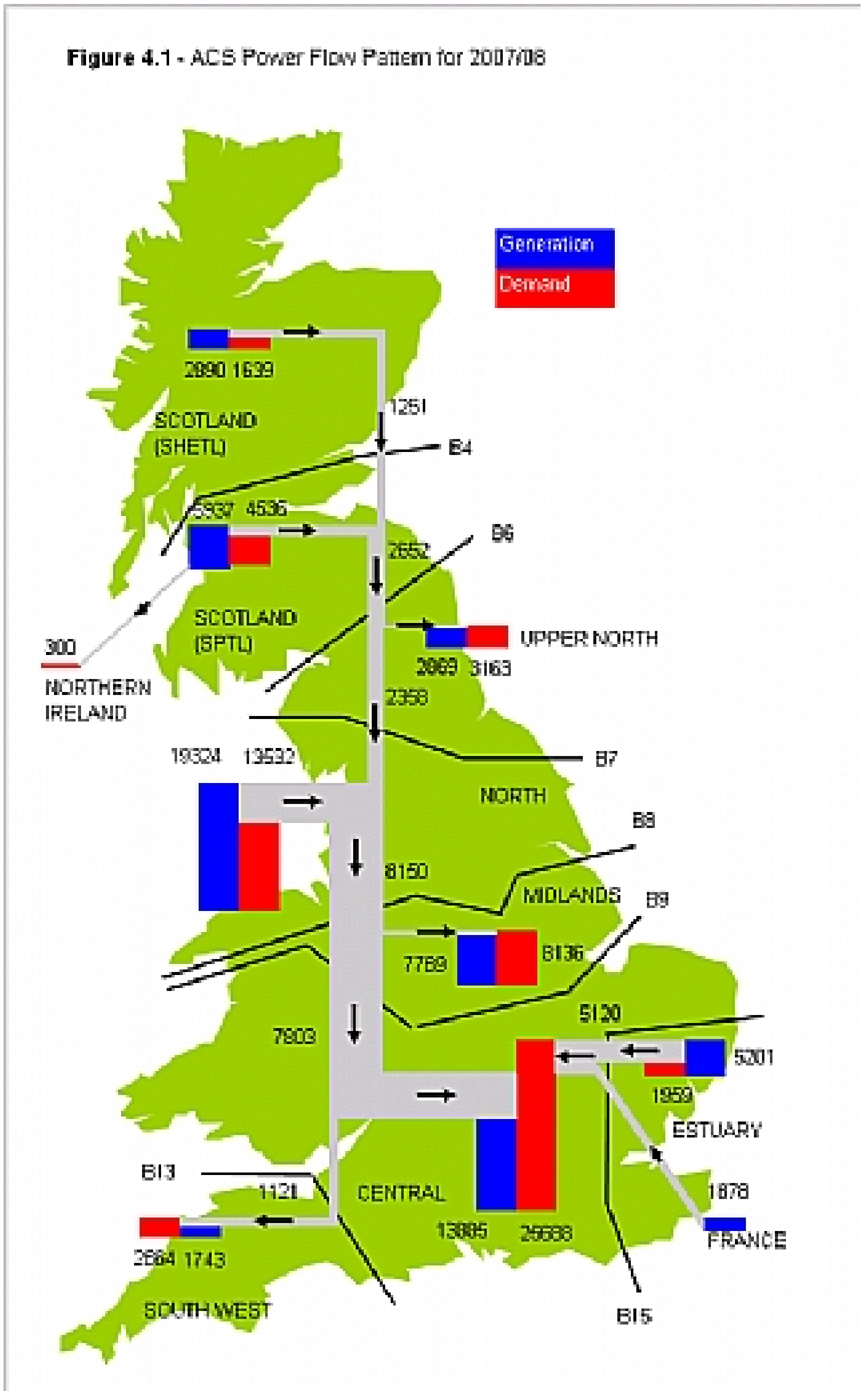
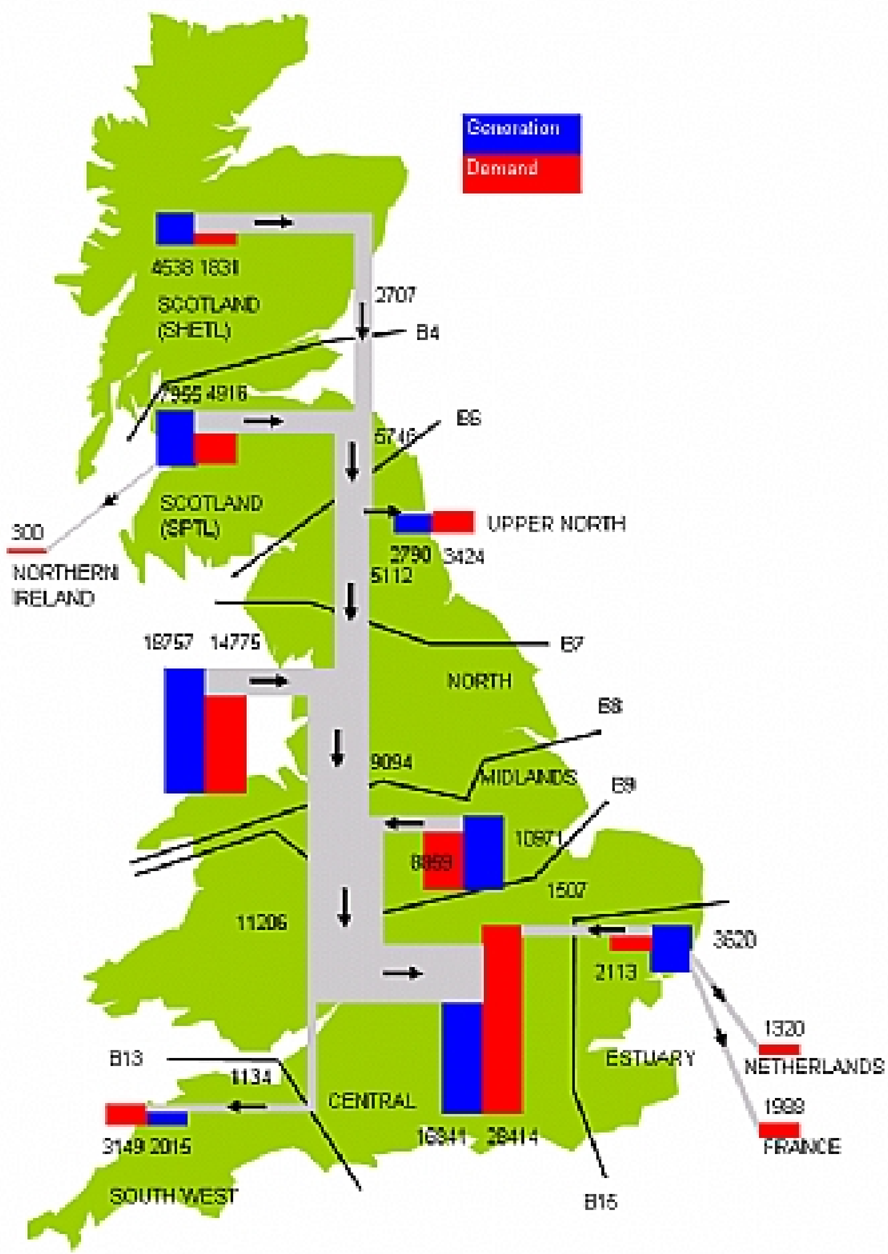


Figure 4.1 - ACS Power Flow Pattern for 2007/08

Figure 4.2

Click to load a larger version of Figure4.2 image

Figure 4.2 - ACS Power Flow Pattern for 2013/14



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 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 10GW by 2010/11and 12.9GW by 2013/14. On the face of it, this wind capacity together with the capacity of other renewables is likely to exceed the government's target on renewables discussed earlier. However, it has to be borne in mind that not all prospective future projects will necessarily proceed to completion.

It is more useful, to consider the potential range of impacts on the GB transmission system in general terms against a background of meeting the government's target of 10% of renewables, which equates to around 8GW of renewables, by 2010.

If there were to be 6GW of (embedded and/or non-embedded) onshore wind farms in Scotland, where wind conditions and the prospects for obtaining consents are favourable, and 2GW of (embedded and/or non-embedded) onshore wind farms in England and Wales, the broad transmission implications would be as follows. There would be a need for reinforcement of the GB transmission system within Scotland to transmit the power from the wind farms to the Scottish load centres but primarily to facilitate the transfers south into England. The capacity of the interconnections between Scotland and England would need to be enhanced and parts of the system in the North West and North East of England would require reinforcement to accept the additional imports from Scotland.

Alternatively, if there were to be 2GW of (embedded and/or non-embedded) onshore wind in Scotland and 6GW of offshore wind in England and Wales, the broad transmission implications would be as follows. The offshore wind may be embedded or non-embedded but is more likely to be directly connected to the GB transmission system than onshore wind farms. Offshore developments are likely to be located in clusters beyond the 13km exclusion zone but near connection points to the GB transmission system close to the Thames Estuary, the Wash and the North West of England. Given these broad locations, the system effect would be less than in the previous case since flows from Scotland to England would be backed-off. Nevertheless, some transmission development in the Cumbria area could be required and also some reinforcement in the North West to accommodate the 2 GW of onshore wind in Scotland. While the need for transmission reinforcement, and consequently the cost, would be less, the cost of establishing and connecting the actual offshore wind farms is likely to be more.

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. Based on recent 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.

The proportion of conventional generation needed to be retained in the electricity market, given the variable and unpredictable nature of some renewable technologies such as wind, such that current levels of security of supply are not eroded is the subject of the published paper: "A shift to wind is not unfeasible", by Dale, Milborrow, Slark & Strbac, Power UK Issue 109, March 2003.

For example, for 8000MW of wind (e.g. in line with Government's 2010 target of 10% renewables), around 3000MW of conventional capacity (equivalent to some 37% of the wind capacity) can be retired without any increased probability that load reductions would be required due to generation shortages on cold days. However, as the amount of wind increases, the proportion of conventional capacity that can be displaced without eroding the level of security reduces. For example, for 25000MW of wind only 5000MW (i.e. 20% of the wind capacity) of conventional capacity can be retired. 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.

However, balancing costs would be expected to rise in line with the wind portfolio. This is because, as described above, an increase in generation from sources of unpredictably fluctuating output is expected to result in increased holding of System Reserve and procurement of services to manage system frequency. We have previously estimated that for the case with 8000MW of wind needed to meet the 10% renewables target for 2010, balancing costs can be expected to increase by around £2 per MWh of wind production. This figure is now under review as it was calculated before a number of developments in market rules (e.g. CAP047 Response Pricing) and increases in underlying market costs (e.g. recent fluctuations in generation fuel prices).

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. 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 Suppliers 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 Owner's 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, which 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 station, 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 a continuing growth in embedded generation. It is important for National Grid to play its part in facilitating this growth 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.

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.

However, balancing costs would be expected to rise in line with the wind portfolio. We have previously estimated that for the case with 8000MW of wind needed to meet the 10% renewables target for 2010, balancing costs can be expected to increase by around £2 per MWh of wind production. This would represent an additional £40million per annum, approximately 10% of existing annual balancing costs. However, this figure is now under review as it was calculated before a number of recent developments in market rules (e.g. CAP047 Response Pricing) and increases in underlying market costs (e.g. recent rises in generation fuel prices).

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.

