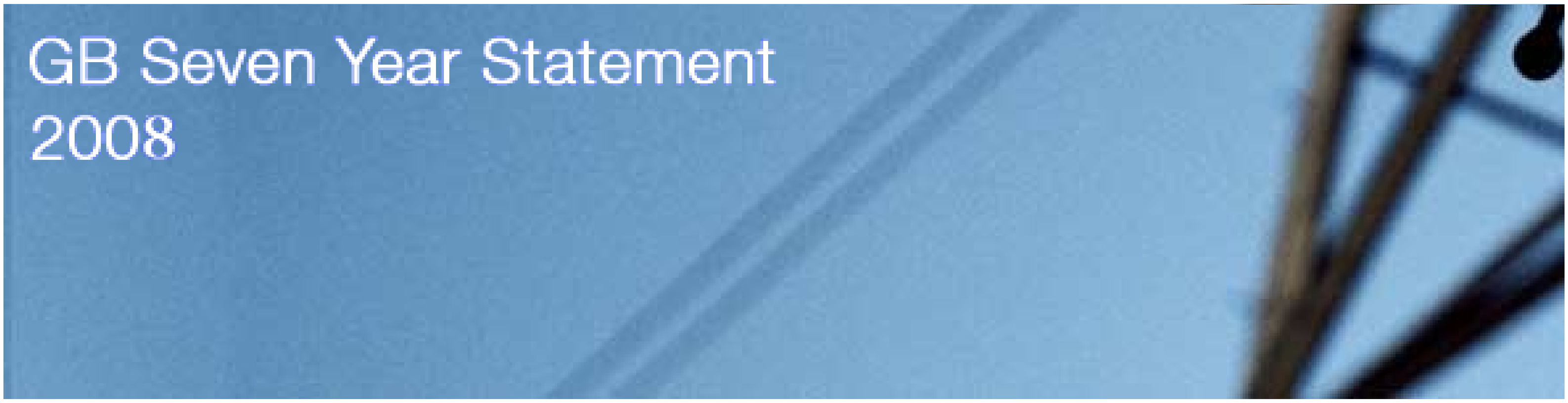
nationalgrid



Introduction to Chapter 7

GB Transmission System described the existing and planned transmission network in terms of its components and structure. This chapter describes the performance of the existing and planned transmission network in terms of:

(i) circuit capacities;

(ii) system power flows;

(iii) grid supply point loadings;

(iv) short circuit currents (single phase and three phase); and

(v) system and zonal power losses.

The reader is reminded that, as explained in Scope on the GB transmission system, the 'SYS background' does not necessarily contain all transmission reinforcement schemes which may in the event be required for compliance with the Licence Standard. GB Transmission System Capability identifies only those reinforcement schemes judged to be necessary to ensure that the transmission system is compliant for the SYS background (see Table 8.2). Additional reinforcements to those in Table 8.2 may in the event also be required.

It is useful at this point to explain, in simple terms, the difference between circuit capacity, loading and boundary capability.

The capacity or rating of a circuit is the maximum loading which may be permitted to flow on that circuit under specific conditions (e.g. ambient/seasonal temperature).

The loading on a circuit is the actual or forecast power flow on that circuit resulting from a given set of conditions (e.g. the demand level and the generating plant used in meeting the demand).

The capability of a boundary is the maximum transfer across the boundary that can be tolerated for the particular background of demand and generation under consideration without breaching security criteria. This means that following 'secured events' such as fault outages of transmission circuits, there are, inter alia, no overloaded items of transmission equipment or unacceptable voltages, and all demand is supplied (save as permitted by specific demand connection criteria). The precise criteria are defined in Licence Standard, which is more fully referred to as the GB Security and Quality of Supply Standard (GB SQSS). Compliance with the standard is a condition of the Transmission Licence.

Circuit capacities and loadings are reported in this chapter. Boundary capabilities are reported in GB Transmission System Capability.

Again, as with the previous chapter, many of the figures discussed in this chapter have been included in the Figures and only referenced in the text.

Circuit Capacities

Table B.2.1a for SHETL, Table B.2.1b for SPT and Table B.2.1c for NGET show, inter alia, the post fault continuous ratings (in MVA) of all the circuits of the main interconnected GB transmission system for each season of the year.

Bases of Power Flow Analyses

Overview

The power flows presented in this chapter are based on the SYS background and the Planned Transfer Condition.

The SYS background includes:

(a) the customer based forecast unrestricted ACS Peak GB Demand on the GB transmission System, which is given in Table 2.1 (essentially row 3);

(b) generation selected from a ranking order based on the existing and proposed new generation for which an appropriate Bilateral Agreement is in place. This generation is presented and discussed in Chapter 3. The techniques for selecting which generation is used to meet the demand are described below; and

(c) the existing transmission network and those planned future transmission developments which have been technically and financially sanctioned by the relevant Transmission Licensee. This is described in Chapter 6.

The demand forecasts used in the power flow analyses include transmission losses ACS Peak GB Demand . For the purpose of illustrating the general power flows throughout the system, these losses are effectively apportioned uniformly across Grid Supply Points through the application of the correction factor described in Customer Demand Data. However, where greater accuracy is required for determining the need for local transmission reinforcements, we would more accurately calculate the losses particular to that local zone.

The forecast unrestricted ACS Peak GB Demand given in Table 2.1 is presented on several bases and it is clearly important that the appropriate basis is selected for use in power flow analyses. The demand stream given in row 3 of Table 2.1 treats exports from Scotland to Northern Ireland across the Moyle interconnection have been treated as demand and is also net of station demand. This latter point recognises that the value of power station TEC is used for power system analyses. TEC is net of any auxiliary demand supplied through the station transformers (station demand) and, consequently, the ACS Peak Demand used is also net of station demand.

Please note, however, that for the presentational purposes of the generation ranking order of operation given in Table 7.1 , which is presented and discussed later in this chapter, exports across the Moyle interconnector have been treated as negative generation. This is compatible with the demand stream given in line 5 of Table 2.1, which also is net of station demand.

For illustrative purposes, a useful reference system condition on which to base studies is the Planned Transfer Condition. The Planned Transfer Condition is defined in the Licence Standard. The following paragraphs outline how the techniques for modelling the Planned Transfer, which are set out in the Licence Standard, have been applied for the purposes of this Statement.

Modelling of the Planned Transfer Condition

Appendix C of the Licence Standard sets out how the Planned Transfer Condition should be modelled. For this purpose, two techniques are described, namely: the Ranking Order Technique (to be applied when the plant margin exceeds 20%); and the Straight Scaling Technique (to be applied when the plant margin is 20% or less).

It should be noted, however, that the License Standard definition of Plant Margin differs from the definition given in Chapter 5, which is used for the more general purposes of this Statement.

The Licence Standard (i.e. the GB Transmission System “Security and Quality of Supply Standard”) 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".

The basic difference between the two definitions lies in the fact that, the Licence Standard definition treats imports as negative demand but the SYS definition, used in Chapter 5, treats imports as generation. Whilst the Plant Margin in MW terms remains the same, in percentage terms the SYS margins are lower than would be the case using the Licence Standard definition. Please note that, whilst the wording of the SYS definition of Plant Margin does not mention exports to External Systems, it is implicit that such exports should be treated as positive demand.

The overall process for modelling the planned transfer may be regarded as being made up of the following three parts, the first two of which concern the ranking order technique and the third is obviously concerned with the straight scaling technique. The three parts are:

- Ranking the relevant generating units in order of their relative likelihood of operation at peak;
- Identifying which plant is most likely to be contributing towards meeting the peak demand; and finally
- Applying the straight scaling technique.

<u>Ranking Plant in Order of Likelihood of Operation at Peak</u>

This part of the process can be further subdivided into:

- treatment of imports and exports across External Interconnections;
- ordering (i.e. placing the generating units into a ranking order of likely operation); and
- limiting the output attributed to each unit in the ranking order such that station TEC is not exceeded.

<u>External Interconnections:</u>

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. 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 Plant Margin.

However, when ranking generating plant in order of likelihood of operation at peak, the level of imports and exports across External Interconnections is subject to special treatment. That treatment recognizes that, notwithstanding the export capability (as expressed in Table 3.12), the expected actual level of exports and imports is, itself, a function of the prevailing plant/demand balance.

In brief, the methodology employed is to first calculate the margin of installed generation over demand 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 these two Interconnectors for the peak of each year. For margins up to and including a nominal 20%, the full import capability is assumed. For margins of 40% or over, the full export capability 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 in the generation ranking order of operation presented in Table 7.1. This approach differs from the methodology used to evaluate Plant Margins which, amongst other things, treats imports as positive generation and exports as positive demand in accordance with the definition of Plant Margin.

A particular result of the application of the above methodology is that, for the purpose of ranking plant in order of likelihood of operation at peak, 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.

Ordering:

A list is compiled of all relevant generating units in the "SYS Background". The level of imports and/or exports across External Interconnections as derived from application of the methodology outlined in the previous section, are added to the list.

The term Transmission Entry Capacity (TEC) is defined and used solely on a power station basis and does not exist on a generating unit basis. In view of this, each generating unit on the list is attributed with the appropriate Registered Capacity (RC) and each power station is attributed with the appropriate TEC, correct as at the "data freeze date".

All generating units, imports and/or exports are then arranged in order of their perceived likelihood of operation at the time of the ACS Peak GB Demand. For existing generation, this is achieved by inspection of the unit operation experienced over previous winter periods, which are taken as being from the beginning of December to the end of January. In general, if the unit operated at the daily peak it is attribute a score of "1" whether operated at full or part load. If the unit did not operate it is attributed a score of "0". Scores for each unit are then aggregated to give the "probability of running" for each unit. A high probability of running would mean that the relevant unit is ranked as having a high likelihood of operation over the coming winter peaks and vice versa.

However, the above represents a general rule and, rather than strict adherence, the rule is applied in a pragmatic way. That is, the results of its application are tempered by judgement based market intelligence. Accordingly, a particular plant with a low score may be moved up the ranking if market intelligence suggests this to be the more likely outcome or vice versa.

Future plant is ranked according to plant type. Future plant is likely to achieve a relatively high ranking given that it likely to be modern and efficient unless the particular plant is designed to operate at base load only.

Limiting Aggregate Unit Output to Station TEC:

Ordering the generating units, as described above, may result in generating units at the same power station being placed in widely differing positions in the ranking order. The aggregate of the unit RCs at each power station is then limited to the station TEC. This is achieved by progressively accumulating the unit RC of each station in the ranking order and comparing the aggregate with the relevant station TEC. If and when the cumulative RC equals or exceeds station TEC, then the RC of subsequent, as yet unselected, units at that station are set to zero. This goes some way towards emulating whole set modelling. In cases where the aggregate of the unit RC at a station needs to be reduced by less than a whole set, that reduction is spread proportionately across all selected units at the station (i.e. units higher in the ranking order) unless a reduction in a GT unit can accommodate the difference between aggregated RC and TEC. At this point in the process, all plant has an assumed 100% availability.

The resultant ranking order of generation operation, with each power station output limited to the appropriate TEC, is given in Table 7.1.

As a point of interest, Figure 7.1(a), Figure 7.1(b), Figure 7.1(c) and Figure 7.1(d) indicate how generation was actually used to meet demand on each of the four days referred to in Figure 2.2 of Chapter 2. These are the winter maximum (Monday, 17/12/07), typical winter (Wednesday, 16/01/08), typical summer (Wednesday, 20/06/07) and summer minimum (Sunday, 29/07/07) respectively.

Figure 7.1(a)

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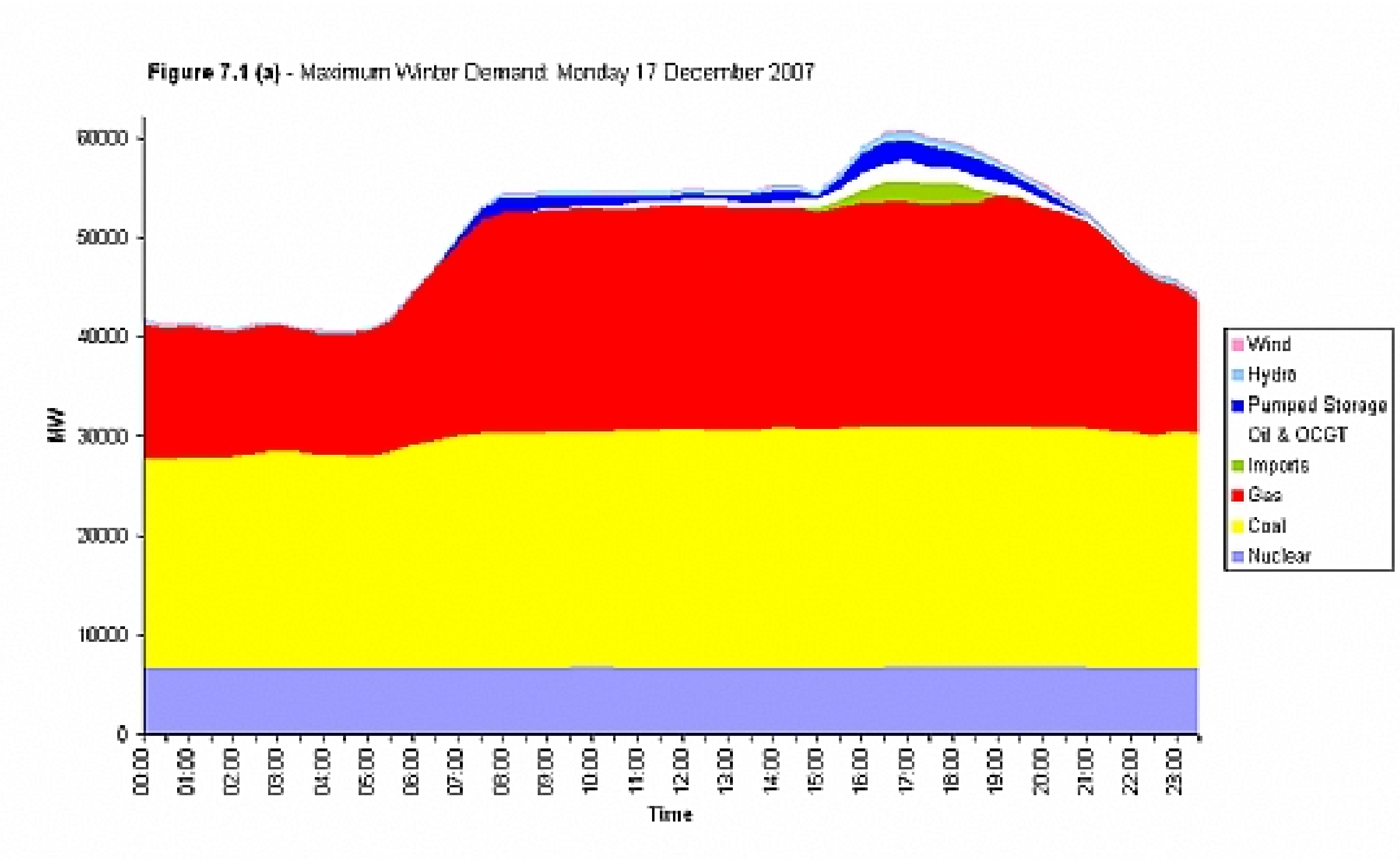

Figure 7.1(b)

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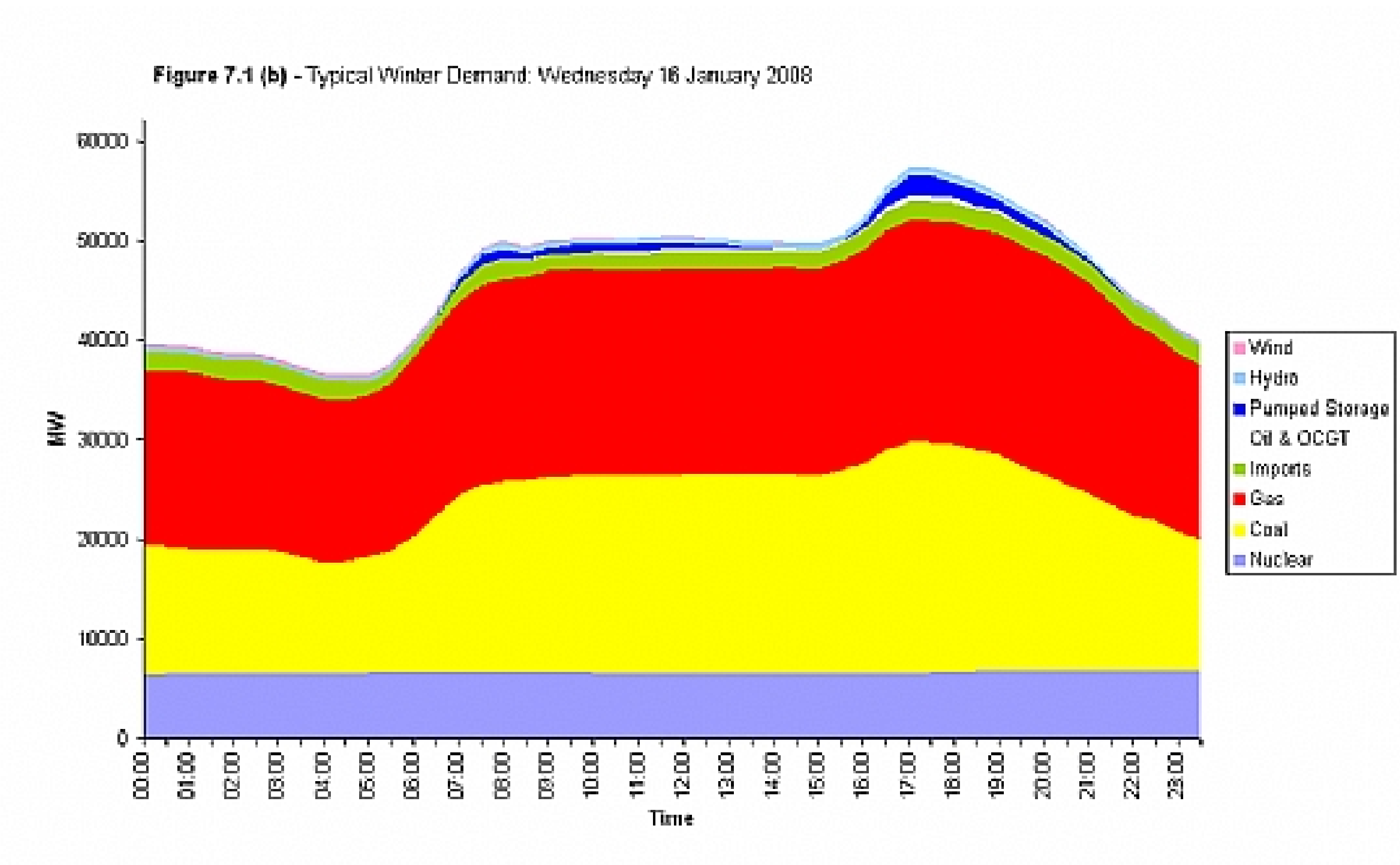

Figure 7.1(c)

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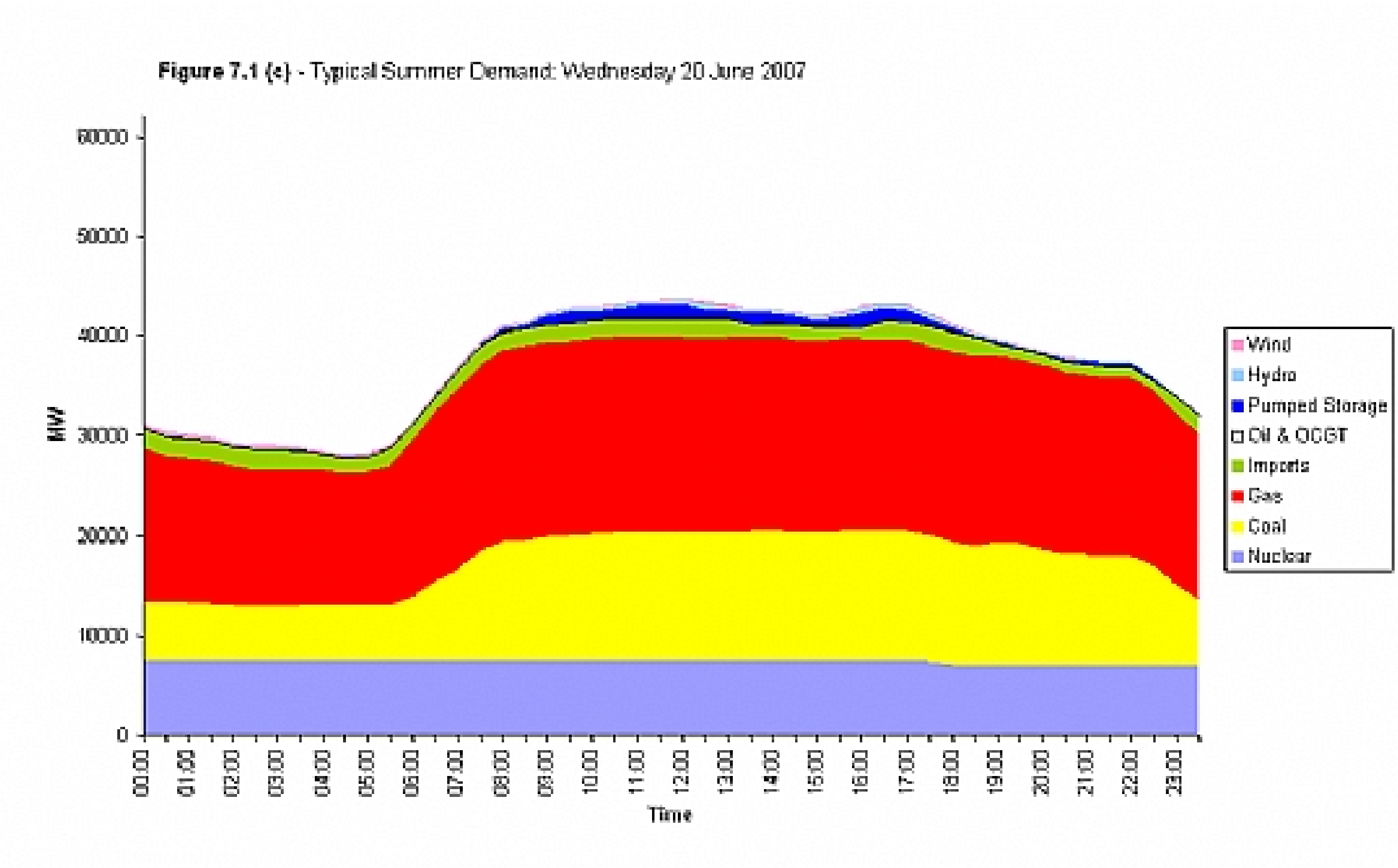

Figure 7.1(d)