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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	ABNE3-	4	Biomass
SHEPD	Blairhill (Cauldron Linn) Hydro		0.43	Hydro
SHEPD	Stormontfield Hydro		0.1	Hydro
SHEPD	Bendealt (Novar)		8.82	Wind
SHEPD	Meal an Tuirc (Novar)		7.84	Wind
SHEPD	Mitchells of Letham	ARBR30	1	Biomass
SHEPD	Arnish Moor Wind, Lewis		3.9	Wind
SHEPD	Chliostair		1.2	Hydro
SHEPD	Gisla		0.7	Hydro
SHEPD	Beannachran Dam	BEAU31	0.2	Hydro
SHEPD	Ben Glass Hydro		0.92	Hydro
SHEPD	Little Wyvis Hydro		0.65	Hydro
SHEPD	Luichart Dam		0.09	Hydro

SHEPD	Misgeach Hydro		0.4	Hydro
SHEPD	Orrin Dam		0.3	Hydro
SHEPD	Falls of Conis Hydro		0.92	Hydro
SHEPD	Ardverickie Hydro	BOAG31	1.35	Hydro
SHEPD	Cuaich Hydro		2.6	Hydro
SHEPD	Deanston Distillery Hydro	BRAC31	0.5	Hydro
SHEPD	Glen Finglas Hydro		0.46	Hydro
SHEPD	Glen Turret Hydro		2	Hydro
SHEPD	Monzie Hydro		0.15	Hydro
SHEPD	Inverbain Hydro	BROA31	0.9	Hydro
SHEPD	Nostie Bridge - Hydro		1.2	Hydro
SHEPD	Cromwell Park Hydro	BUMU31	0.1	Hydro
SHEPD	Stanley Mills Hydro		1	Hydro
SHEPD	Claddoch Hydro	CAAD31	0.2	Hydro
SHEPD	Lussa Hydro		2.4	Hydro
SHEPD	Gigha		0.2	Hydro
SHEPD	Duchally Hydro	CASS31	0.45	Hydro
SHEPD	Cluanie Dam - Hydro	CEAN31	0.3	Hydro
SHEPD	Dundreggan Dam - Hydro		0.2	Hydro
SHEPD	Loyne Tunnel - Hydro		0.6	Hydro
SHEPD	Allt na Lairgie	CLAC31	6	Hydro
SHEPD	Douglas Water Hydro, near Inveraray		2.5	Hydro
SHEPD	Douglas Water Hydro, near Inveraray (Additional)		0.5	Hydro
SHEPD	Drimsynie - Hydro		0.42	Hydro
SHEPD	Glen Kinglas, Cairndow		1	Hydro
SHEPD	Sron Mhor		5	Hydro
SHEPD	Storr Lochs Hydro	DUGR31	2.7	Hydro
SHEPD	Striven Hydro	DUNO3-	6	Hydro
SHEPD	Findhorn Wind	ELGI3-	0.9	Wind
SHEPD	Mullardoch	FASN3-	2.5	Hydro
SHEPD	Garry Dam - Hydro	FAUG31	0.3	Hydro
SHEPD	Garry Gualach - Hydro		0.9	Hydro

SHEPD	Invergarry Dam		0.3	Hydro
SHEPD	Quoich Dam		0.4	Hydro
SHEPD	Ardtornish Hydro	FWIL31	0.66	Hydro
SHEPD	Glen Tarbert		0.99	Hydro
SHEPD	Glenborrodale Hydro		0.15	Hydro
SHEPD	Gorton - Hydro		0.1	Hydro
SHEPD	Kingairloch Hydro		3.5	Hydro
SHEPD	Morar - Hydro		0.8	Hydro
SHEPD	Mucomir - Hydro		1.8	Hydro
SHEPD	Silverhill House - Hydro		0.1	Hydro
SHEPD	Dundee University CHP	GLAG32	3	CHP
SHEPD	Abhainn Ceuileig Hydro	GRUB31	3	Hydro
SHEPD	Garbhaig Hydro		1	Hydro
SHEPD	Kerry Falls Hydro		1.3	Hydro
SHEPD	Loch Dubh		1.06	Hydro
SHEPD	Loch Poll		0.23	Hydro
SHEPD	Meig Dam		0.1	Hydro
SHEPD	Vaich Tunnel		0.3	Hydro
SHEPD	Achanalt Hydro	GRUB51	2.6	Hydro
SHEPD	Dunmoglas Wind	INNE31	0.6	Wind
SHEPD	Garrogie Hydro		2	Hydro
SHEPD	Corriegarth Hydro		3	Hydro
SHEPD	Foyers Falls Hydro		5	Hydro
SHEPD	Biomass Generator, Rothes Distillers	KEIT3-/MACD	4.99	Biomass
SHEPD	Flex Hill Wind		4.5	Wind
SHEPD	Gask Turriff Biomass Generation		0.5	Biomass
SHEPD	Acharn Burn Hydro	KIIN31	0.45	Hydro
SHEPD	Glen Lyon Estate		1	Hydro
SHEPD	Glenfinglas Hydro		0.5	Hydro
SHEPD	Lochay Comp set		2.1	Hydro
SHEPD	Lochay Fish Pass		0.5	Hydro
SHEPD	Lubeoch		4.2	Hydro
SHEPD	Stronuich Dam Hydro		0.2	Hydro
SHEPD	Rothlenorman Wind	KINT3-	0.6	Wind

SHEPD	Taits Mills		7.5	CHP
SHEPD	Shin Diversion Weir	LAIR31	0.1	Hydro
SHEPD	Lairg Hydro		3.5	Hydro
SHEPD	Lintrathen Water Works	LUNA31	0.3	Hydro
SHEPD	Lochhead Landfill		2	Bio Mass
SHEPD	Clatto Water Works	LYND31	0.2	Hydro
SHEPD	Baldovie Waste	MILC31	8.3	waste
SHEPD	Knowehead Waste		0.93	waste
SHEPD	Michelin Wind		4	Wind
SHEPD	Berriedale Farm - Hydro	MYBS31	0.1	Hydro
SHEPD	CHP generation, Aberdeen	PERS31	1.45	CHP, gas
SHEPD	Muggiemoss Paper - CHP		8.1	CHP
SHEPD	Tarbothill Wind		2.1	Wind
SHEPD	Western Hatton		0.3	Biomass
SHEPD	Ashfield Farm - Hydro	PORA31	0.3	Hydro
SHEPD	Bowmore - Diesel		6	Diesel
SHEPD	Clachbreck Farm - Hydro		0.11	Hydro
SHEPD	Claddach - Wave		0.15	Wave
SHEPD	Loch Gair		6	Hydro
SHEPD	Ormsary Estate - Hydro		0.55	Hydro
SHEPD	Twin Lochs, Achnamara		0.5	Hydro
SHEPD	Auchtertyre Hydro	RANN31	0.8	Hydro
SHEPD	Gaur		6.5	Hydro
SHEPD	Loch Ericht		2.2	Hydro
SHEPD	Dalchonzie	SFIL3-	4	Hydro
SHEPD	Lednoch		3	Hydro
SHEPD	Stoney Hill Landfill Site	STRI	3.2	Landfill, Biomass
SHEPD	Stoney Hill Landfill Site (Phase 2)		2.13	Landfill, Biomass
SHEPD	Auchindarroch - Hydro	TAYN31	0.69	Hydro
SHEPD	Awe Barrage - Hydro		0.5	Hydro
SHEPD	Balliemeanoch - Hydro		0.95	Hydro
SHEPD	Barcaldine factory biomass		4.5	Biomass

SHEPD	Beinn Ghlas		8.66	Wind
SHEPD	Beochlich - Hydro		1	Hydro
SHEPD	Blarghour Farm - Hydro		0.48	Hydro
SHEPD	Braevallich - Hydro		3	Hydro
SHEPD	Corriegarth Hydro		3	Hydro
SHEPD	Glen Duror - Hydro		0.7	Hydro
SHEPD	Hillcrest Wind, Tiree		0.6	Wind
SHEPD	Kilmelford		2.1	Hydro
SHEPD	Luing - Wind		0.11	Wind
SHEPD	Marine Resource - Hydro		0.45	Hydro
SHEPD	Tiree - Diesel		2.8	Diesel
SHEPD	Tiree Wind		0.6	Wind
SHEPD	Tobermory - Hydro		0.3	Hydro
SHEPD	Tralaig Dam - Hydro		0.08	Hydro
SHEPD	BuFarm	THOS31	2.7	Wind
SHEPD	European Marine Test Centre		7	Wave
SHEPD	Flotta Wind, Orkney		2	Wind
SHEPD	Forss Wind, Caithness		2.6	Wind
SHEPD	Isle of Burray Wind, Orkney		0.9	Wind
SHEPD	Kirkwall - Diesel		15.5	Diesel
SHEPD	Sigurd		1.5	Wind
SHEPD	Thorn Finn		4.25	Wind
SHEPD	Forss Wind (II)		4.99	Wind
SHEPD	Stromness Wind		0.3	Wind
SHEPD	Burgar Hill wind		5	Wind
SHEPD	Westray Development, Orkney		0.9	Wind
SHEPD	Spurness Wind Farm		7.5	Wind
SHEPD	Camserney Hydro	TUMB31	0.9	Hydro
SHEPD	Clunie Dam Hydro		0.2	Hydro
SHEPD	Dirnanean Hydro		0.2	Hydro
SHEPD	Glen Lyon Hydro		0.17	Hydro
SHEPD	Lude Estate Hydro		0.1	Hydro
SHEPD	Pitlochry Dam Hydro		0.1	Hydro

SHEPD	Trinafour Hydro		0.6	Hydro
SHEPD	Stakethill	WOHI5-	0.2	Wind
SHEPD	TOTAL		288.78	
SP Distribution Ltd	Carsfad	Carsfad	12	Hydro
SP Distribution Ltd	Craig	Chapelcross	8	Wind
SP Distribution Ltd	Green Oakhill Landfill	Clydes Mill	3.9	Waste to Energy
SP Distribution Ltd	Summerston Landfill	Killermont	2.9	Waste to Energy
SP Distribution Ltd	Garlaf 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	Greengairs	Cumbernauld	10.4	Waste to Energy
SP Distribution Ltd	Wetherhill	Dumfries	18.2	Wind
SP Distribution Ltd	Earlstoun	Earlstoun	14	Hydro
SP Distribution Ltd	Cathkin Landfill	East Kilbride South	3.2	Waste to Energy
SP Distribution Ltd	Blackhill	Eccles	28.6	Wind
SP Distribution Ltd	Dun Law	Galashiels	17.2	Wind
SP Distribution Ltd	Myres Hill	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	3.5	Waste to Energy
SP Distribution Ltd	Bow Beat (Emly Bank)	Kaimes	15	Wind
SP Distribution Ltd	Bow Beat (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 2	Killermont	2.1	Waste to Energy
SP Distribution Ltd	Shewalton Landfill	Kilmarnock South	1.8	Waste to Energy
SP Distribution Ltd	Roche Site 1	Kilwinning	16	OCGT
SP Distribution Ltd	Bonnington	Linnmill	11	Hydro
SP Distribution Ltd	Hagshawhill	Linnmill	15.6	Wind
SP Distribution Ltd	Hagshawhill Extension	Linnmill	26	Wind
SP Distribution Ltd	Stonebyres	Linnmill	6	Hydro