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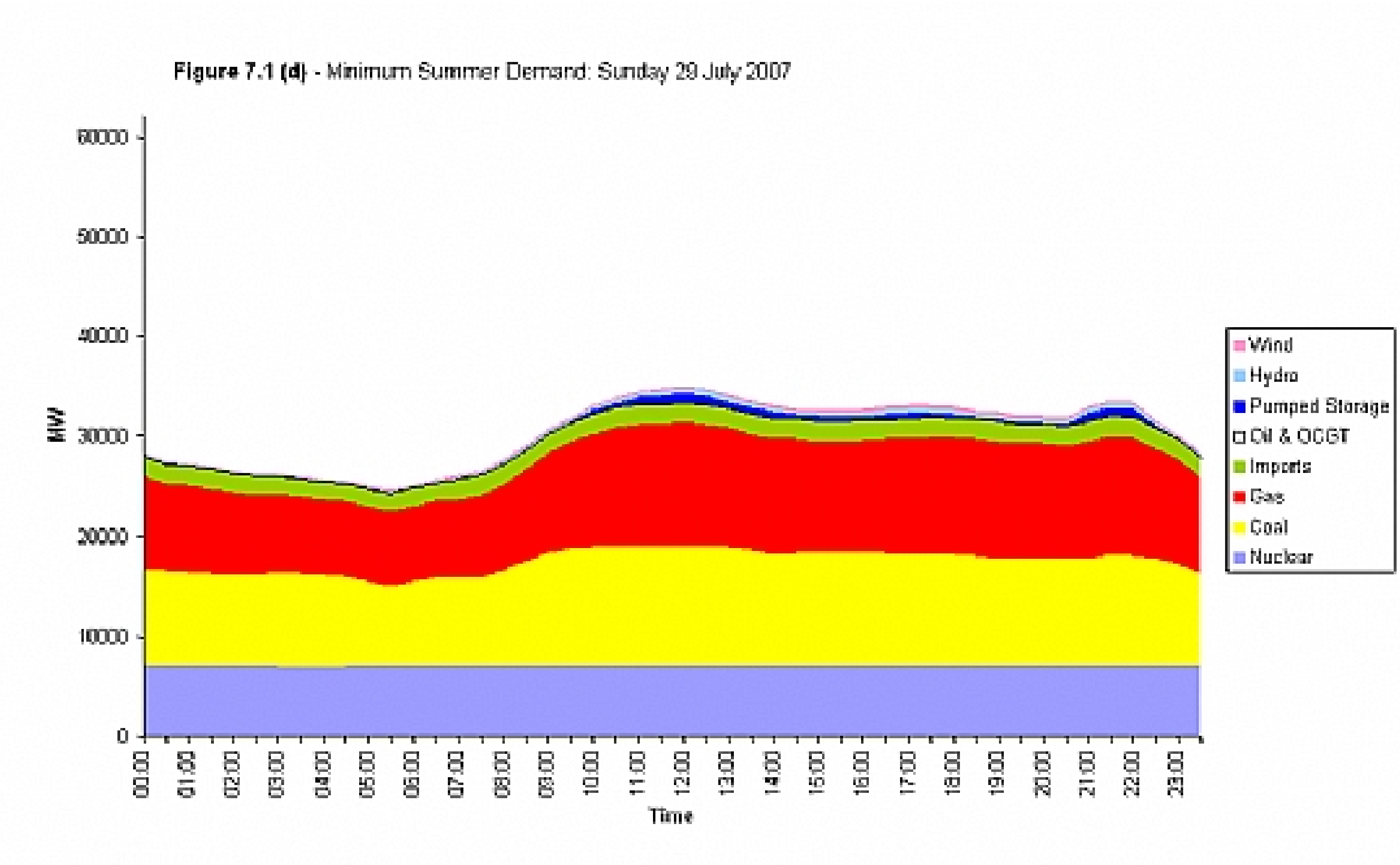

The same information is given in pie chart form in Figure 7.2(a), Figure 7.2(b), Figure 7.2(c) and Figure 7.2(d).

Figure 7.2(a)

Click to load a larger version of Figure7.2(a) image

Figure 7.2 (a) - Total Energy Supplied over Day of Maximum Winter Demand: Monday 17 December 2007

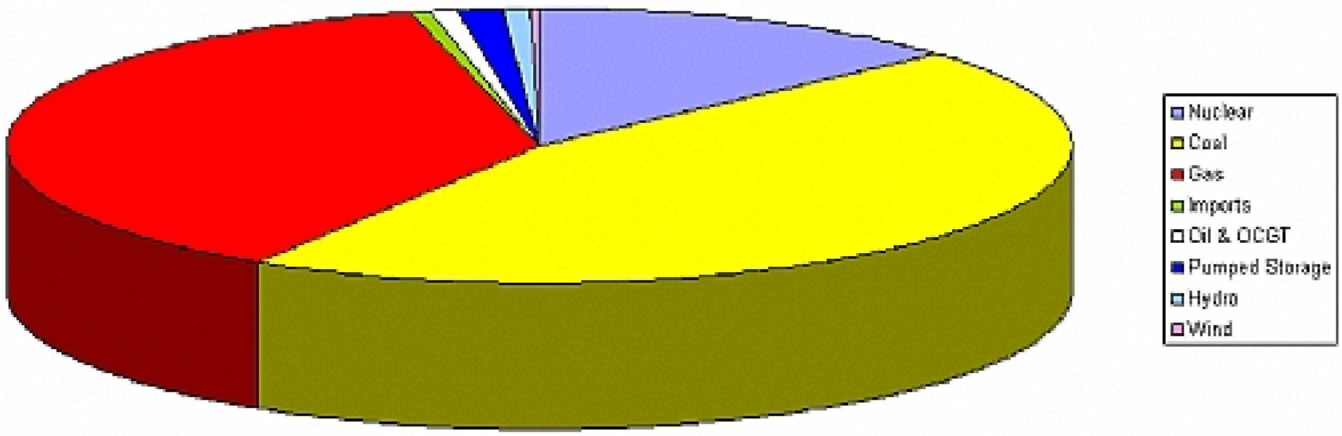

Figure 7.2(b)

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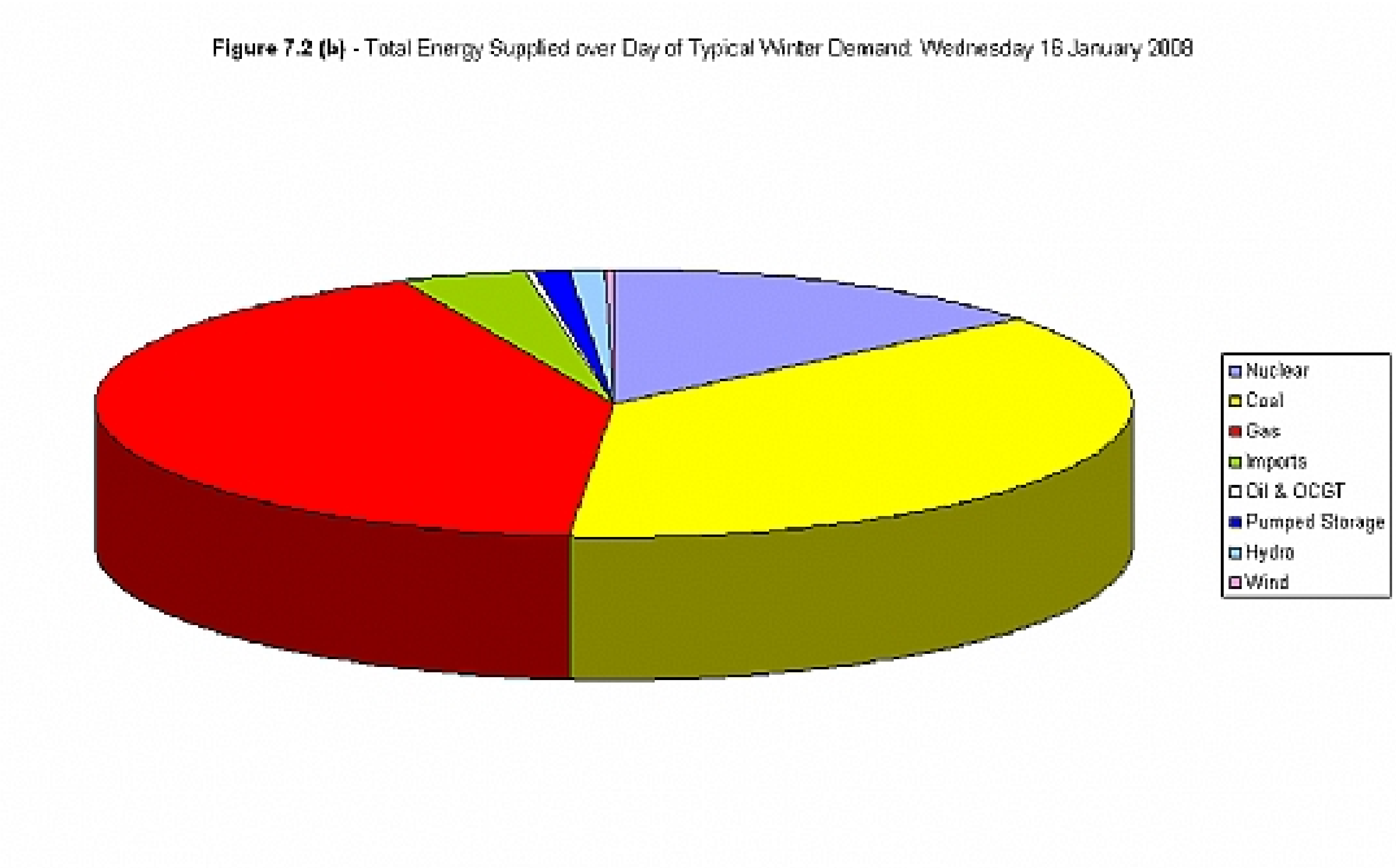

Figure 7.2(c)