SP Distribution Ltd	Kaimes Landfill	Livingston	2.6	Waste to Energy
SP Distribution Ltd	Grants, Girvan	Maybole	5	OCGT
SP Distribution Ltd	Auchenlea	Newarthill	2.3	Waste to Energy
SP Distribution Ltd	Greengairs	Newarthill	2	Waste to Energy
SP Distribution Ltd	Barkip Landfill	Saltcoats	1.1	Waste to Energy
SP Distribution Ltd	Haulpland Muir	Saltcoats	24	Wind
SP Distribution Ltd	Wardlaw Wood	Saltcoats	18	Wind
SP Distribution Ltd	Westfield CL	Westfield	12.5	Biomass
SP Distribution Ltd	TOTAL		406.7	
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	Wind
United Utilities (Norweb)	Eon off shore (twin)	Harker	99	Wind
United Utilities (Norweb)	Moresby Moss	Harker	65	Wind
United Utilities (Norweb)	Ormonde Energy Wind	Heysham	99.9	Wind
United Utilities (Norweb)	Ormonde Energy Gas	Heysham	99.9	Gas
United Utilities (Norweb)	Barrow Off Shore	Heysham	99.9	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	TOTAL		1182.7	
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	8.25	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)	TOTAL		434.85	
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	6.08	Gas
CE Electric (YEDL)	Pentex (East Midlands) Ltd	Keadby	9	
CE Electric (YEDL)	Winterton Landfill	Keadby	3.87	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)	TOTAL		198.25	
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	TOTAL		608.3	
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)		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)		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)		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)		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)		Swansea North	3.9	ONSHORE WIND
Western Power Distribution (South Wales)		Swansea North	5.6	HYDRO
Western Power Distribution (South Wales)		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)		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)		Uskmouth	10	OTHER GENERATION
Western Power Distribution (South Wales)		Uskmouth	8.4	CHP
Western Power Distribution (South Wales)	TOTAL		292.4	
Western Power Distribution (South West)		Alverdiscott / Indian Queens	9.6	Onshore Wind
Western Power Distribution (South West)			6.6	Onshore Wind
Western Power Distribution (South West)			2	Other
Western Power Distribution (South West)			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)			7.25	Other
Western Power Distribution (South West)			3	Onshore Wind
Western Power Distribution (South West)			4.5	Onshore Wind

Western Power Distribution (South West)			1.25	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)			5.6	Onshore Wind
Western Power Distribution (South West)			1.6	Other
Western Power Distribution (South West)			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)			3.03	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)			2.25	Landfill Gas
Western Power Distribution (South West)			49.9	OCGT
Western Power Distribution (South West)			1.5	Other
Western Power Distribution (South West)			1.02	Landfill Gas
Western Power Distribution (South West)			2.2	Landfill Gas
Western Power Distribution (South West)			1.05	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)			50	OCGT
Western Power Distribution (South West)		Seabank / Bridgewater / Taunton	1.2	Other
Western Power Distribution (South West)			1.25	Other
Western Power Distribution (South West)			2.6	Landfill Gas
Western Power Distribution (South West)			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)			9.7	Medium CHP
Western Power Distribution (South West)			1.19	Other
Western Power Distribution (South West)			10	Other
Western Power Distribution (South West)			3	Other
Western Power Distribution (South West)			4.5	Other
Western Power Distribution (South West)	TOTAL		259.39	
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	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)	TOTAL		412.1	
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)	TOTAL		344	
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)	BSC Bury 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	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)	Gunfleet Sands Windfarm	Bramford	100.4	Wind
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)	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)	TOTAL		801.1	
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)	TOTAL		261.6	
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)	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)	TOTAL		312.2	
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	60	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	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	TOTAL		935.2	
	GRAND TOTAL		6737.57	

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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 2007/08	Generation Netted Off at Time of GB Peak (MW) 2007/08	Generation Netted Off at Time of GB Peak (MW) 2008/09	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
SHEPD	1	Northern Scotland	288.78	50.1	50.1	50.1	50.1	50.1	50.1	50.1
SP Distribution Ltd	2	Southern Scotland	406.7	98	98	98	98	98	98	98
CE Electric (NEDL)	3	Northern	434.9	118	118	118	118	118	118	118
United Utilities	4	North West	1182.7	805.1	985.1	1041.1	1041.1	1041.1	1041.1	1041.1
CE Electric (YEDL)	5	Yorkshire	198.3	219	219	219	219	219	219	219
SP Manweb	6	North Wales & Mersey	935.2	529	559	559	559	559	559	559
Central Networks East	7	East Midlands	412.1	22	22	22	22	23	23	23
Central Networks West	8	Midlands	344	11	11	11	11	11	11	11
EDF Energy Networks (EPN)	9	Eastern	801.1	200	200	200	200	200	200	200
Western Power Distribution South Wales	10	South Wales	292.4	47.1	47.1	47.1	47.1	47.1	47.1	47.1

EDF Energy Networks (SPN)	11	South East	312.2	252	252	252	252	252	252	252
EDF Energy Networks (LPN)	12	London	261.6	73	73	73	73	73	73	73
Southern Electric Power Distribution	13	Southern	608.3	150	150	150	150	150	150	150
Western Power Distribution South West	14	South Western	259.4	158.7	158.7	158.7	158.7	158.7	158.7	158.7
GB Total			6737.68	2733	2943	2999	2999	3000	3000	3000

Introduction to Chapter 5

This chapter brings together information on generation capacity from Generation Capacity and 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.

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); 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 23.6GW of generating plant planned for commissioning over the period from the 2007/08 winter peak to the 2013/14 winter peak, will commission.

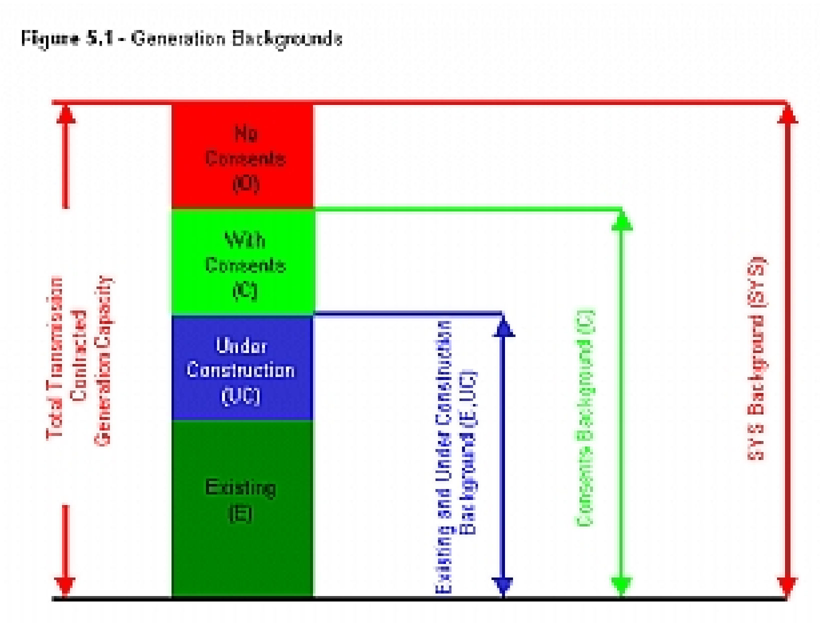
However, unless plant is already under construction there can be only limited certainty that any particular project will proceed to completion and, accordingly, there are a number of areas of uncertainty relating to the future generation position and consequently the future plant/demand position. These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



- 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.

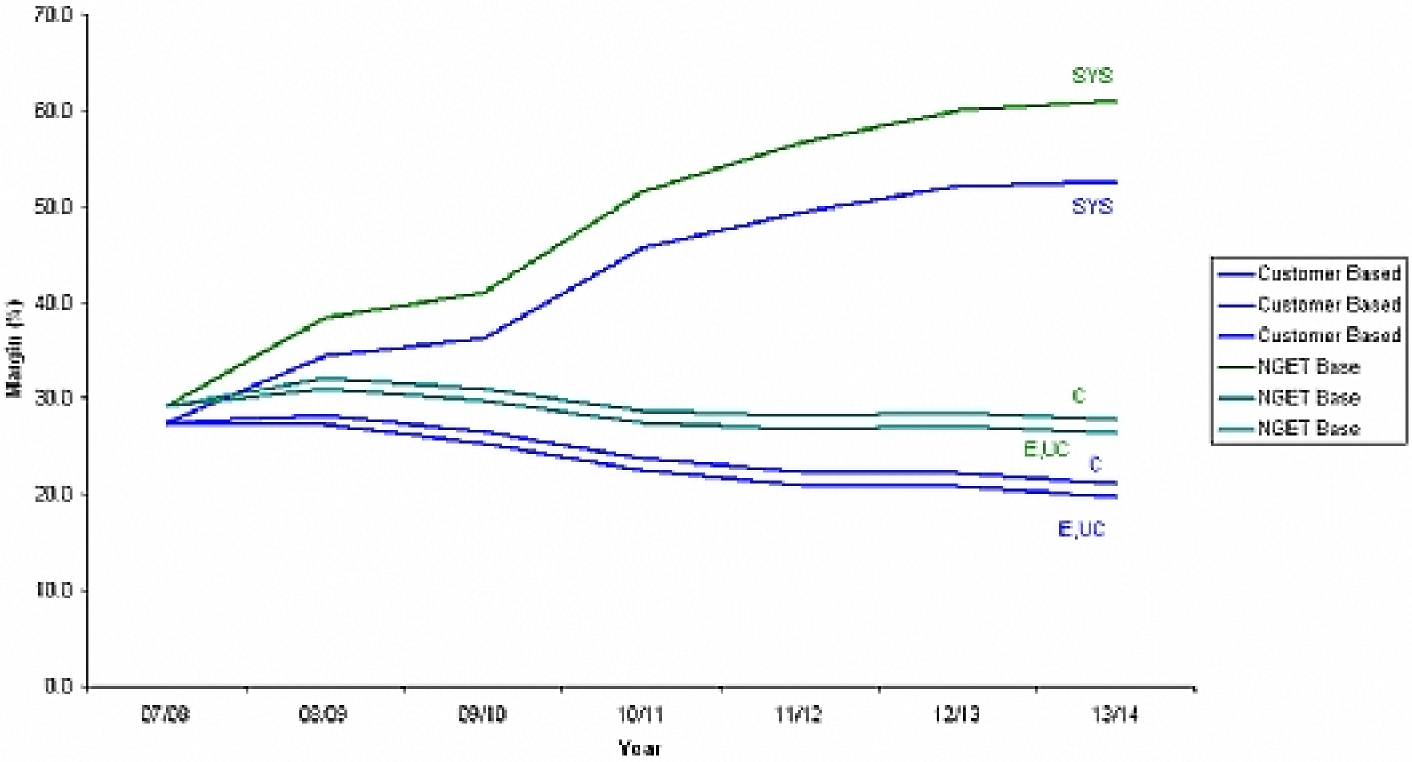
Table 3.7 and Table 3.8 of Chapter 3 identify, amongst other things, which new 'transmission contracted' generation since 2000/01 is either existing by 2007/08 (9.7MW) or under construction (2.6GW). The tables also show how much of the remaining new 'transmission contracted' generation has, where relevant, obtained the necessary S36 and S14 consents (915MW) and how much has yet to obtain consent (21GW).

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 11 December 2006.

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 2013/14 (i.e. when the demand less station demand is some 66.8GW as presented in row 3 of Table 2.1**),** the Plant Margin in that year would obviously reduce by around 1.5 percentage points (i.e. 100*1GW/66.8GW = 1.5%) relative to the margins shown in Tables 5.1 to 5.4 and the related figures.

Decommissioning

Table 3.11 lists generating units, which 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 2013/14 winter peak**,** the plant margin in that year would obviously increase by around 0.75 percentage points (i.e. 100*0.5GW/66.8GW) 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.