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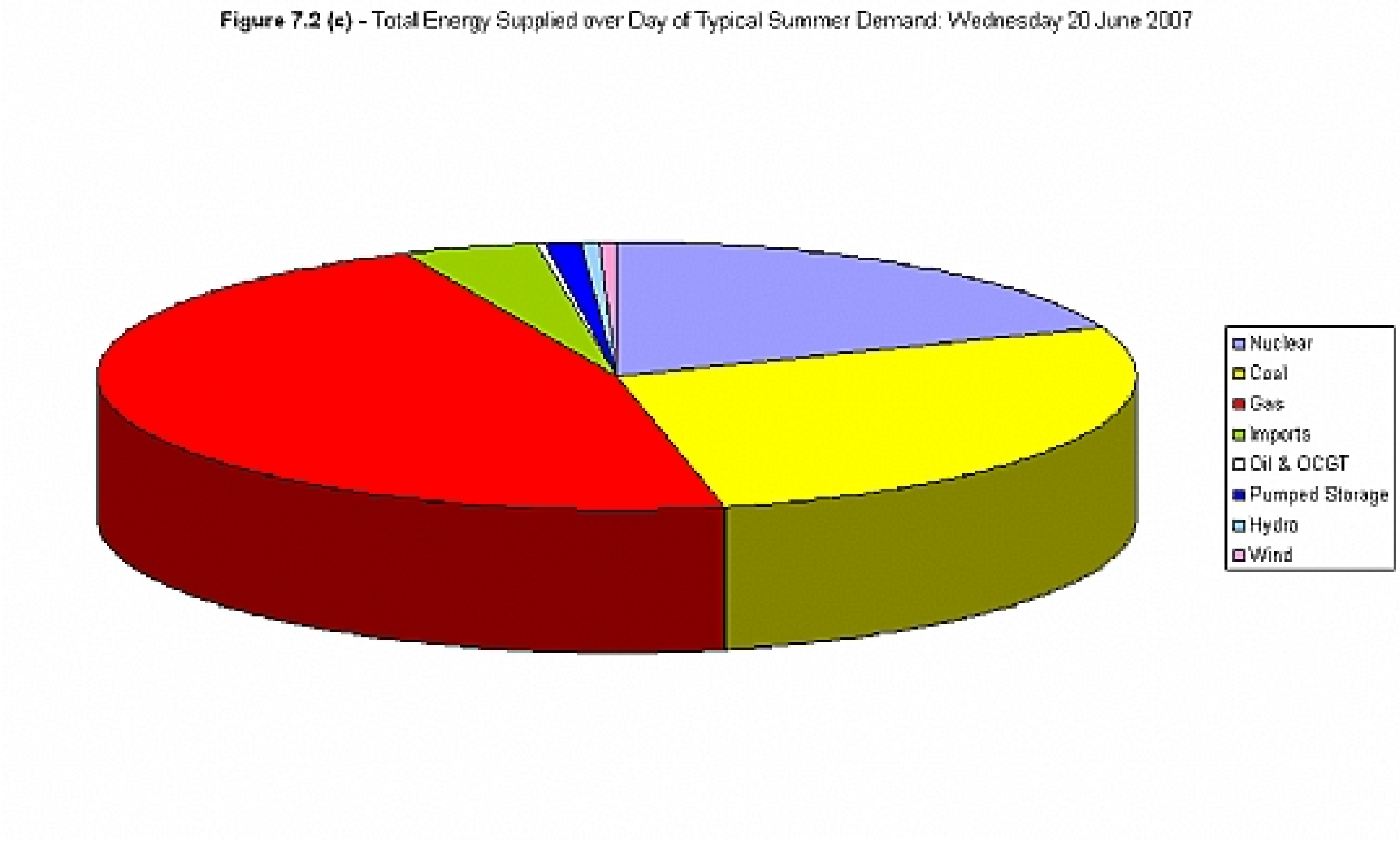

Figure 7.2(d)

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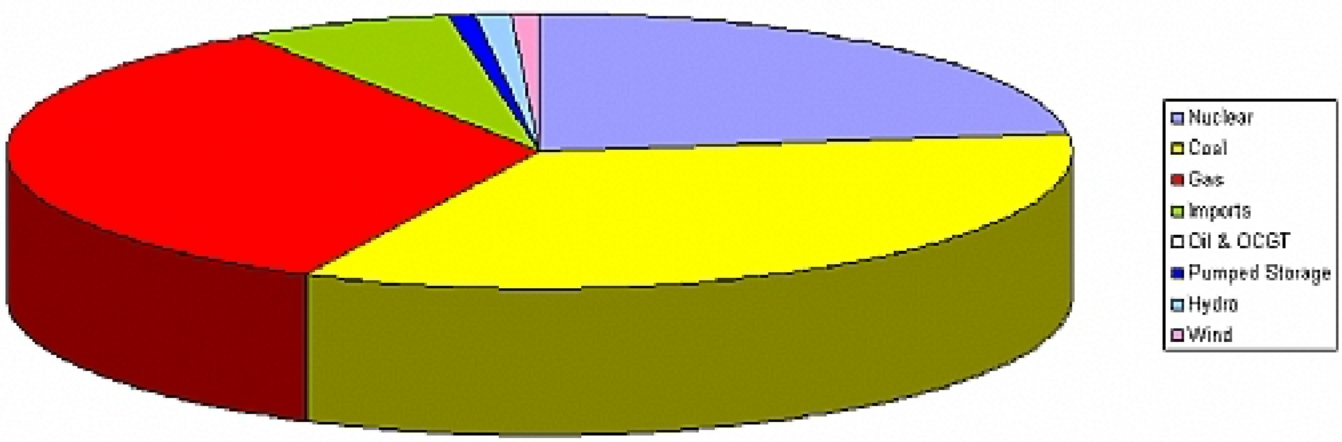
Figure 7.2 (d) - Total Energy Supplied over Day of Minimum Summer Demand: Sunday 29 July 2007



Identification of Contributory and Non - Contributory Plant

This part of the process is concerned with identifying that generating plant which is most likely to operate at the time of system peak in a climate where plant margins exceed 20%.

For analysing the performance of the transmission system at the time of winter peak, the load factor over the winter peak period becomes relevant. Experience shows that this is in the region of 90% and 36% for conventional and wind based generation respectively. These figures translate into assumed winter peak availabilities of 100% and 40% for conventional and wind based generation capacity respectively.

Accordingly, in establishing which plant, in the ranking order of Table 7.1, is to be regarded in this Statement as contributory and which is to be regarded non-contributory, the cumulative system generation capacity to be compared with demand in the calculation of plant margin has been taken as 100% of the capacity of each conventional generator and 40% of that of each wind farm.

The lower ranking plant in the ranking order is then progressively removed and treated as non-contributory, until a Plant Margin of just 20% is achieved. It is worth reiterating that the Plant Margin referred to is as defined for the purpose of the Licence Standard.

The result of the above ranking order technique, which is used only if the plant margin exceeds 20%, is a list of contributory plant, with unit outputs, which sum to equal 120% of (unrestricted "ACS Peak GB Demand" less Station Demand). The full capacities of all the contributory generation is used as the initial basis for system studies.

Application of the Straight Scaling Technique

The straight scaling technique is applied when the plant margin, as defined in the Licence Standard, is equal to or less than (although still positive) 20%. Accordingly, the straight scaling technique is applied following application of the ranking order technique or otherwise straight away when the plant margin is already 20% or less.

The straight scaling technique, which is set out in the Licence Standard, involves the application of scaling factors ‘A’ and ‘S’. The ‘A factors’ relate to the expected availability of each generating plant type at the time of the peak. The ‘S factors’ relate to the ratio between the system demand to be met and the total generation capacity available. Under the technique, the generation output, for study purposes, of all contributory plant is calculated for the ‘planned transfer condition’ by applying 'A' and 'S' scaling factors to their capacities such that the aggregate effective generation of all contributory plant is equal to the forecast peak demand plus transmission losses less imports from external systems.

In recognition of their different characteristics and use, specific values of the ‘A factors’, which relate to expected generating plant availability, defined in the Licence Standard may be used for thermal, hydro and wind generation. The values are chosen in order that the ‘required transfer capability’ , which is simply the sum of the ‘planned transfer’ and the appropriate ‘interconnection allowance’, will represent approximately the same percentile of the actual distribution of power transfers at time of peak demand whether the background includes wind or hydro generation or not. In the power system analyses, which underlie the power flows and capabilities presented in this Statement, the following values were used: 100% for thermal; 100% for hydro; and 72% for wind.

Imports from External Systems are not subject to scaling. According to the Licence Standard definition of Plant Margin, imports from External Systems are deducted from the demand to be met and Exports to External Systems form part of the demand to be met.

Overview of Main Power Flows at Peak

Power flows on the SHETL network for each of the seven years from 2008/ 09 to 2014/15 are illustrated in the following series of figures: Figure C.1.1 ; Figure C.1.2 ; Figure C.1.3 ; Figure C.1.4 ; Figure C.1.5 ; Figure C.1.6 ; and Figure C.1.7.

Power flows on the SPT network for each of the seven years from 2008/09 to 2014/15 are illustrated in the following series of figures: Figure C.2.1 ; Figure C.2.2 ; Figure C.2.3 ; Figure C.2.4 ; Figure C.2.5 ; Figure C.2.6 and Figure C.2.7.

Power flows on the NGET network for each of the seven years from 2008/09 to 2014/15 are illustrated in the following series of figures: Figure C.3.1; Figure C.3.2 ; Figure C.3.3 ; Figure C.3.4 ; Figure C.3.5 ; Figure C.3.6 and Figure C.3.7.

While the complex power flow program used computes nodal voltage, phase angles and both real and reactive power flows on the system only the real (MW) power flows have been displayed on the figures, both for ease of presentation and for clarity.

The requirements placed on the transmission system depend on the size and geographical/ system location of generation and demand.

SYS Boundaries and SYS Study Zones introduced the 17 SYS boundaries which are used for the purpose of illustrating system performance, illustrating the need or otherwise for transmission system reinforcement and for describing opportunities. These boundaries encompass the 17 SYS Study Zones.

Table 7.2 and Table 7.3 summarise the Planned Transfers, under the SYS background, for each of the 17 SYS Study Zones and across each of the 17 SYS boundaries respectively. Please note that, unlike the generation ranking order of Table 7.1 which treats the exports from Scotland to Northern Ireland across the Moyle interconnector as negative generation, Table 7.2 and Table 7.3 treat such exports as demand, which is in line with Table 2.1 of Electricity Demand.

There is a slight difference in the values of summated demand, which appear towards the foot of Table 7.2 compared with the demand forecast of row 3 of Table 2.1 . This is due to the fact that the system losses included in the forecasts of Table 2.1 reflect estimates made at the time of formulating the forecasts whereas Tables 7.2 and 7.3 (and the power flow analyses presented in this chapter) include calculated system losses derived from the system analyses.

In general terms, the disposition of demand and generation across the GB transmission system is such that much of the generation capacity is located in or towards the northern parts of the system while much of the demand is located in the southern parts of the system. As a consequence, the resultant power broadly flows from the northern parts to the southern parts of the system, particularly at times of the GB system peak.

The capacity of transmission contracted generation is set to rise by some 30.2GW over the period 2008/09 to 2014/15 (Table 3.5 refers). Amongst other things, Generation Disposition described the disposition of this future plant. In broad terms 6.1GW will be located in Scotland, 5.2GW in the north of England and 4.2GW in the midlands with the remaining 14.7GW south of the midlands to south boundary. However, these figures do not include the prospective growth of embedded generation; particularly in wind farms. This receives some consideration in Embedded and Renewable Generation.

The year on year fluctuations in planned transfer, displayed in Table 7.2 and Table 7.3, are not only a function of changes in demand and installed generation disposition, but also of the changing contributory plant disposition. Generation Disposition reports that, the forecast disposition of contributory generation and ACS demand across the system is such that, against the SYS background, the high power transfers at times of peak demand from the, northern parts of the system to the southern parts, are expected to persist.

Under the 'SYS background' the export from Scotland into England (i.e. across Boundary 6) displays a more or less steady increase over the period. Most 'North to South' boundaries display a similar trend, which is partly a product of the northern location of much of contracted renewable energy developments. Small perturbations reflect the changing 'in merit' generating plant.

The increase in import into the Southwest Peninsula is arrested during a period due to new generation scheduled to connect in that part of the network while the demand in London displays a steady growth resulting in a gradual increased London import over the period.

Figure 7.3 and Figure 7.4 illustrate the broad power flow pattern for 2008/09 and 2014/15 respectively. The capability of the GB transmission system to transport these levels of power transfer across system boundaries is the subject of Transmission System Capability. Amongst other things, that chapter explains that in considering boundary transfers and capabilities and the possible need for additional reinforcement it is important to take account of the requirements of the planning criteria in the Licence Standard. In particular, planning criteria relating to the main interconnected transmission system require that a margin for security (i.e. the interconnection allowance) should be allowed for.

Figure 7.3

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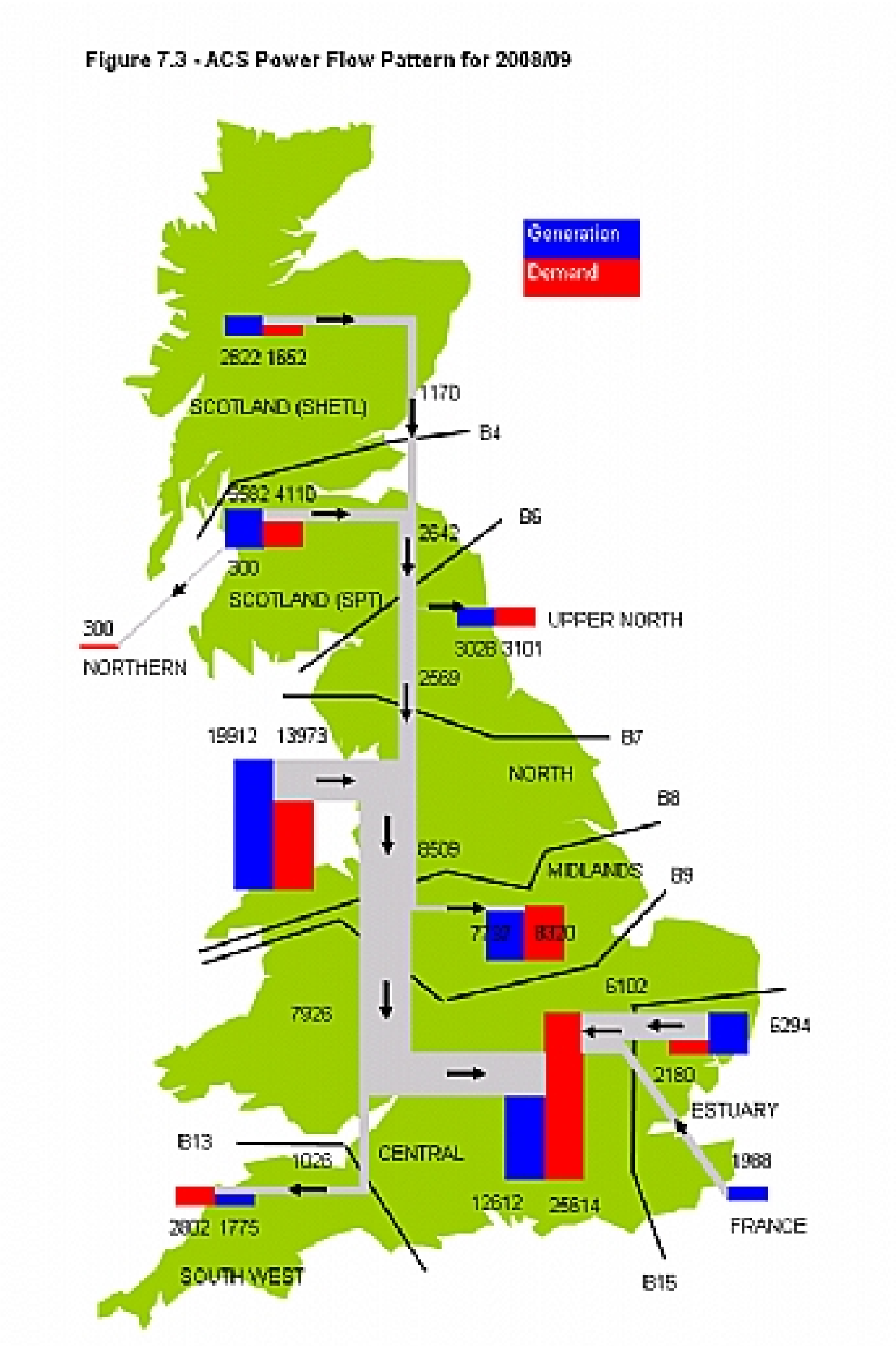
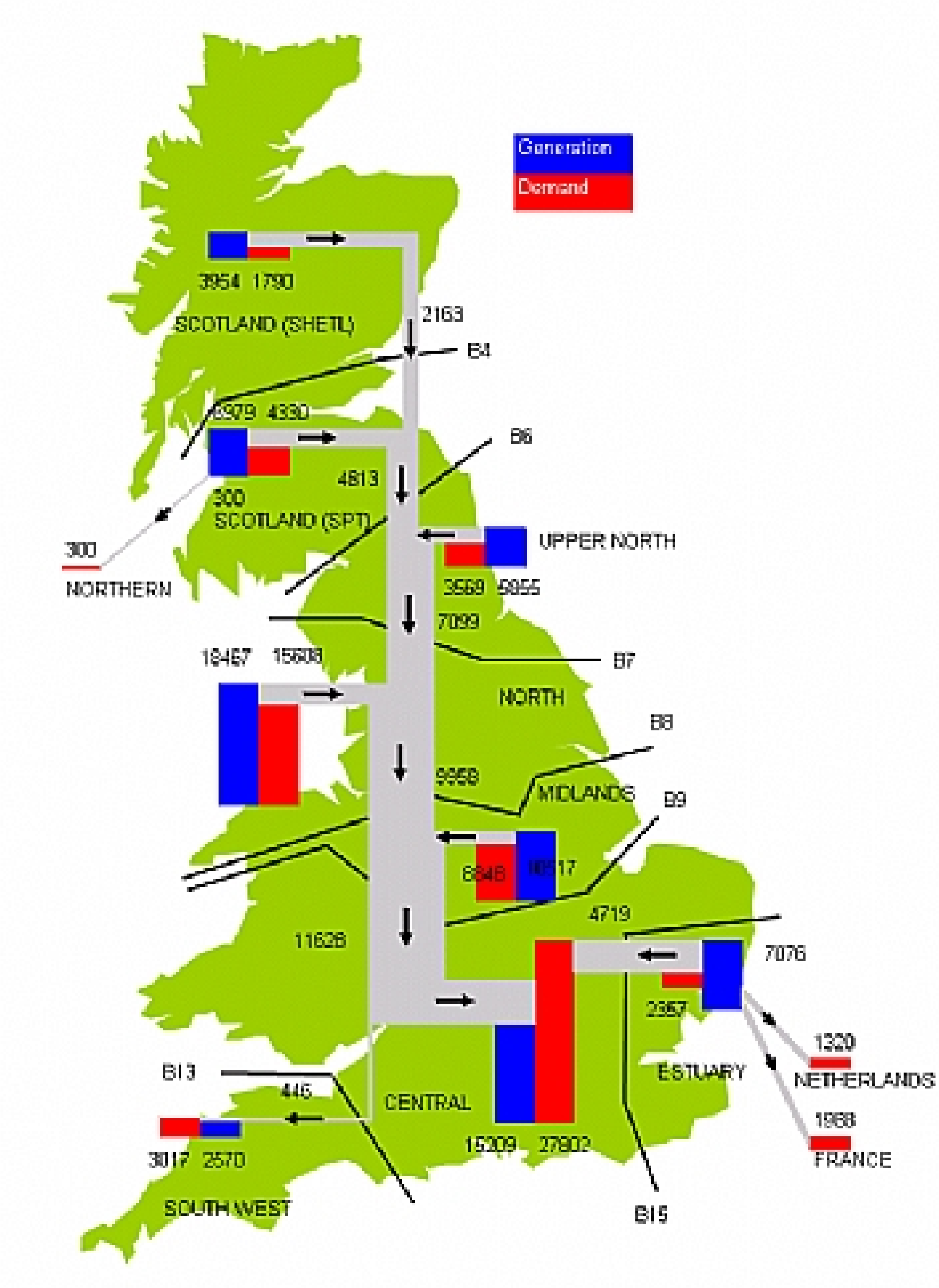


Figure 7.3 - ACS Power Flow Pattern for 2008/09

Figure 7. 4

Click to load a larger version of Figure7. 4 image

Figure 7.4 - ACS Power Flow Pattern for 2014/15



The outturn power flows at the peak of any year may differ from those given in Table 7.2 , Table 7.3, Figure 7.3 , Figure 7.4, and the series of figures included in Appendix C for a number of reasons. These include:

- the generation capacity and location may easily differ due to the decommissioning of plant, the addition of new plant, transmission contracted plant not being constructed, the non availability of particular generating units and of course a different ranking order of operation being used;
- the demand level and disposition may differ from that forecast. The level may easily differ by ± 1GW (± 2%) due to the temperature on the day of peak differing from that of Average Cold Spell;
- the unplanned (fault) outage of transmission circuits. A number of supergrid circuits may be out of service at any given time due to fault breakdown. Power flows in the neighbourhood of such circuit outages may be markedly affected; and
- the planned outage of transmission circuits for urgent maintenance, although such outages are more likely to be arranged for the summer months when demand and circuit loadings are lower.

There are clearly a great many variables, which will influence the outturn power flow. However, whilst the power flows displayed in the various tables and figures of this chapter may not be experienced in practice, they are nevertheless indicative of the flows to be expected under the SYS background. Power flows, transmission capabilities and the possible need for further transmission reinforcement based on our current view of a more likely outturn than the SYS background are discussed in GB Transmission System Capability.

Off-Peak Power Flows

At off-peak times less generation capacity is needed to meet the reduced demand and only the higher plant in the ranking order is used within the limits of system constraints. Thus the power flows around the system and circuit loadings not only change as a result of the lower demand levels but also because of the changes in the contributory generation disposition.

Transmission circuit thermal ratings reduce outside the winter period and, in addition, the system may become depleted due to transmission circuits and generation units being taken out of service for planned maintenance and other reasons. Maintenance practices on our system generally results in a boundary made up of about eight circuits being continuously depleted by one or other of its circuits between the months of April and October.

The net result is that both circuit loadings and boundary capabilities will vary at off-peak times according to prevailing conditions. They may be either higher or lower relative to the peak period. In view of the many variables associated with the real-time operation of the system, it is not a worthwhile exercise to present a rigorous analysis of possible future off-peak power flows and capabilities in this Statement.

In the real time phase of operation the system is managed such that it complies with the operational criteria in our Licence Standard. In applying this standard, which is aimed at ensuring the required level of security and quality of supply, prevailing conditions are taken into account. Power transfers around the system are managed such that, amongst other things, circuit loadings would remain within their rating and boundary transfers within their capability and no unacceptable conditions will arise even with specified circuit fault outages on top of any maintenance outages.

Grid Supply Point Loading

It was explained in Demand on the Grid Supply Points that Grid Supply Points (GSPs) are the points of connection between the GB transmission system, distribution networks, Large power stations and other Non-Embedded Customers where we deliver electricity.

The loading on a GSP is the demand on the lower voltage (LV) side less the output of any Large power station connected to the LV side or embedded within the distribution system fed from that point. An allowance for the output from embedded Medium and Small power stations is already included in the users' demand estimates as explained in Customer Demand Data.

For the SYS background, the GSP net loading is the difference between the flows into and out of that GSP. Such power flows are shown in the series of power flow figures included in Appendix C. This GSP loading is net of any generation at that point. A more direct and detailed indication of GSP loading at maximum demand is given in the series of tables presented in Appendix E.

It was also explained in Customer Demand Data that, for infrastructure planning, the demand at the time of the GB system peak is used. These forecasts of demand at the time of system peak underlie the customer based demand forecast of Table 2.1 and the series of power flow figures included in Appendix C. For GSP planning, the demand at the GSP peak is more appropriate. This demand is used, together with appropriate allowances for embedded Large power stations, in the application of the criteria for design of demand connections in the Licence Standard.

Short Circuit Currents

Engineering Recommendation G74 defines a computer based method for the calculation of short circuit currents and has been registered under the Restrictive Trade Practices Act (1976) by the Energy Networks Association (ENA), formerly the Electricity Association, and the associated Statutory Instrument has been signed to this effect.

Three phase to earth and single phase to earth short circuit current analyses have been conducted by each Transmission Licensee (SHETL, SPT and NGET), in respect of their own Transmission Areas, in accordance with ER G74. The series of tables presented in Appendix D, list the results of these analyses. To assist the reader in understanding the results, the next section of this chapter explains some of the salient points relating to the short circuit calculations including assumptions made and terminology used.