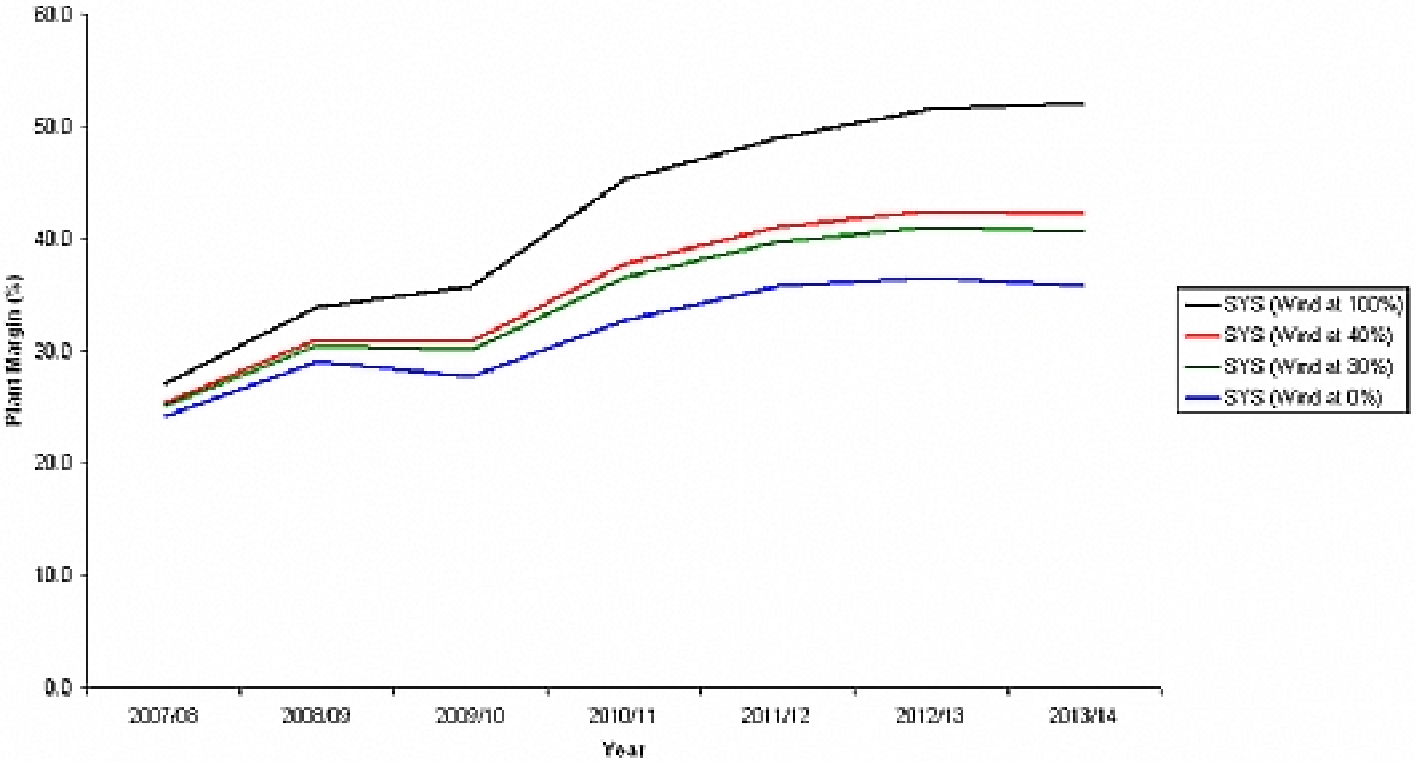
However, to enhance transparency and promote greater understanding within this chapter, additional plant margins have been calculated for a range of assumptions on the availability of wind generation capacity at the time of the winter peak. Nevertheless, it should be remembered that such a range is quite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

Figure 5.3

Click to load a larger version of Figure5.3 image

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



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 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 Netherland 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 20%, the full import is assumed. For margins of 40% or over, the full export is assumed. For margins between 20% and 40% a linear reduction in exports/increase in imports is assumed such that at a margin of 30% there are no imports or exports across the Cross Channel Link or the Netherlands Interconnector.

Throughout this methodology a pragmatic assumption of 300MW export to Northern Ireland 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 300MW export to Northern Ireland 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 Netherland Link (from 2010/11) of 1320MW as equivalent to generation. The pragmatic assumption of a 300MW export at peak to Northern Ireland is, as previously mentioned, treated as demand. Should the transfers across both the Cross Channel Link and Netherland 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 94095MW to 90717MW (a reduction of 3378MW) and increase peak demand from 64600MW to 67978MW (an increase of 3378MW). This would reduce the calculated margin from 45.2% to 33.5% (or 11.7 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 2007/08 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 1.6 percentage points (i.e. 100*1GW/61.7GW).

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.

The margins shown in Figure 5.2 and Table 5.4 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 2008/09 and 2010/11, previously discussed in Generation Capacity Additions, is a common feature in all backgrounds.

When reduced availability in wind farm output is taken into account, the apparent margins are naturally reduced significantly as illustrated in Figures 5.3 and Tables 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 2007/08 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.

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 78.4GW in 2007/08 to 101.9GW by 2013/14. By 2013/14 it is projected that CCGT capacity will exceed coal capacity by 9.5GW and will account for 37.8% 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 Services

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, the majority of 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.

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 2006/07 Winter Outlook Report published in October 2006. http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/9041_24304b.pdf

An updated view of this analysis will appear in our, soon to be published, June 2007 Winter Consultation Report.

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 300MW export at peak across the External Interconnection between Scotland and Northern 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 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 2007 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".

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

Plant Type	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change (MW)
Biomass	45	97	97	97	97	97	392	347
CCGT	25532	29287	29712	33962	36862	38457	38457	12925
CHP	1725	2326	2326	2326	2326	2326	2326	601
Hydro	1028.2	1028.2	1028.2	1028.2	1128.2	1128.2	1128.2	100
Interconnector	1988	1988	1988	3308	3308	3308	3308	1320
Large Unit Coal	4413	4413	4413	4413	4413	4413	4413	0
Large Unit Coal + AGT	21462	21462	21462	21462	21462	21462	21462	0
Medium Unit Coal	1152	1152	1152	1152	1152	1152	1152	0
Medium Unit Coal + AGT	1102	1102	1102	1102	1102	1102	1102	0
Nuclear AGR	8365	8365	8365	8365	8365	8365	8365	0
Nuclear Magnox	1450.4	980	980	0	0	0	0	-1450.4
Nuclear PWR	1190	1190	1190	1190	1190	1190	1190	0
OCGT	588.9	588.9	588.9	588.9	588.9	588.9	588.9	0
Offshore Wind	140	640	640	2090	2090	2590	2590	2450
Oil + AGT	3496	3496	3496	3496	3496	3496	3496	0

Pumped Storage	2300	2744	2744	2744	2744	2744	2744	444
Small Unit Coal	783	783	783	783	783	783	783	0
Wind	1597.5	2472.9	4554.8	5987.8	6560.9	7461.5	8424.8	6827.3
Total Capacity	78358	84115	86621.9	94094.9	97668	100663.6	101921.9	23563.9
GB Demand at ACS Peak (MW)	61500	62600	63600	64600	65400	66200	66800	5300
Plant Margin (%)	27.4	34.4	36.2	45.7	49.3	52.1	52.6	25.2

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

Plant Type	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change (MW)
Biomass	45	45	45	45	45	45	45	0
CCGT	25532	26857	26857	27282	27282	28132	28132	2600
CHP	1725	2326	2326	2326	2326	2326	2326	601
Hydro	1028.2	1028.2	1028.2	1028.2	1128.2	1128.2	1128.2	100
Interconnector	1988	1988	1988	1988	1988	1988	1988	0
Large Unit Coal	4413	4413	4413	4413	4413	4413	4413	0
Large Unit Coal + AGT	21462	21462	21462	21462	21462	21462	21462	0
Medium Unit Coal	1152	1152	1152	1152	1152	1152	1152	0
Medium Unit Coal + AGT	1102	1102	1102	1102	1102	1102	1102	0
Nuclear AGR	8365	8365	8365	8365	8365	8365	8365	0
Nuclear Magnox	1450.4	980	980	0	0	0	0	-1450.4
Nuclear PWR	1190	1190	1190	1190	1190	1190	1190	0
OCGT	588.9	588.9	588.9	588.9	588.9	588.9	588.9	0
Offshore Wind	140	140	140	140	140	140	140	0
Oil + AGT	3496	3496	3496	3496	3496	3496	3496	0

Pumped Storage	2300	2744	2744	2744	2744	2744	2744	444
Small Unit Coal	783	783	783	783	783	783	783	0
Wind	1597.5	1597.5	1797.5	1797.5	1804.4	1804.4	1811.9	214.4
Total Capacity	78358	80257.6	80457.6	79902.6	80009.5	80859.5	80867	2509
GB Demand at ACS Peak (MW)	61500	62600	63600	64600	65400	66200	66800	5300
Plant Margin (%)	27.4	28.2	26.5	23.7	22.3	22.1	21.1	-6.4

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

Plant Type	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	Change (MW)
Biomass	45	45	45	45	45	45	45	0
CCGT	25532	26857	26857	27282	27282	28132	28132	2600
CHP	1725	1725	1725	1725	1725	1725	1725	0
Hydro	1028.2	1028.2	1028.2	1028.2	1028.2	1028.2	1028.2	0
Interconnector	1988	1988	1988	1988	1988	1988	1988	0
Large Unit Coal	4413	4413	4413	4413	4413	4413	4413	0
Large Unit Coal + AGT	21462	21462	21462	21462	21462	21462	21462	0
Medium Unit Coal	1152	1152	1152	1152	1152	1152	1152	0
Medium Unit Coal + AGT	1102	1102	1102	1102	1102	1102	1102	0
Nuclear AGR	8365	8365	8365	8365	8365	8365	8365	0
Nuclear Magnox	1450.4	980	980	0	0	0	0	-1450.4
Nuclear PWR	1190	1190	1190	1190	1190	1190	1190	0
OCGT	588.9	588.9	588.9	588.9	588.9	588.9	588.9	0
Offshore Wind	140	140	140	140	140	140	140	0

Oil + AGT	3496	3496	3496	3496	3496	3496	3496	0
Pumped Storage	2300	2744	2744	2744	2744	2744	2744	444
Small Unit Coal	783	783	783	783	783	783	783	0
Wind	1597.5	1597.5	1597.5	1597.5	1597.5	1597.5	1597.5	0
Total Capacity	78358	79656.6	79656.6	79101.6	79101.6	79951.6	79951.6	1593.6
GB Demand at ACS Peak (MW)	61500	62600	63600	64600	65400	66200	66800	5300
Plant Margin (%)	27.4	27.2	25.2	22.4	21	20.8	19.7	-7.7

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Table 5.4 - Plant Margins (%)

Demand Forecast	Generation Background	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Customer-Based	SYS	27.4	34.4	36.2	45.7	49.3	52.1	52.6
Customer-Based	C	27.4	28.2	26.5	23.7	22.3	22.1	21.1
Customer-Based	E/UC	27.4	27.2	25.2	22.4	21	20.8	19.7
NGET 'Base'	SYS	29.1	38.3	41.1	51.5	56.5	60	61
NGET 'Base'	C	29.1	32	31	28.7	28.2	28.6	27.8
NGET 'Base'	E/UC	29.1	31	29.7	27.4	26.8	27.1	26.3

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

Generation Background	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
SYS (Wind at 100%)	27.4	34.4	36.2	45.7	49.3	52.1	52.6
SYS (Wind at 40%)	25.7	31.4	31.3	38.2	41.4	42.9	42.7
SYS (Wind at 30%)	25.4	30.9	30.5	36.9	40.1	41.4	41
SYS (Wind at 0%)	24.6	29.4	28	33.2	36.1	36.9	36.1

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 2013/14. 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 11 December 2006.

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 2011/12. 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

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 2007/08 (as at the data freeze date of 11 December 2006) 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 2013/14.

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 •' 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.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.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, which are existing as at the winter of 2007/08, 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 2008/09 to 2013/14. 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 2008/09 to 2013/14. 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.