Tables B.6a to B.6c list the types of circuit breakers currently found at SHETL, SPT and NGET substations respectively together with their ratings (the NGET ratings are given for 400kV and 275kV voltage levels only). From this list it can be seen that several substations have a mixture of circuit breakers installed and this results in a range of ratings for those substations. Generally the substation infrastructure will have a similar rating to the associated circuit breaker.

The listed ratings should be regarded as indicative and therefore used as a general guide only. Should a customer require more detailed information relating to a specific site he may contact us as described in Further Information.

Furthermore, although the short circuit duties at a node may at times exceed the rating of the installed switchgear, the switchgear may still not be overstressed for one or more of the following reasons:

- the topology of the substation is such that the switchgear is not subjected to the full fault current from all of the infeeds connected to that node. This is the case for feeder/transformer circuit breakers and mesh circuit breakers under normal operating conditions;
- switchgear is only subjected to excessive fault current when sections of busbar are unselected. This is the case for busbar coupler/section circuit breakers. On these occasions the substation can usually be temporarily re-switched or segregated to reduce the fault level; or
- re-certification of switchgear or modifications to its system is already in hand that will remove the overstressing.

Finally, please also note that, as explained in Network Parameters, substation running arrangements are subject to variation. The running arrangements used for determining the short circuit currents presented in Appendix D may, in some cases, differ slightly from those presented elsewhere in this Statement.

Engineering Recommendation G74

International Standard IEC909, "Short-Circuit Current Calculation In Three Phase AC Systems" was issued in 1988 and has subsequently been published as British Standard BS7639. When IEC909 was issued the Electricity Supply Industry had no standard method or uniform methodology for fault level calculation. The hand calculation methodology detailed in IEC909 was considered conservative for the UK supply system and it was believed that its application could lead to excessive investment. In consideration of this potential excessive investment, an industry wide working group was established in 1990 to define "good industry practice" for the calculation of short circuit currents.

The resulting document, Engineering Recommendation G74 (ER G74), defines a computer based method for calculation of short circuit currents which is more accurate than the methodology detailed in IEC909 and, as a consequence, potential capital investment is more accurately identified. As previously mentioned, ER G74 has been registered under the Restrictive Trade Practices Act (1976) by the ENA and the associated Statutory Instrument has been signed to this effect.

Short Circuit Current Calculation

Sophisticated computer programs are used for the purpose of conducting short circuit current analyses. Each analysis is based on an initial condition from an AC load flow and is carried out in accordance with ER G74. The broad calculation methodology is summarised in the following paragraphs.

When assessing the duties associated with busbars, bus section/coupler circuit breakers and elements of mesh infrastructure, it is assumed that all connected circuits contribute to the fault. When assessing the duties associated with individual feeder/transformer circuits it is assumed that the fault occurs on the circuit side of the circuit breaker with the remote ends of the circuit open. These represent the most onerous conditions.

Short-circuit currents are calculated using a full representation of the GB transmission network. Directly connected and Large embedded generating units are also discretely represented with their electrical parameters based on data provided by the owner of the generating unit. Other Network Operators' networks are represented by network equivalents at the interface between the GB transmission system and the Network Operator's network. For example, a DNO network connected to a 132kV busbar supplied by SGTs will usually be represented by a single network equivalent in the positive phase sequence (PPS) and zero phase sequence (ZPS) networks. The use of network equivalents allows short-circuit currents in the GB transmission system to be calculated with acceptable accuracy and provides a good indication of the magnitude of the short-circuit currents at interface substations. Short-circuit currents quoted in Tables D.1 to D.12 for interface substations are not, however, suitable for specifying short-circuit requirements for new switchgear at the interface substations. These will need to be agreed between the relevant Transmission Licensee and the Network Operator on a site specific basis.

Short Circuit Current Terminology

The short circuit current is made up of an AC component with a relatively slow decay rate as shown in Figure 7.5 and a DC component with a faster decay rate as shown in Figure 7.6 . These combine into the waveform shown in Figure 7.7 . The waveform in Figure 7.7 represents worst case asymmetry and as such will be infrequently realised in practice.

Figure 7.5

Click to load a larger version of Figure7.5 image

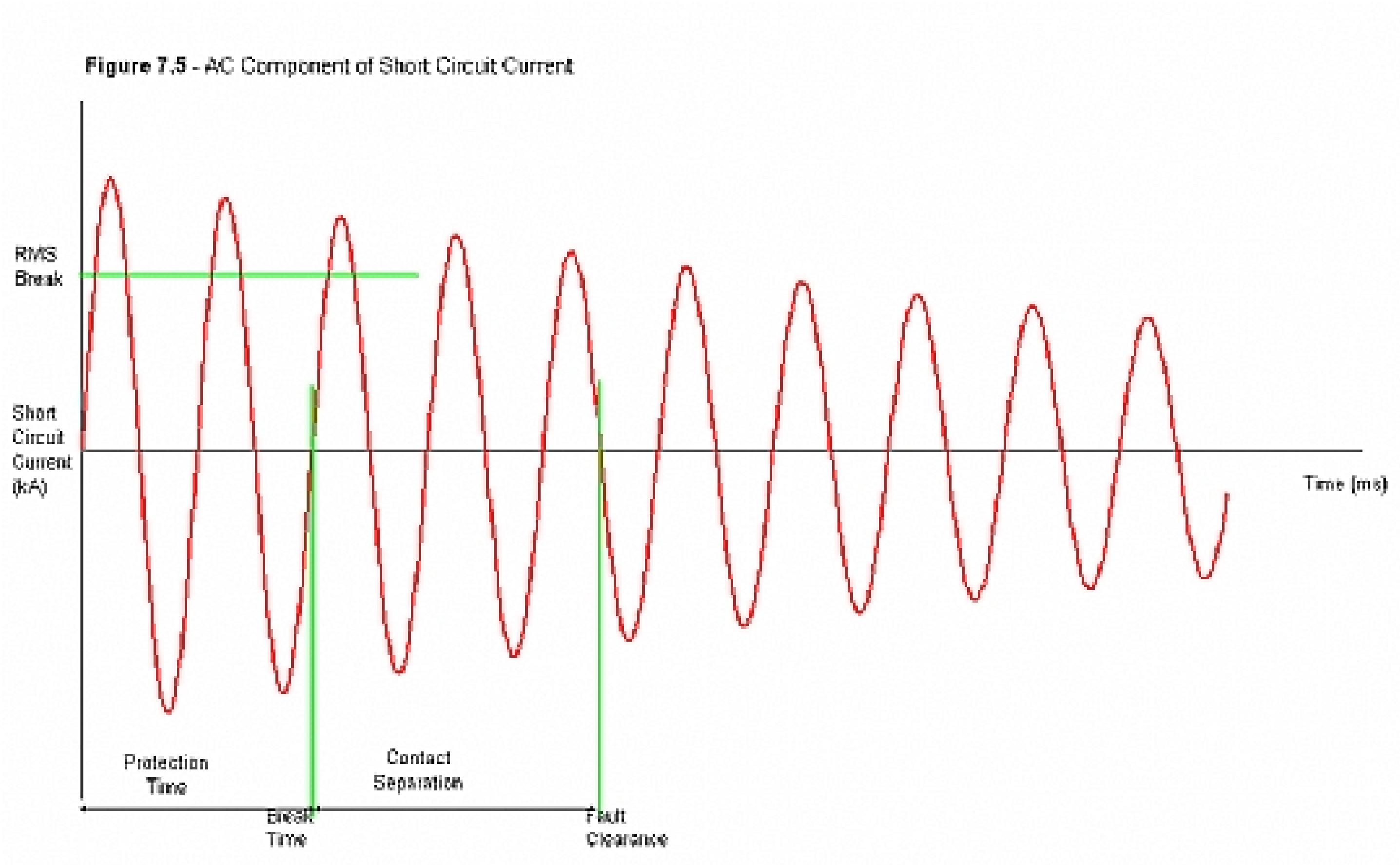
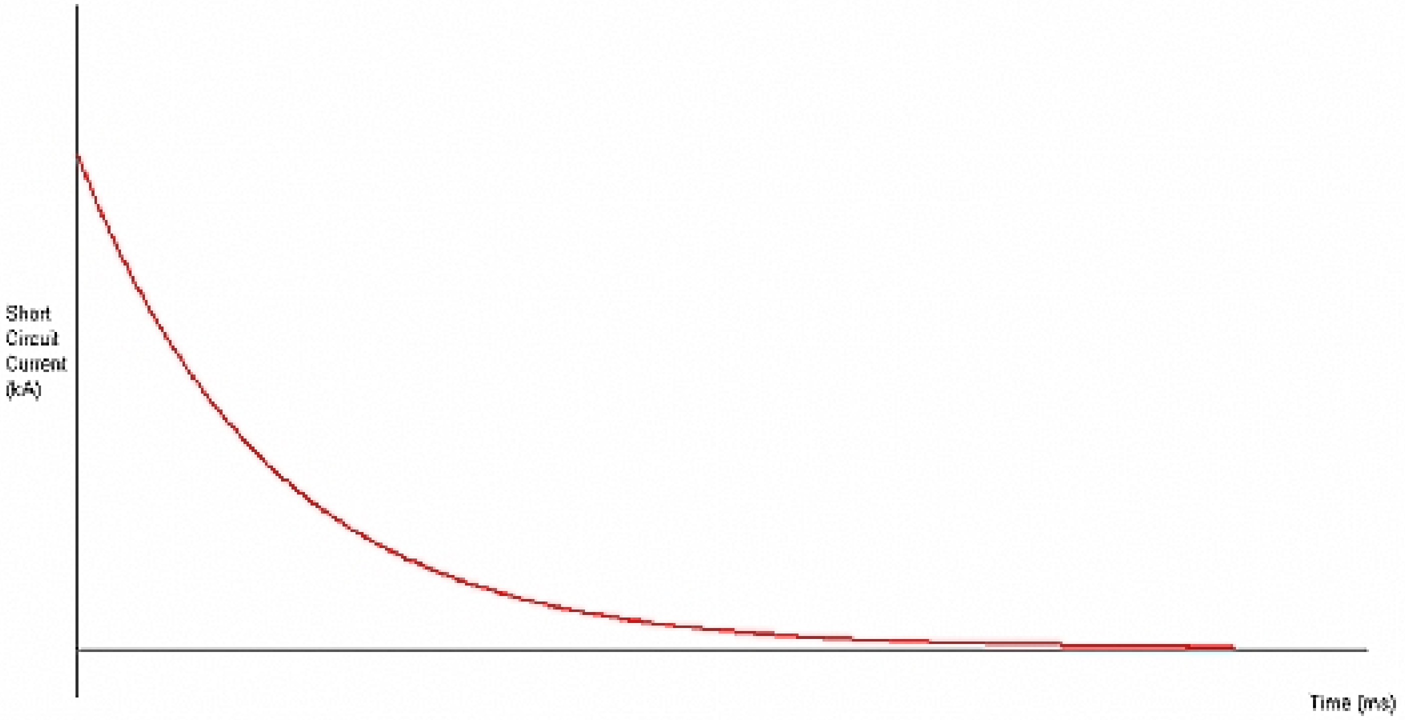


Figure 7.6

Click to load a larger version of Figure7.6 image

Figure 7.6 - DC Component of Short Circuit Current



X/R Ratio

The DC component decays exponentially according to a time constant which is a function of the X/R ratio. This is the ratio of reactances to resistances in the current paths feeding the fault. High X/R ratios mean that the DC component decays more slowly.