Network Diagrams

The existing 2007/08 GB transmission system is shown schematically in 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 2013/14 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 11 December 2006.

The above schematic figures are complemented by the schematic power flow diagrams, which cover each winter peak from 2007/08 to 2013/14 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 Chapter ("C_0","GB Transmission System Performance").

As mentioned previously, the system location of reactive compensation plant, which is projected to be in existence by 2013/14, is shown schematically in Figure A.2.4 for SHETL, Figure A.3.4 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 2007/08 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 2007/08 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 2007/08 schematic/electrical backgrounds of each Transmission Area.

Table E 1.1 lists the 2007/08 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.2.3 for SHETL, Figure A.3.3 for SPT and Figure A.4.3 for NGET against the backdrop of the 2013/14 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 2007/08 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 2007/08 system.

Introduction to the GB Transmission System

System Overview

By the end of 2007/08 the power system in Great Britain will be made up of 167 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 2007/08 transmission system in Figure A.1.1 . The existing 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 11,216km

275kV 5,960km

132kV & below 4,759km

Total **21,935km**

- Underground Cables

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

400kV 166km

275kV 498km

132kV & below 210km

DC (Channel Link) 327km

Total **1,201km**

- Substations

Transmission system facilities where voltage transformation or switching takes place:

400kV 142

275kV 191

132kV & below 284

Total **617**

- 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 9 (SPT only)

275/132kV 37 (SHETL & SPT only)

400/LV 242 (NGET only and includes 400/132kV units)

275/LV 439

132/LV 246

QBs 19

Total **1102**

- 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 149

66kV 23

33kV and below 170

Total **342**

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 2007/08. 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.

Benefits of an Interconnected Power System

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 (I^2R) 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 Existing Power Stations 2007/08

Fuel Type	Number	Capacity(MW)
Nuclear		
Magnox	4	1450.4
AGR	7	8365
PWR	1	1190
Sub Total	12	11005.4
Coal (+ AGT)		
Small Unit	2	783
Medium Unit	2	2254
Large Unit	13	25875
Sub Total	17	28912
CCGT	41	25532
CHP	12	1741
Sub Total	53	27273
Oil (+ AGT)	3	3496
OCGT	6	588.9
Sub Total	9	4084.9

Hydro	34	1028.2
Pumped Storage	4	2300
Sub Total	38	3328.2
Wind	37	1737.46
Sub Total	37	1737.46
Biomass	1	45
Sub Total	1	45
TOTAL	167	76385.96

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Table 6.2 - Planned Developments on the GB Transmission System

Licensee	Year	Site	Works
SHETL	2007	Ceannacroc/Ft Augustus	Connect Millenium Wind, Ceannacroc, 65MW at 132kV.
SHETL	2007	Coupar Angus	Connect Drumderg Wind Farm, Dalrulzion, 32MW at 33kV
SHETL	2007	Dunvegan	Connect Ben Aketil Wind, Dunvegan, Skye, 21MW at 33kV.
SHETL	2007	Dunvegan	Connect Ben Aketil Wind, Dunvegan (Add. Cap.), 7MW at 33kV.
SHETL	2007	Inveraray / Port Ann	Connect Eredine Forest Wind, Argyll (SRO), 30MW at 132kV.
SHETL	2007	Strathbrora	Connect Strathbrora Wind, Brora, 67MW at 275kV, by 01/10/07.
SHETL	2007	Overhead Line works	132kV OHL circuit between Peterhead and St Fergus
SHETL	2007	Peterhead	the 3rd SGT addition to Peterhead
SHETL	2007	Fraserburgh	Grid Transformer upgrade
SHETL	2007	Lunanhead	Grid Transformer upgrade
SHETL	2007	Invergarry	Grid Transformer upgrade
SHETL	2007	Inverness	Grid Transformer upgrade

SHETL	2007	Bridge of Dun	Connect Tullo Wind Farm, Laurencekirk, 14MW at 33kV.
SHETL	2008	Cable works	Replace Dundee City 132kV cable
SHETL	2008	Killin Substation	Grid transformer upgrade
SHETL	2008	Boat of Garten	Grid transformer upgrade
SHETL	2008	Tummel Bridge	Grid transformer upgrade
SHETL	2008	Dounreay	Connect Akron Wind (Caithness), 20MW at 33kV.
SHETL	2008	Carradale	Connect Largie Wind, South Kintyre, 40MW at 33kV.
SHETL	2008	Dunvegan	Connect Edinbane Wind, Skye, 56MW at 132kV.
SHETL	2008	Kingsburn	Connect Kingsburn wind farm (20MW), Fintry, Stirling.
SHETL	2008	Lairg	Connect Lairg - Achany Wind Farm, 62MW at 33kV.
SHETL	2008	Nant	Connect Carraig Gheal (75MW of wind generation).
SHETL	2008	Orrin	Connect Fairburn Wind (Orrin), 42MW at 132kV, by 31/05/08.
SHETL	2008	Sloy Area	Construct Inverarnan substation (19218) 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	2008	Errochty	ELW phase shifter installation
SHETL	2008	Strathleven	Connect Ballindalloch Muir Wind Farm, Balfron, 20.8MW.
SHETL	2009	Gordonbush	Connect Gordonbush Wind, Caithness, 88MW at 275kV/33kV, by 22/2/08. Construct a renewable generation tee-in connection at Gordonbush (13129) on the 275kV line from Dounreay to Beauly.
SHETL	2009	Tealing	Install a +225/-75MVAr SVC at Tealing 275kV substation. Install 2 x 45MVAr MSCs at Tealing 132kV substation.
SHETL	2009	Overhead Line work	132 kV OHL reconductor between Inverrary/Port Ann
SHETL	2009	Mossford	Grid transformer upgrade
SHETL	2009	Overhead Line work	2nd 132kV circuit between Fort Augustus and Broadford
SHETL	2009	Overhead Line work	Killin/St Fillans 132kV reconductor
SHETL	2009	Overhead Line work	Shin/Cassley 132kV reconductor
SHETL	2009	Persley	Grid transformer upgrade
SHETL	2009	Brora	Grid transformer upgrade
SHETL	2010	Ceannacroc	Grid transformer upgrade
SHETL	2010	Fiddes	Grid transformer upgrade

SHETL	2010	Luichart	Grid transformer upgrade
SHETL	2010	Dounreay	Extend 275 kV and 132 kV busbars, and install a second 275/132 kV interbus auto-transformer, at Dounreay substation. Upgrade the existing 150 MVA interbus auto-transformer at Dounreay to 240MVA.
SHETL	2010	Errochty / Burghmuir	Connect Griffin Windfarm, near Aberfeldy, 216MW at 132kV.
SHETL	2010	Killin	Replace the existing 15MVA 132/33kV transformer with a higher rated 45MVA 132/33kV transformer.
SHETL	2010	Overhead Line Works	Beauly / Dounreay Phase 1 (2nd 275kV circuit).
SHETL	2011	Aultmore	Connect Aultmore Windfarm, 60MW at 132kV.
SHETL	2011	Ardmore	Grid transformer upgrade
SHETL	2011	Dunvegan	Grid transformer upgrade
SHETL	2011	Harris	Grid transformer upgrade
SHETL	2011	Beauly / Dounreay	Connect Strathy North & South Wind, 226MW at 275kV.
SHETL	2011	Blackhillock	Connect Berry Burn Wind, near Nairn, 82.5MW at 33kV.
SHETL	2011	Blackhillock / Kintore	Connect Clashindarroch Wind, Huntly, 113MW at 33kV.
SHETL	2011	Dunbeath	Connect Dunbeath Wind Farm, 55MW at 33kV.
SHETL	2011	Fort Augustus	Connect Glendoe Hydro, Fort Augustus, 100MW at 132kV.
SHETL	2011	Mybster	Connect Causeymire Wind (Phase 2), 7MW.
SPTL/SHETL	2011	Overhead Line 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. Replace switchgear and connections at Easterhouse and Clyde's Mill 275kV substations, and install a series reactor at Windyhill on the Windyhill-Neilston 275kV circuit.
SHETL	2011	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	2011	Fort Augustus	Connect 2 x 30MVAr shunt reactors at Fort Augustus 132kV substation.
SHETL	2011	Boat of Garten	Connect Tomatin Windfarm, 30MW at 33kV.

SHETL	2012	Brackley	Establish a new 132/33kV substation compound at Brackley Wind Farm including a twin 90MVA 132/33kV transformer arrangement. Construct two 132kV wood pole overhead lines over a route length of approximately 9km between Ardbrecknish 275/132kV substation and Brackley Wind Farm.
SHETL	2012	Braco	Connect Snowgoat Glen Windfarm, 28MW by 31/10/12.
SHETL	2012	Bridge of Dun	Connect Montreathmont Moor Wind, Angus, 40MW at 33kV.
SHETL	2012	Cruach Mor	Establish a new 132/33kV substation compound at Cruach Mor, including a two 120MVA 132/33kV transformer arrangement. Construct two 132kV wood pole overhead lines, over a route length of approximately 5km, between Ardbrecknish 275/132kV substation and Cruach Mhor.
SHETL	2012	Cruach Mor	Connect Cruach Mor Wind Farm, Inverary (90MW) at 132/33kV.
SHETL	2012	Dounreay / Kirkwall	132kV circuits.
SHETL	2012	Dunbeath	Connect Beatrice Pilot Wind, 10MW at 33kV.
SHETL	2012	Dunoon	Connect Black Craig 40MW wind farm.
SHETL	2012	Errochty / Bonnybridge	Connect Calliacher Wind (96MW) at 132kV.
SHETL	2012	Kintore / Tealing	Connect Mid Hill Wind, Stonehaven, 75MW at 275/33kV, by 31/10/12.
SHETL/SPT	2012	Kintyre	Hunterston / Crossaig subsea crossing.
SHETL	2012	Kirkwall	132/33kV substation.
SHETL	2012	Kirkwall / St Marys	132kV circuits.
SHETL	2012	Mybster	Connect Camster Windfarm, Caithness, 63MW at 33kV.
SHETL/SPT	2012	North Argyll	Establish a new 275/132kV substation at Ardbrecknish in Argyll. Connect the new substation to Dalmally 275kV substation with a new 275kV double-circuit line.
SHETL	2012	Sron Mor	Connect Shira wind farm, Sron Mor, Argyll, 75MW.
SHETL	2012	St Marys	132/33kV substation.
SHETL	2012	Stacain	Wind farm connecting at 132 kV. The connection will comprise a twin 60 MVA 132/33 kV transformer substation supplied directly from Ardbrecknish Substation.
SHETL	2012	Stacain	Connect Stacain wind farm, Sron Mor, Inverary, 42MW.
SHETL	2012	Stornoway	Connect Parc (South Lochs) Wind, Lewis, 250MW.
SHETL	2012	Dounreay	Connect Fairwind (Orkney) Ltd, 126MW at 33kV.

SHETL	2012	Western Isles	HVDC Link
SHETL	2013	Alness	Connect Novar 2 Windfarm (32MW).
SHETL	2013	Caithness	Connect North Nesting Wind, Shetland (250MW) via an HVDC link.
SHETL	2013	Fasnakyle	Additional 6MW of hydro capacity.
SHETL	2013	Mybster	Connect Stroupster Wind Farm, near Wick, Caithness (31.5MW).
SHETL	2013	Stornoway	Connect Eishken Estate, Isle of Lewis, 300MW of wind generation.
SHETL	2013	Thurso	Connect Bailllie and Bardnaheigh Wind (75MW).
SHETL	2013	Overhead Line Works	Reconductor the Beauly-Foyers-Blackhillock 275 kV double-circuit line with larger capacity conductor between Beauly and Leys, and between Leys and Blackhillock. Establish a new 275 kV switching station at Leys, at the existing Foyers line tee point.
SHETL	2013	Shetland	HVDC Link (1st link only) for North Nesting, with necessary reactive power compensation
SPT	2006	Coatbridge	Commenced installation of two 275/33kV transformers at Coatrbidge and two 275kV circuits from Newarthill to Coatbridge. Remove redundant 132/33kV transformers.
SPT	2006	Earlsburn	Connect Earlsburn Wind Farm (32.5MW) at 33kV.
SPT	2006	Eccles	Completed replacement of 132kV switchgear.
SPT	2006	Govan	Completed replacement of the 132kV gas compression cable between Govan and Haggs Road GSP's on the No.2 circuit.
SPT	2006	Govan	Replace 33kV switchgear.
SPT	2006	Neilston	Completed replacement of 132kV switchgear.
SPT	2006	Townhill	Reconfigured Longannet-Townhill 275kV and Townhill-Westfild 275kV circuits to form a Longannet-Westfield 275kV circuit.
SPT	2007	Chapelcross	Replace 132/33kV transformers T1, T2 and T3 with two 90MVA units. Replace 33kV switchgear. This will increase the fault rating at Chapelcross 33kV substation.
SPT	2007	Coatbridge	Complete installation of two 275/33kV transformers at Coatrbidge and two 275kV circuits from Newarthill to Coatbridge. Reconfigure Newarthill 275kV substation.
SPT	2007	Coylton	Replace 33kV switchgear.
SPT	2007	Crookston	Replace 132/33kV transformers T1B and T2B.
SPT	2007	Dalmarnock	Partial undergrounding of the Dalmarnock - Carntyne 132kV No.1 and No.2 circuits.

SPT	2007	Dalswinton	Connect Dalswinton Wind Farm (30MW) at 33kV.
SPT	2007	Easterhouse	Replace 33kV switchgear.
SPT	2007	Govan	Replace 132/33kV transformers T1 and T2.
SPT	2007	Greenknowes	Connect Greenknowes Wind Farm (30MW) at 33kV.
SPT	2007	Helensburgh	Refurbish 132kV Substation.
SPT	2007	Hunterston - Inverkip	Partial conductor replacement on Hunterston - Inverkip No.1 and No.2 400kV circuits. XC Route only.
SPT	2007	Hunterston - Neilston	Commence conductor replacement on Hunterston - Neilston and partial conductor replacement on Hunterston - Kilmarnock South 400kV circuits. XB Route only.
SPT	2007	Kendoon	Refurbish 132kV Substation.
SPT	2007	Minsca	Connect Minsca Wind Farm (38MW) at 33kV.
SPT	2007	Newton Stewart	Refurbish 132kV Substation.
SPT	2007	Portobello	Replace 275/33kV transformers T1A and T2A with 120MVA units.
SPT	2007	Steven's Croft	Connect Steven's Croft Biomass Generator (45MW) at 33kV and replace 33kV switchgear at Chapelcross.
SPT	2007	Whitelee	Connect Whitelee Wind Farm (322MW) at 33kV.
SPT	2007	Windyhill	Complete replacement of the 132kV gas compression cable between Windyhill and Kilbowie GSP on the No.1 circuit.
SPT	2008	Barmoor	Connect Barmoor Wind Farm (30MW) at 33kV.
SPT	2008	Berwick	Replace 30MVA 132/33kV transformer with 60MVA unit.
SPT	2008	Drone Hill	Connect Drone Hill Wind Farm (37.8MW) at 33kV.
SPT	2008	Dun Law Ext.	Connect Dun Law Extension Wind Farm (32MW) at 33kV.
SPT	2008	Dungavel	Connect Dungavel Wind Farm (44MW) at 33kV.
SPT	2008	Greenock	Connect Greenock Wind Farm (55MW) at 33kV.
SPT	2008	Harestanes	Connect Harestanes Wind Farm (CEC - 220MW, TEC 213MW) at 132kV.
SPT	2008	Hawick	Reconfigure Gretna-Hawick, Hawick-Galashiels and Gretna-Galashiels 132kV circuits.
SPT	2008	Hunterston - Neilston	Complete conductor replacement on Hunterston - Neilston and partial conductor replacement on Hunterston - Kilmarnock South 400kV circuits. XB Route only.

SPT	2008	Inverarnan	Commission substation connecting the SPT Dalmally-Windyhill 275kV circuits to the SHETL Killin to Sloy 132kV circuits.
SPT	2008	Kaimes	Complete replacement of the 275kV gas compression cables between Kaimes, Whitehouse and Dewar Place substations.
SPT	2008	Longpark	Connect Longpark Wind Farm (48MW) at 33kV.
SPT	2008	Mark Hill 275kV Substation	Establish Mark Hill 275kV substation
SPT	2008	Mark Hill	Connect Mark Hill Wind Farm (99MW) at 33kV.
SPT	2008	Moffat 400kV Substation	Establish Moffat 400kV Substation.
SPT	2008	Moffat 132kV Substation	Establish Moffat 132kV Substation.
SPT	2008	Rothes Bio-Plant	Connect Rothes Bio-Plant (52MW) at 33kV.
SPT	2008	Smeaton - Galashiels	Refurbish 132kV single circuit from Dalkeith to Galashiels. Commission 240MVA 275/132kV at Smeaton and Smeaton to Galashiels 132kV circuit.
SPT	2008	Strathaven - Harker	Commence upgrade of Strathaven - Harker route to double circuit 400kV operation.
SPT	2008	Strathaven - Harker: Coalburn	Establish Coalburn 400/132kV Substation.
SPT	2008	Strathaven - Harker: Elvanfoot	Establish Elvanfoot 400/25kV Substation. Decommission Elvanfoot 275/25kV substation.
SPT	2008	Toddleburn	Connect Toddleburn Wind Farm (36MW) at 33kV.
SPT	2008	Whitehouse	Replace 275/33kV transformers T1 and T2.
SPT	2009	Aikengall	Connect Aikengall Wind Farm (48MW) at 33kV.
SPT	2009	Mark Hill 132kV Substation	Establish Mark Hill 132kV Substation
SPT	2009	Arecleoch	Connect Arecleoch Wind Farm (150MW) at 33kV.
SPT	2009	Broadmeadows	Connect Broadmeadows Wind Farm (36MW) at 33kV.
SPT	2009	Busby	Complete refurbishment of 275kV Substation.
SPT	2009	Clyde	Connect Clyde Wind Farm (519MW) at 33kV.
SPT	2009	Crystal Rig 2	Connect Crystal Rig 2 Wind Farm (200MW) at 400kV.
SPT	2009	Devol Moor - Erskine	Commission new double circuit 132kV overhead line and remove redundant single circuit. Re-configure Erskine 132kV Substation.
SPT	2009	Devol Moor - Erskine: Braehead Park	Re configure substation to form a second Neilston/ Paisley 132kV circuit and a second Govan/ Haggs Road 132kV circuit.
SPT	2009	Devol Moor - Erskine: Erskine	Re-configure Erskine substation to form two Devol Moor-Braehead Park circuits, each with a tee-off into Erskine.
SPT	2009	Gretna	Establish 132kV overhead line from Gretna 132kV substation to Ewe Hill 132kV substation.

SPT	2009	Ewe Hill	Connect Ewe Hill Wind Farm (92MW) at 33kV.
SPT	2009	Fallago	Connect Fallago Wind Farm (180MW) at 400kV.
SPT	2009	Harrows Law	Connect Harrows Law Wind Farm (141MW) at 132kV.
SPT	2009	Newfield	Connect Newfield Wind Farm (60MW) at 33kV.
SPT	2009	Kilmarnock South - Meadowhead	Connect new Kilmarnock South - Meadowhead 132kV connection and new 240MVA 275/132kV auto-transformer at Kilmarnock South.
SPT	2009	Strathaven - Harker: Linnmill	Convert Linnmill GSP to 132/33kV.
SPT	2009	Strathaven - Harker: Gretna	Uprate Gretna to 400kV operation, completing upgrade of Strathaven-Harker route to double circuit 400kV operation.
SPT	2009	Tormywheel	Connect Tormywheel Wind Farm (32.4MW) at 33kV.
SPT	2009	Waterhead Moor	Connect Waterhead Moor Wind Farm (120MW) at 132kV.
SPT	2010	Afton	Connect Afton Wind Farm (77MW) at 33kV.
SPT	2010	Andershaw	Connect Andershaw Wind Farm (45MW) at 33kV.
SPT	2010	Auchencorth	Connect Auchencorth Wind Farm (45MW) at 33kV.
SPT	2010	Balunton	Connect Balunton Wind Farm (150MW) at 33kV.
SPT	2010	Coylton - New Cumnock	Construct 275kV overhead line and commission New Cumnock 275/132kV substation. Reconfigure Coylton 275kV Substation.
SPT	2010	Dersalloch	Connect Dersalloch Wind Farm (75MW) at 33kV.
SPT	2010	Dewar Place	Replace 275/33kV transformers SGT1 and SGT2.
SPT	2010	Earlshaugh	Connect Earlshaugh Wind Farm (108MW) at 132kV.
SPT	2010	Eccles – Stella West	Complete replacement of overhead line conductor on the Eccles – Stella West 400kV double circuit from Eccles to the NGC area.
SPT	2010	Hearthstanes B	Connect Hearthstaines B Wind Farm (87MW) at 132kV.
SPT	2010	Kyle	Connect Kyle Wind Farm (300MW) at 132kV.
SPT	2010	Limmer Hill	Connect Limmer Hill Wind Farm (80MW) at 33kV.
SPT	2010	Neilston	Connect Neilston Wind Farm (100MW) at 132kV.
SPT	2010	Pencloe	Connect Pencloe Wind Farm (63MW) at 33kV.
SPT	2010	Tongland	Replace 90MVA 132kV quad-booster with a unit of higher rating.
SPT	2010	Ulzieside	Connect Ulzieside Wind Farm (69MW) at 33kV.
SPT	2010	Whiteside Hill 132kV 'Collector' Substation	Establish Whiteside Hill 132kV 'Collector' Substation.
SPT	2010	Whiteside Hill	Connect Whiteside Hill Wind Farm (27MW) at 33kV.

SPT	2010	Windy Standard II 132kV 'Collector' Substation	Establish Windy Standard 132kV 'Collector' Substation.
SPT	2010	Windy Standard II	Connect Windy Standard II Wind Farm (60MW) at 33kV.
SPT	2011	Beauly - Denny: Clyde's Mill and Easterhouse	Replace 275kV switchgear to uprate the Longannet – Clyde's Mill and Longannet - Easterhouse 275kV circuits.
SPT	2011	Beauly - Denny: Denny North	Construct Denny North 400/275kV substation and associated infrastructure to connect 400kV tower line from the SHETL area.
SPT	2011	Beauly - Denny: Windyhill	Commission series reactor on Windyhill – Neilston 275kV circuit.
SPT	2012	Dalmally	Reconfigure Dalmally 275kV Substation and replace overhead line conductor between Dalmally and Windyhill 275kV substations.
SPT	2012	Denny North	Reconfigure the Windyhill – Lambhill – Longannet 275kV circuit to Windyhill – Lambhill – Denny North and Denny North - Longannet No.2 275kV circuits.
SPT	2012	Denny North and Kincardine	Commission one 275kV 150MVAr MSC at Denny North and two 275kV 150MVAr MSC's at Kincardine.
SPT	2012	Kincardine	Replace overhead line conductor and 275kV switchgear to uprate the Kincardine – Grangemouth 275kV circuit.
SPT	2013	Garple 132kV Substation	Establish Garple 132kV Substation and Garple - Blackcraig 132kV overhead line.
SPT	2013	Blackcraig	Connect Blackcraig Wind Farm (71MW) at 33kV.
SPT	2013	Carscreugh	Connect Carscreugh Wind Farm (21MW) at 33kV.
SPT	2013	Currie	Replace overhead line conductor and 275kV switchgear to uprate the Currie - Kaimes 275kV circuit.
SPT	2013	Galloway 132kV Network	Upgrade the Galloway 132kV network to facilitate proposed wind farm connections.
SPT	2013	Margree	Connect Margree Wind Farm (180MW) at 33kV.
NGET	2006	Beddington	Install a new (2nd) 150MVAr MSC at Beddington 275kV substation.
NGET	2006	Braintree	Install an additional SGT by 31/10/06.
NGET	2006	Burwell	Reconfigure Burwell 400kV and 132kV substations.
NGET	2006	Cowley	Install a new SGT.
NGET	2006	East Claydon	Install a new (1st) 225MVAr MSC at East Claydon 400kV substation.
NGET	2006	Feckenham	Install a new 180MVA, 400/66kV transformer, SGT9 by 31/03/06. Install a new 180MVA, 400/66kV transformer, SGT7 by 31/10/06.