DC Component

The DC component of the peak make and peak break short-circuit currents are calculated from two equivalent system X/R ratios. An initial X/R ratio is used to calculate the peak make current, and a break X/R ratio is used to calculate the peak break current. Calculation of the initial and break X/R ratios is undertaken in accordance with IEC 60909-0 (2001-07) Method C (also known as the equivalent frequency method). We consider the equivalent frequency method to be the most appropriate general purpose method for calculating DC short-circuit currents in the GB transmission network.

The DC component of short-circuit current is calculated on the basis that full asymmetry occurs on the faulted phase for a single phase to earth fault or on one of the phases for a three phase to earth fault.

Making Duties

The making duty on bus section/bus coupler breakers is that imposed when they are used to energise an unselected section of busbar which is either faulted or earthed for maintenance. Substation infrastructure such as busbars, supporting structures, flexible connections, conductors, current transformers, wall bushings and disconnectors must also be capable of withstanding this duty.

The making duty on individual circuits is that imposed when they are used to energise a circuit which is either faulted or earthed for maintenance. This encompasses the persistent fault condition associated with Delayed Auto-Reclose (DAR) operation.

Breaking Duties

Bus section/coupler breakers are required to break the fault current associated with infeeds from all connected circuits if a fault occurs on an uncommitted section of busbar. Circuit breakers associated with a feeder/transformer or a mesh corner are required to break the fault current on the basis that the circuit breaker is the last circuit breaker to open clearing the fault.

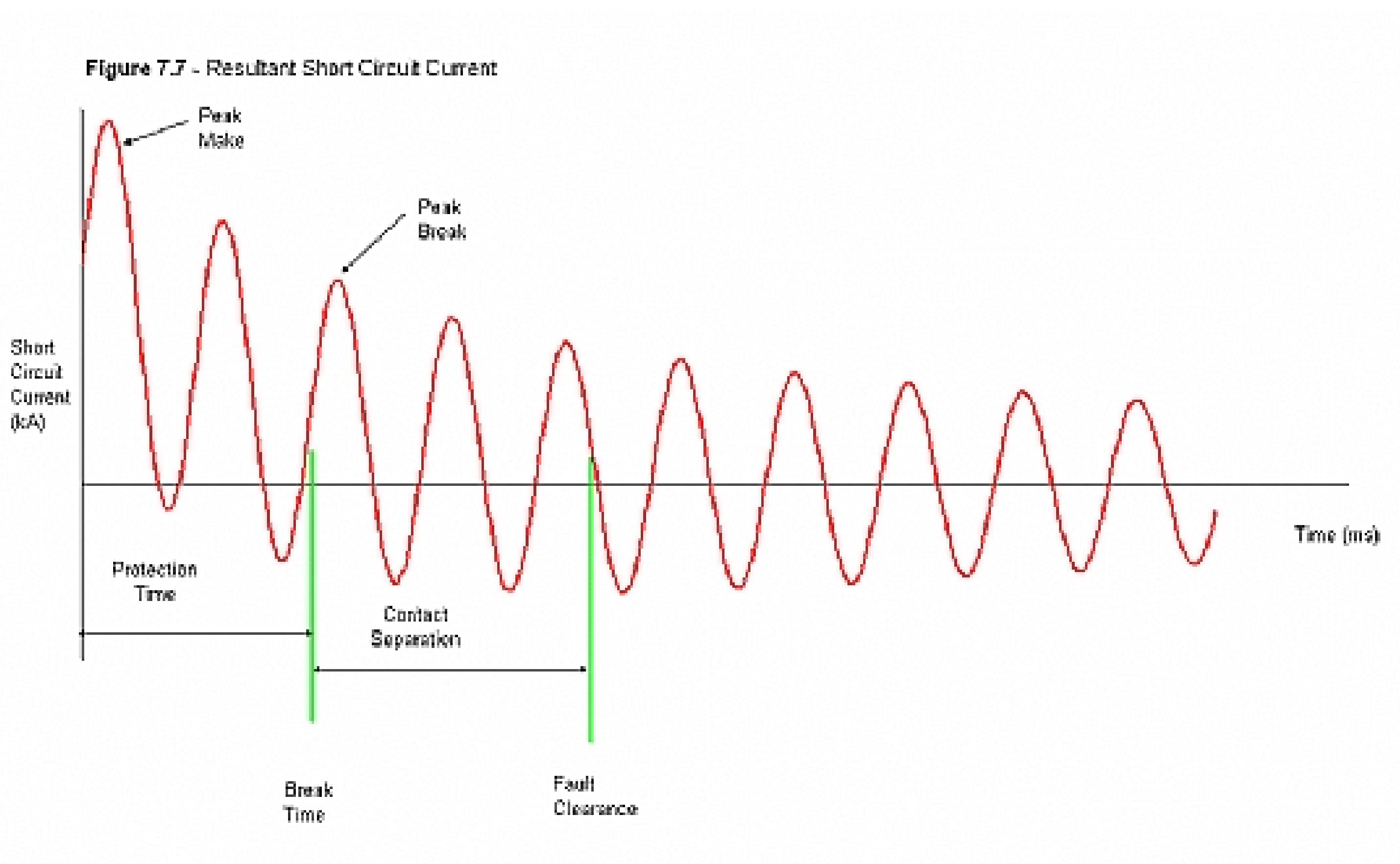
Circuit breakers associated with faulted circuits are required to interrupt fault current in order to safeguard system stability, prevent damage to plant and maintain security and quality of supply.

Initial Peak Current

In Figure 7.7, both the AC and DC components are decaying and the first peak will be the largest and occurs at about 10ms after the fault occurrence. This is the short circuit current that circuit breakers must be able to close onto in the event that they are used to energise a fault, hence this duty is known as the Peak Make. However, this name is slightly misleading because this peak also occurs during spontaneous faults. All equipment in the fault current path will be subjected to the Peak Make duty during faults and should therefore be rated to withstand this current. The Peak Make duty is an instantaneous value.

Figure 7.7

Click to load a larger version of Figure7.7 image



RMS Break Current

This is the RMS value of the AC component of the short circuit current at the time the circuit breaker contacts separate (see Figure 7.5), and does not include the effect of the DC component of the short circuit current.

DC Break Current

This is the value of the DC component of the short-circuit current at the time the circuit breaker contacts separate (see Figure 7.6).

Peak Break

As both the AC and DC components are decaying, the first peak after contact separation will be the largest during the arcing period. This is the highest instantaneous short circuit current that the circuit breaker has to extinguish, hence this duty is known as the Peak Break. This duty will be considerably higher than the RMS Break because, like the Peak Make duty, it is an instantaneous value (therefore multiplied by the square-root of 2) and also includes the DC component.

Choice of Break Time

The RMS Break and Peak Break will of course be dependent on the break time. The slower the protection, the later the break time and the more the AC and DC components will have decayed. For the purposes of this Statement a uniform break time of 50ms has been applied at all sites. For the majority of our circuit breakers, this is a fair or pessimistic assumption. In this context it should be noted that the break time of 50ms is the time to the first major peak in the arcing period, rather than the time to arc extinction.

Data Requirements

Generator Infeed Data

All generating units of directly connected Large power stations are individually modelled together with the associated generator transformers. Units are represented in terms of their Positive Phase Sequence (PPS) sub transient and transient reactances (submitted under the provision of Grid Code), as well as the DC stator resistances and Negative Phase Sequence (NPS) reactances (neither of these data items are submitted under the Grid Code but the stator resistance value is currently derived or assumed from historic records and the NPS reactance is calculated as the average of the relevant PPS sub transient reactances ((Xd" + Xq")/2). Fault level studies for planning purposes are carried out under maximum plant conditions (i.e. with all Large power stations included whether contributory or not) to simulate the most onerous possible scenario for a future generation pattern.

Auxiliary System Infeed Data

The induction motor fault infeed from the station board is modelled at the busbar associated with the station transformer connection. Where sufficient information is not available, it has been assumed that Auxiliary Gas Turbines are connected to the station boards as well as to the main generating units in order to simulate the most onerous condition. Where the X/R Ratio has not been provided, a value of 10 has been assumed.

Where the information is available, the fault infeed from the unit board, due to induction motors and auxiliary gas turbines, is modelled as an adjustment to the main genset substransient reactance. A more detailed model of the power station system may have to be used to assess fault levels when station and unit boards are interconnected.

GSP Infeed Data

Infeed data for induction motors and synchronous machines at GSPs is submitted by Users under the provision of the Grid Code. Infeeds from induction motors and synchronous machines are modelled as equivalent lumped impedances at the GSP.

Where the information is not available, 1MVA of fault infeed per MVA of substation demand, with an X/R ratio of 2.76 is assumed for all induction motors in the absence of more detailed data. This is in line with the requirements of ER G74.

Where more detailed fault level studies are required at 132kV or below, the associated system should be modelled in detail down to individual Bulk Supply Points (BSP's). Induction motor infeeds should then be modelled at these BSP busbars.

LV System Modelling

Where interconnections exist between GSP’s, these equivalents take the form of PPS impedances between those GSP’s. The ZPS networks take the form of minimum ZPS values modelled as shunts at the GSP busbars.

Where interconnections to other GSP’s do not exist, the equivalents take the form of equivalent LV susceptances modelled as shunts at the GSP busbar. The ZPS networks are modelled as shunt minimum ZPS values at the GSP busbars.

The values of PPS impedances between GSP’s shunt LV susceptances and shunt ZPS minimum impedances are as submitted by the Users under the provision of the Grid Code.

Power Losses

The following information on system power losses and zonal power losses is indicative only and is included to provide an insight into the level and type of power loss which may be expected around the system at the time of system ACS peak and against the SYS background only. At other times and/or against other backgrounds different levels of power loss may arise.

System Power Losses

An estimate of the level of system power loss occurring at the time of the ACS Peak GB Demand for the years 2008/09 to 2014/15 against the SYS background is given in Table 7.4. The losses shown are those incurred on the system between the power station generating unit and the grid supply points and are made up of:

- 'Variable' (I^2R) transmission heating losses in the overhead lines, underground cables and other equipment on our transmission system but excluding grid supply transformers at the GSPs;
- 'Fixed' losses made up of corona losses on outdoor transmission equipment and iron losses in transformers;
- 'Variable' (I^2R) heating losses (copper losses) in grid supply transformers at the GSPs; and
- 'Variable' (I^2R) heating losses (copper losses) in generator transformers.

It is stressed that the losses shown in Table 7.4 are indicative only. They correspond to the time of ACS Peak Demand and have been evaluated against the 'SYS background'. The 'fixed' losses, like the 'variable' losses, can also vary to a certain extent. Accordingly, the exact losses on the day can vary for a number of reasons including:

- the outturn demand and/or in-merit generation pattern being different resulting in changed power flows and consequential changes to the variable losses which are a function of the square of the power flow (I^2R); and
- weather conditions being more or less adverse than forecast. For example if 'heavy rain' or 'wet snow' prevails across Great Britain then the so called 'fixed' losses (e.g. corona) could be some 100MW or more higher.

Total system power losses are shown in line 5 of Table 7.4 and these have also been expressed as a percentage (line 7) of the forecast ACS peak demand stream given in row 3 of Table 2.1 less station demand and less transmission losses (line 6). The demand forecast given in Table 2.1 reflects the demand seen at the metering points at the power stations and accordingly includes both transmission and distribution system losses. As some metering is on the high voltage side of the generator transformers and some on the low voltage side, generator transformer copper losses are only partially taken into account.