NGET	2006	Frodsham	Remove the 275kV switchgear and mesh substation at Frodsham, and construct a double tee-point for the circuits to Frodsham 132kV by 31/12/06.
NGET	2006	Grendon	Install a two new (1st and 2nd) 225MVAr MSCs at Grendon 400kV substation.
NGET	2006	Hams Hall	Install a new (2nd) 225MVAr MSC at Hams Hall 400kV substation.
NGET	2006	Harker	Connect two new 400/26.25-0-26.25kV traction transformers rated at 80/40/40MVA, by 30/10/06.
NGET	2006	Heysham	Connect the new 140MW Heysham offshore windfarm at Heysham 132kV.
NGET	2006	Iron Acton	Install a new 240MVA, 275/132kV, transformer SGT5, and two line circuit breakers on the Whitson No. 1 circuit, by 31/07/06.
NGET	2006	Lackenby	Install two new 400kV circuit breakers at Lackenby 400kV substation to be used as an SGT feeder and a bus coupler. Install a new 1100MVA 400/275kV SGT (SGT7) and modify the 275kV connections to Lackenby 275kV substation and Greystones 'A' and 'B' 275kV substations using cables.
NGET	2006	Monk Fryston	Unbank the Ferrybridge and Bradford West 275kV circuits.
NGET	2006	Overhead Line Works	Refurbish the Chickerell-Mannington 1 & 2 400kV circuits.
NGET	2006	Penwortham	Remove the existing 275/132kV transformer SGT2A connected to Penwortham East 132kV. Install a new 240MVA, 400/132kV transformers SGT10 at Penwortham 400kV. Connect the new transformer to Penwortham East 132kV using a new cables of length 0.7km, by 31/10/06. Bank the existing 400/275kV transformers SGT5 and SGT7 together at 275kV. Connect the existing 275/132kV transformer SGT2B to the banked SGT5 and SGT7, and to the Washway Farm-Kirkby 275kV no. 1 circuit. Bank the existing 400/275kV transformers SGT6 and SGT8 together at 275kV. Connect the existing 275/132kV transformer SGT1B to the banked SGT6 and SGT8, and to the Washway Farm-Kirkby 275kV no. 2 circuit.
NGET	2006	St. Johns Wood	Divert the 132kV St Johns Wood-Mill Hill cables into a temporary 132kV EDF switchboard.
NGET	2006	Seabank	Connect SGT4, a new 400/132kV, 240MVA transformer, by 31/10/06.
NGET	2006	Wilton	Increase TEC from 0MW to 38MW.
NGET	2006	Wymondley	Install a new (1st) 225MVAr MSC at Wymondley 400kV substation.

NGET	2007	Beddington	Relocate the two Rowdown 400/275kV transformers to Beddington 275kV substation. Remove the two existing Beddington - Rowdown 275kV cable circuits. Retain the existing 400kV cable circuit between Beddington and Rowdown.
NGET	2007	Blyth	Install two new (1st and 2nd) MSCs at Blyth 275kV substation.
NGET	2007	Cellarhead	Install a 5th SGT, SGT10, a 400/132kV, 240MVA transformer at Cellarhead 400kV substation, for completion by 31/10/07. A 2nd 132kV coupler is also to be installed at Cellarhead 132kV substation.
NGET	2007	City Road	Extend the exising 400kV GIS substation at City Road to enable a section 6 to be installed. Loop in the St Johns Wood-City Road no. 2 circuit into the new 400kV section 6. Install a new (6th) 400/132kV, 240MVA transformer. Work to complete by 31/10/07.
NGET	2007	Dungeness	Planned closure of Dungeness A Nuclear Magnox station (440MW).
NGET	2007	Grendon	Install a new (3rd) 225MVAr MSC at Grendon 400kV substation.
NGET	2007	Harker	Install a new (1st) 150MVAr MSC at Harker 275kV substation.
NGET	2007	Hendon	By 31/10/07, install new 275/132kV 240MVA SGT unit at Elstree. Install approximately 12km of 132kV cable to a new 132kV switch bay connected to EDFs new 132kV GIS substation at Hendon (new GSP) to connect to the Hendon/Mill Hill demand group.
NGET	2007	Kingsnorth	Install a new 2000MVA Series Reactor at Kingsnorth 400kV substation.
NGET	2007	Knaresborough	Establish new substation at Knaresborough with 2 new 240MVA 275/132kV transformers. Uprate a length of 132kV circuit from Knaresborough to near Bramham to 275kV operation, and construct 4km of new line to connect to the Monk Fryston-Poppleton 275kV circuit, by 31/12/07.
NGET	2007	Littlebrook	Replace SGT3 and SGT4A in the Hurst-Littlebrook circuits with two new 950MVA units.
NGET	2007	Ninfield	Install new SGT by 31/12/07.
NGET	2007	Pembroke	Connect 800MW of new CCGT capacity (Pembroke 1 stage 1) at Pembroke 400kV substation for RWE Npower plc.
NGET	2007	Rayleigh	Install new 400/132kV SGT (SGT3) at Rayleigh connecting to a new 132kV GIS substation located at Rayleigh Main.
NGET	2007	Redbridge	By 31/10/07, install a new 275/33kV 180MVA SGT4 unit. Install an automatic switching scheme at the site.

NGET	2007	Sizewell	Planned closure of Sizewell A Nuclear Magnox station (458MW).
NGET	2007	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 850MW of CCGT capacity (Langage stage 1) to the new substation.
NGET	2007	Penwortham	Remove the existing 275/132kV transformer SGT3A connected to Penwortham East 132kV. Install a new 240MVA, 400/132kV transformer SGT11 at Penwortham 400kV. Connect the new transformer to Penwortham East 132kV using a new cable of length 0.7km, by 30/11/07.
NGET	2007	St. Johns Wood 66kV (Lodge Road)	Install a new 400/66kV SGT9B circuit at St Johns Wood connecting to a new Lodge Road 66kV substation. Divert 275/66kV SGT2A into a new 66kV switchbay via new 66kV cables.
NGET	2007	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, as a temporary turn-in. 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	2007	Wilton	Increase TEC from 38MW to 50MW.
NGET	2007	Wymondley	Install a new (2nd) 225MVAr MSC at Wymondley 400kV substation.
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, by 31/10/07.
NGET	2008	Bramley	Install two new (5th and 6th) 400/132kV, 240MVA SGT's.
NGET	2008	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	2008	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	2008	Drakelow	Connect a new 1230MW CCGT power station at Drakelow 400kV substation.
NGET	2008	East Claydon	Install a new (2nd) 225MVAr MSCDN at East Claydon 400kV substation.

NGET	2008	Enderby	Install a new 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	Frodsham	Install two new 80MVA 400/25kV two-phase transformers.
NGET	2008	Harker	Install a new (1st) 225MVAr MSC at Harker 400kV substation.
NGET	2008	Hutton	Connect two new 400/26.25-0-26.25kV traction transformers rated at 80/40/40MVA.
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	Kemsley	Install 2 new 2750MVA QBs at Kemsley on the Kemsley/Canterbury North route. Upgrade 3 existing circuit breakers at Kemsley 400kV to enable solid operation of the substation.
NGET	2008	Lister Drive	Install a fourth 240MVA, 275/132kV transformer at Lister Drive, by 31/05/08.
NGET/SPT	2009	Overhead Line Works	Uprate the Harker-Gretna-Strathaven 275kV circuit to 400kV operation.
NGET	2009	Overhead Line Works	Reconductor the Kingsnorth-Northfleet East and Northfleet East-Singlewell 400kV circuits with GAP-type conductor.
NGET	2009	Rhigos	Connect 299MW of wind generation.
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	Oldbury	Planned closure of Oldbury Nuclear Magnox station (470MW).
NGET	2008	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	2008	Overhead Line Works	Reconductor the Canterbury North-Kemsley 1 & 2 400kV circuits.

NGET	2008	Pembroke	Connect a further 1200MW of new CCGT capacity (Pembroke 1 stage 2) at Pembroke 400kV substation for RWE Npower plc.
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 South. 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	2008	Sizewell	Connect Geater Gabbard Offshore Windfarm (500MW) by 31/10/08 at Sizewell.
NGET	2008	Staythorpe	Connect 425MW of new CCGT generation (Staythorpe Stage 1) at Staythorpe 400kV substation by 31/10/08.
NGET	2008	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	2008	Walpole	Extend the busbars at Walpole 400kV substation, and connect a new generator bay.
NGET	2008	Walpole	Connect Lincs offshore windfarm (250MW) at Walpole 400kV substation by 09/07/08.
NGET	2008	West Burton	Return the temporary turn-in at West Burton to a Keadby-Spalding North 400kV circuit.
NGET	2009	Bramford	Turn in the Pelham-Sizewell 400kV circuit at Bramford to form Pelham-Bramford and Bramford-Sizewell 400kV circuits. Install a new (5th) 400/132kV, 240MVA SGT at Bramford.

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.
NGET	2009	Grain	Connect 0MW of HVDC link capacity (Netherlands Interconnector Stage 1).
NGET	2009	Grendon	Install a new (4th) 225MVAr MSC at Grendon 400kV substation.
NGET	2009	High Marnham	Replace the disconnectors at High Marnham 400kV substation to achieve a rating of 2210MVA.
NGET	2009	Mannington	By 31/10/09, install a new additional 400/132kV 240MVA transformer at Mannington substation.
NGET	2009	Neepsend	Install a new, 900MVA 275kV series reactor (9% impedance on rating) at Neepsend 275kV substation in the Neepsend-Stocksbridge 275kV circuit.
NGET	2009	Hackney	Install three new 400/132kV transformers (SGT3, SGT4 and SGT5) 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 no. 2 circuit, uprating the Hackney-West Ham route to form a new Hackney-West Ham 400kV no. 2 circuit, and install a new 400/275kV SGT (SGT7) at Hackney to connect to the existing Hackney-Tottenham 275kV no. 1 circuit.
NGET	2009	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	2009	Overhead Line Works	Increase the thermal rating of the West Burton-Grendon, Cottam-Staythorpe 2 and Staythorpe-Grendon 400kV circuits, by increasing the operating temperature to 85C. Hotwire the Deeside-Treuddyn tee 400kV 1 & 2 circuits for 90C operation.
NGET	2009	Rhigos	Construct a new 400kV 6-bay double-busbar substation at Rhigos, including a bus coupler circuit breaker. Connect the Cilfynydd-Pembroke no. 2 circuit into the new 400kV substation, creating the Cilfynydd-Rhigos and Pembroke-Rhigos no. 1 400kV circuits. Connect the Pembroke-Walham circuit into the new 400kV substation, creating the Rhigos-Walham and Pembroke-Rhigos no. 2 400kV circuits.
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	Saltend North	Construct a new five-bay GIS switchboard (including a bus coupler) at Saltend North 275kV substation. Turn one of the existing Creyke Beck-Saltend North 275kV circuits into the new switchboard.

NGET	2009	Transmission Works	Install a second cable per phase on the Ross-on-Wye cable sections of the Rhigos-Walham and Rassau-Walham 400kV double circuit. Construct a new 400kV Severn Crossing to increase the capacity of the Cilfynydd-Whitson-Seabank and Imperial Park-Melksham 400kV circuits. Divert the existing 275kV Severn crossing circuit through the vacated 400kV cable tunnel to increase the capacity of the Whitson-Iron Acton 275kV double circuit.
NGET	2009	Underground Cable Works	Remove the Medway tunnel cable rating limitation on the Grain-Kemsley circuits by improved cooling.
NGET	2009	Uskmouth	Connect the 425MW Uskmouth 2 Stage 1 CCGT at Uskmouth 275kV by 31/10/09.
NGET	2009	Uskmouth	Connect 425MW of new CCGT generation (Severn Power Stage 1) at Uskmouth 275kV by 31/10/09.
NGET	2009	Walpole	Extend the busbars at Walpole 400kV substation, and connect a new generator bay. Equip the 2nd 400kV section breaker at Walpole.
NGET	2009	Walpole	Connect Docking Shoal offshore windfarm (500MW) at Walpole 400kV substation by 31/07/09.
NGET	2010	Beddington	Add a second 400kV cable circuit from Rowdown to Beddington
NGET	2010	Blyth	Construct a new 400kV substation at Blyth. Connect the new substation into the Stella West-Eccles 400kV double circuit by installing two new 400/275kV transformers and by constructing a double tee-point. Connect the new 400kV Blyth substation to the new double tee-point on the Stella West-Eccles 400kV 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	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 and two new (1st and 2nd) 225MVAr MSCDNs at Bramford 400kV substation.
NGET	2010	Coventry	Install a new (1st) 150MVAr MSCDNs at Coventry 275kV substation.
NGET	2010	Cleve Hill	Connect 200MW of offshore wind generation (London Array stage 1) at the new Cleve Hill 400kV substation by 27/06/10. Connect a further 800MW of offshore wind generation (London Array stage 2) at the new Cleve Hill 400kV substation by 31/10/10.
NGET	2010	Feckenham	Install a two new (1st and 2nd) 225MVAr MSCs at Feckenham 400kV substation. Install a new (1st) 150MVAr MSC at Feckenham 275kV substation.

NGET	2010	Grain	At Grain 400kV substation, increase the capacity of the HVDC link capacity to the Netherlands to 800MW import/1390MW export by 01/04/10.
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	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, replace the 5 existing OHBR140 400kV circuit breakers associated with bus section switches and reactor connections, with new 63kA rated units.
NGET	2010	Hackney	Loop-in the new Hackney 400kV substation into the existing Tottenham-Hackney-West Ham no. 1 circuit, 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.
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	Hillhouse	Construct a new 400kV AIS double-busbar substation at Hillhouse, including two skeletal generator bays. Construct a new 400kV double-circuit route from Stanah 400/132kV substation to Hillhouse (approximately 1.5km). Replace the two existing 400/132kV SGTs with new SGTs at Hillhouse. Install two 132kV cables from Hillhouse to the existing United Utilities Stanah 132kV substation.
NGET	2010	Hillhouse	Connect the new Walney Offshore Wind Farm (450MW) at Hillhouse 400kV substation by 31st October 2010.
NGET	2010	Keadby	Replace circuit breakers X405 and X210 with 4000A duty 63kA fault rated switchgear at Keadby 400kV substation.
NGET	2010	Langage	Connect the remaining 400MW (stage 2) of the new Langage CCGT power station.
NGET	2010	North Hyde	Install two additional 275/66kV, 240MVA SGTs, by 31/10/10.
NGET	2010	Norwich	Install a new (1st) 225MVAr MSCDN at Norwich 400kV substation.

NGET	2010	Overhead Line Works	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	Overhead Line Works	Hot-wire the Drax-Thornton double-circuit route for 75C operation.
NGET	2010	Overhead Line Works	Reconductor the Cottam-Keadby 400kV double-circuit route with Matthew (GAP) conductor.
NGET/SPT	2010	Overhead Line Works	Reconductor the Stella West-Eccles 400kV double-circuit route with 3x700mm2.
NGET	2010	Pembroke	Connect 400MW of new CCGT capacity (Pembroke 2 stage 1) at Pembroke 400kV substation for Milford Power Ltd.
NGET	2010	Penwortham	Install quadrature boosters at Penwortham 400kV substation, to be connected in series with the Penwortham-Daines and Penwortham-Padiham 400kV circuits.
NGET	2010	Overhead Line Works	Up-rate 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	2010	Overhead Line Works	Turn the Grain-Tilbury-Coryton and Kingsnorth-Tilbury-Rayleigh 400kV circuits into a new 400kV, 7-bay double-busbar substation at Tilbury. Connect the new substation to 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. Connect into West Thurrock 400kV substation as installed under the works to connect the Britned Interconnector capacity in 2010. Install two new 400/33kV SGTs at West Thurrock.

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	Staythorpe	Connect 425MW of new CCGT generation (Staythorpe Stage 2) at Staythorpe 400kV substation by 31/10/10.
NGET	2010	Stoke Bardolph	Establish a new Grid Supply Point at Stoke Bardolph, near Nottingham, by 31/10/10. Construct a new 400kV substation at Stoke Bardolph, including two new 400/132kV, 240MVA transformers. Turn the High Marnham-Ratcliffe on Soar 400kV circuit into the new substation to form High Marnham-Stoke Bardolph and Stoke Bardolph-Ratcliffe on Soar 400kV circuits.
NGET	2010	Sundon	Install three new (2nd, 3rd and 4th) 225MVAr MSC's at Sundon 400kV substation.
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 Race Bank offshore windfarm (500MW) at Walpole 400kV substation by 01/07/10.
NGET	2010	Walpole	Connect the new Sutton Bridge B (1305MW) CCGT at Walpole 400kV substation by 31/10/10.
NGET	2010	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	2010	West Burton	Connect the new West Burton B Stage 1 (435MW) CCGT at West Burton 400kV substation by 31/10/10.
NGET	2013	Margam	Connect Prenergy Woodchip Power Station, 295MW.

NGET	2010	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	Willington East	Install a new (2nd) 225MVAr MSC at Willington East 400kV substation.
NGET	2010	Wylfa	Planned closure of Wylfa Nuclear Magnox station (TEC = 980MW).
NGET	2010	Wymondley	Turn the Sundon-Pelham 400kV circuit into Wymondley 400kV substation to form Sundon-Wymondley and Wymondley-Pelham 400kV circuits. Install an additional 400kV section breaker and an additional 400kV bus coupler. Relocate the existing Pelham 400kV circuit at Wymondley.
NGET	2011	Grain	Connect 430MW of gas-fired generation for the re-powering of Unit 4 at Grain. The TEC increase of 430MW brings the total TEC of Grain power station to 2645MW.
NGET	2011	Grain	Connect a new 7-bay GIS extension to the existing 400kV GIS substation section at Grain, constructed for the connection of the Britned Interconnector. Connect a new bus section switch between Section 4 and Section 5 of Grain 400kV substation.
NGET	2011	Harker	Install a new (2nd) 225MVAr MSC at Harker 400kV substation.
NGET	2011	Kingsnorth	Install a new 400kV 2-switch bay reactor tie at Kingsnorth, re-utilising the former Reactor 1 at Grain.
NGET	2011	Overhead Line Works	Carry out thermal upratings on the Pembroke-Swansea North 400kV 1, 2, 3 & 4 circuits, Swansea North-Cilfynydd 400kV 1, 2 and 3 circuits, and Baglan Bay-Margam 275kV circuit.
NGET	2011	Pembroke	At Pembroke 400kV substation, double up the three bus section and two bus coupler circuit breaker bays. Extend the 400kV busbars to accommodate five new generator bays. Replace all 400kV feeder circuit breakers and line protections.
NGET	2011	Pembroke	Connect a further 1600MW of new CCGT capacity (Pembroke 2 stage 2) at Pembroke 400kV substation for Milford Power Ltd.
NGET	2011	Swansea North	Construct a new 400kV substation at Swansea North. Turn the Pembroke-Cilfynydd and Pembroke-Rhigos 1 & 2 400kV circuits into the new substation. This forms Pembroke-Swansea North 1, 2, 3 & 4, Swansea North-Cilfynydd 1 & 2, and Swansea North-Rhigos 1 & 2 400kV circuits.

NGET	2011	Underground Cable Works	Increase the rating of cable sections of the Rayleigh-Tilbury-Kingsnorth and Grain-Tilbury-Coryton 400kV circuits under the Tilbury estuary, by installation of a cable oil oscillation system.
NGET	2011	West Burton	Connect the new West Burton B Stage 2 (870MW) CCGT at West Burton 400kV substation by 31/10/11.
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	Eaton Socon	Extend section 1 main and reserve busbars to allow connection of a generator bay. Connect 475MW of new CCGT generation (Little Barford B) by 13/04/12.
NGET	2012	Elstree	Install a new quadrature booster.
NGET	2012	Enderby	Install two new (3rd and 4th) 225MVAr MSCs at Enderby 400kV substation.
NGET	2012	Heysham	Connect 500MW of offshore wind generation (West of Duddon Sands) at Heysham 400kV.
NGET	2012	Overhead Line Works	Reconductor the Cellarhead-Macclesfield and Cellarhead-Daines 400kV overhead line circuits with 2 x 620mm² GZTACSR GAP conductor.
NGET	2012	Pelham	Install two new (1st and 2nd) 225MVAr MSCs at Pelham 400kV substation.
NGET	2012	Staythorpe	Connect 850MW of new CCGT generation (Staythorpe Stage 3) at Staythorpe 400kV substation by 31/10/12.
NGET	2012	Whitegate	Install a 150MVAr MSC at Whitegate 275kV substation.
NGET	2012	Wymondley	Install two new (3rd and 4th) 225MVAr MSCs at Wymondley 400kV substation.
NGET	2012	Heysham	Extend Heysham 400kV substation to provide a new skeletal generation bay. Install a new section switch in the main bar and rebuild one of the existing section switches to accommodate the extension. Install a new GIS reserve bus section breaker, including two new isolators, at Heysham 400kV substation.

NGET	2012	Overhead Line Works	Uprate the 275kV circuits between Kirkby and Penwortham to 400kV operation. Replace the two 275/132kV 180MVA SGTs at Washway Farm with 400/132kV 240MVA units. Replace other 275kV substation assets at Washway Farm with 400kV equipment. Remove the 400/275kV transformers at Penwortham and rationalise the remaining 275kV assets. Construct a new 400/275kV banking compound at Kirkby. Install 4 x 1000MVA 400/275kV transformers, of which one will be an existing Penwortham unit. Install a quadrature booster at Lister Drive 275kV substation, to be connected in series with the Birkenhead-Lister Drive 275kV circuit.
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 onstructing a new 400kV double-circuit underground cable of length approximately 1km.
NGET	2013	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	2013	Transmission Works	Refurbish sections of the VE route on the Margam-Pyle and Baglan Bay-Swansea North 275kV circuits, including cable sections on each circuit at Baglan Bay and Pyle. Hotwire the following circuits: Pyle-Cowbridge 1 & 2 275kV, Iron Acton-Whitson 1 & 2 275kV, Swansea North-Cilfynydd 1 & 3 400kV, Swansea North-Rhigos 1 & 2 400kV, Rhigos-Cilfynydd and Rhigos-Walham 400kV.

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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