Please note that there is a slight difference between the value of forecast ACS peak demand including losses given in Table 7.4 (i.e. row 5 plus row 6) and that given in row 3 of Table 2.1 . This is due to the fact that the system losses included in the forecasts of Table 2.1 reflect estimates made at the time of formulating the forecasts whereas Table 7.4 includes calculated system losses derived from system analyses.

The transmission heating losses (line 1) are a function of the power flow pattern around the system and the reduction in 2009/10 is due to the commissioning of new plant in the south which ‘backs off’ the north to south flows.

Fixed losses (line 2) are fairly constant over the period. Please note that values provided for fixed losses are estimated based on reasonable growth from last year’s values. Grid Supply transformer heating losses (line 3) display a modest increase over the period in step with the growth in forecast ACS Peak Demand (line 6). Generator Transformers heating losses (line 4) display a modest increase over the period.

Less significant perturbations, perhaps not obvious in the results displayed in the table, are caused by a number of factors including: increased transmission capacity (through reinforcement rather than reprofiling) which reduces transmission heating losses; or embedded large power stations closing, decommissioning or otherwise becoming non-contributory which can increase grid supply transformer heating losses.

Relative to the system power losses reported in the 2007 GB SYS, there is a small increase in total losses. This is also reflected in the corresponding increase in transmission heating losses, which are the dominant component of system power losses.

Zonal Power Losses

Amongst other things, the commissioning and operation of a new power station will have an effect on transmission losses and this will be a function of its system location and the prevailing power flows at the time.

Clearly, if a new power station were to be located in the north, and this were to displace the operation of southern generation, then the north to south power flows would increase, transmission losses would increase and some of the output of the new station would, in effect, be 'lost' to the system. However, if the new power station were to be located in the south and this displaced northern generation, the converse would be true; north to south power flows would decrease, system losses would decrease and the relative net effect would be as if a larger station had been installed. Table 7.5 demonstrates this by showing the relative effect on transmission losses of locating 100MW of new generating plant in each zone consecutively. For this purpose, the 17 SYS Study Zones introduced in SYS Boundaries and SYS Study Zones have been used.

Please note, however, that the power flows presented in this Statement are based around a winter peak demand case using an average plant availability which tends to give rise to a general north to south power transfer. At other times of the year, when plant availability and market conditions may modify the generation patterns, zonal losses can change dramatically. For example, if Scotland becomes an importing area during the summer period then siting generation in Scotland is likely to have a beneficial effect on GB transmission losses.

The analysis was carried out against the SYS background for the 2008/09 winter peak. The installation of new generation was represented by a 100MW reduction in demand spread across the nodes within the relevant zone. The computer program used in the analysis requires that the total generation matches total demand (including losses) and scales generation capacity accordingly. The studies were arranged such that the effective 100MW of new generation was compensated for by a slight reduction in the output of all other generation in the study. That is no plant was displaced from operating. This was repeated for each of the 17 zones and the change in losses, relative to a reference case where no 100MW of new generation was introduced, was calculated.

Table 7.5 is based on the calculations conducted as described above and lists the effectiveness of placing 100MW of additional generation in each zone. The effectiveness has been expressed in percentage terms. For example, an effectiveness of 92% means that for generation increase of 100MW in the zone in question, 92MW would meet demand, while 8MW would be lost to increased losses. The effectiveness expressed in percentage terms provides an indication of the effectiveness of the installation of levels of generation greater than 100MW.

The change in losses is, of course, due to the overall increase or decrease in transfers across the GB transmission system rather than due to a local change in the zone in which the additional generation is located. The absolute values of effectiveness should not be relied upon, given the simplicity of the underlying studies. However, arranging the zones in order of effectiveness, as in Table 7.5, does provide a useful, and reasonably robust, indicator of the relative merits of locating generation in each of the 17 SYS Study Zones across the system on the basis of optimising (i.e. minimising) overall transmission system losses.

Table 7.5 shows that a small increase in generation in the zones north of zone 5 has an effectiveness of 90% or less in meeting demand across the system at the time of winter peak. In contrast to this, a small increase in generation in the South West (zone 17) has an effectiveness of 104% in meeting demand by virtue of reducing transmission power losses. Please note that the generation effectiveness in zones 1 to 6 is likely to be understated due to the non-compliance of Boundary 6.

Finally, whilst the results may hold for the addition of 100MW of new generation, it does not follow that they would hold for say 1000MW of new generation. The aim of the above exercise was to provide an insight into the general effect of generation location on the overall GB transmission losses. The capacity of 100MW of new generation was selected as, in itself, it has a relatively small system impact. The choice of a larger capacity (say 1000MW) would be more likely to incur heavy local loading of transmission circuits creating increased local transmission losses. Depending on the location, this may increase or decrease the overall GB system losses. It is also more likely that a generator of this size would require network reinforcement to ensure compliance with the Licence Standard. Consequently, it would not be appropriate to calculate zonal losses until that reinforcement had been included in the study. The effect of a smaller generator capacity (say 1MW) would not be seen.

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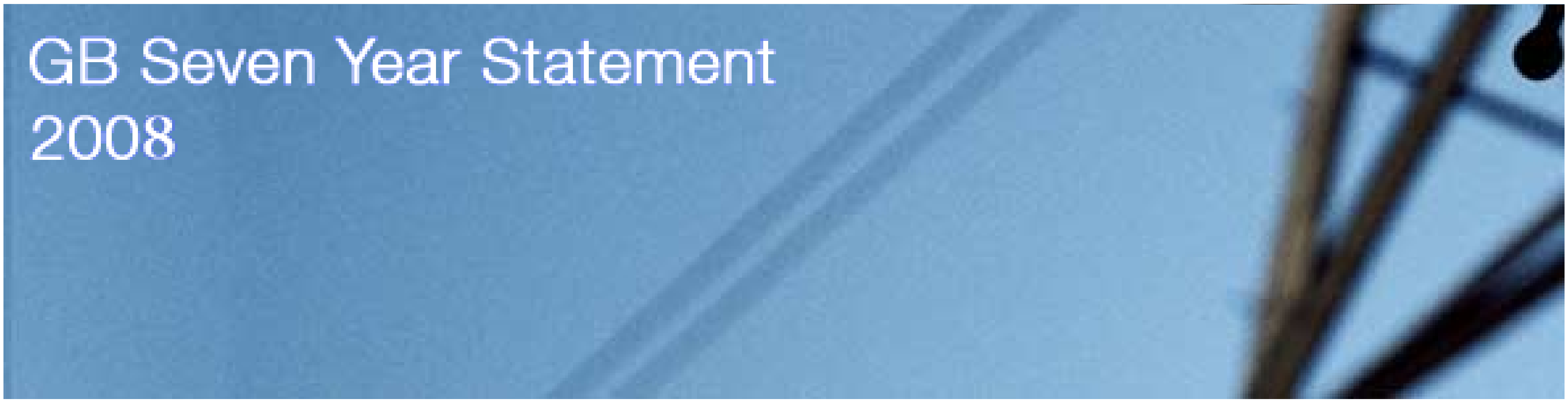

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Table 7.1 - GB Generation Ranking Order

Rank	BM Unit ID	Station	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
1		IFA Bipole 1 Pole 1	497	-0.2	-148.6	-497	-497	-497	-497
2		IFA Bipole 1 Pole 2	497	-0.2	-148.6	-497	-497	-497	-497
3		IFA Bipole 2 Pole 1	497	-0.2	-148.6	-497	-497	-497	-497
4		IFA Bipole 2 Pole 2	497	-0.2	-148.6	-497	-497	-497	-497
5		Netherlands Interconnector	0	0	-394.6	-1320	-1320	-1320	-1320
6		Moyle	-300	-300	-300	-300	-300	-300	-300
7		East-West Interconnector	0	0	0	-500	-500	-500	-500
8		Flotta Terminal	10	10	10	10	10	10	10
9		Exxon MossMorran	16	16	16	16	16	16	16
10		Stoneywood Mills (Wiggins Teape Stoneywood)	12	12	12	12	12	12	12

11	DERW-1	Willington (Derwent)	228	228	228	228	228	228	228
12	DIDCB6	Didcot B	775	775	775	775	775	775	775
13	E_HYTHE	Lynes Common	49.9	49.9	49.9	49.9	49.9	49.9	49.9
14	FELL-1	Hutton (Sellafield)	155	155	155	155	155	155	155
15	GRMO-1	BP Grangemouth	120	120	120	120	120	120	120
16	HEYM27	Heysham 2	600.5	600.5	600.5	600.5	600.5	600.5	600.5
17	KEAD-1	Keadby	735	735	735	735	735	735	735
18	LBAR-1	Little Barford A	665	665	665	665	665	665	665
19	PEHE-1	Peterhead CCGT1	1220	1220	1220	1220	1220	1220	1220
20	PEHE-2	Peterhead	304	304	304	304	304	304	304
21	ROCK-1	Rocksavage	748	748	748	748	748	748	748
22	SCCL-2	Saltend	366.7	366.7	366.7	366.7	366.7	366.7	366.7
23	SHOT-1	Shotton	210	210	210	210	210	210	210
24	SIZB-1	Sizewell B	600	600	600	600	600	600	600
25	SIZB-2	Sizewell B	600	600	600	600	600	600	600
26	SPLN-1	Spalding	880	880	880	880	880	880	880
27	TESI-1	Teesside	937.5	937.5	937.5	937.5	937.5	937.5	937.5
28	TESI-2	Teesside	937.5	937.5	937.5	937.5	937.5	937.5	937.5
29	WBUPS-2	West Burton A	503	503	503	503	503	503	503
30	WYLF-1	Wylfa	245	245	0	0	0	0	0
31	WYLF-2	Wylfa	245	245	0	0	0	0	0
32	WYLF-3	Wylfa	245	245	0	0	0	0	0
33	WYLF-4	Wylfa	245	245	0	0	0	0	0
34	DRAXX-3	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
35	RUGPS-7	Rugeley B	498	498	498	498	498	498	498
36	IRNPS-1	Ironbridge B	482	482	482	482	482	482	482
37		Amlwch	0	0	0	0	270	270	270
38		Abernedd Stage 1	0	0	0	0	0	0	435
39		Abernedd Stage 2	0	0	0	0	0	0	0
40		Drakelow	0	1230	1230	1230	1230	1230	1230
41		Grain Stage 1	0	0	860	860	860	860	860
42		Grain Stage 2	0	0	0	430	430	430	430
43		Immingham Stage 2	601	601	601	601	601	601	601
44		Little Barford B	0	0	0	0	475	475	475

45		Langage Stage 1	905	905	905	905	905	905	905
46		Marchwood	900	900	900	900	900	900	900
47		Pembroke 1 Stage 1	0	800	800	800	800	800	800
48		Pembroke 1 Stage 2	0	1200	1200	1200	1200	1200	1200
49		Pembroke 2 Stage 1	0	0	0	0	0	1200	1200
50		Pembroke 2 Stage 2	0	0	0	0	0	0	800
51		Severn Power Stage 1	0	425	425	425	425	425	425
52		Severn Power Stage 2	0	0	425	425	425	425	425
53		Staythorpe Stage 1	0	425	425	425	425	425	425
54		Staythorpe Stage 2	0	425	425	425	425	425	425
55		Staythorpe Stage 3	0	850	850	850	850	850	850
56		Sutton Bridge B	0	0	0	1305	1305	1305	1305
57		Brine Field	0	0	0	1020	1020	1020	1020
58		West Burton B Stage 1	0	0	435	435	435	435	435
59		West Burton B Stage 2	0	0	0	870	870	870	870
60		Wilton	50	50	50	50	50	50	50
61		Blyth	0	0	0	0	0	0	1600
62		Teesport	0	0	0	0	0	0	925
63		Hatfield	0	0	0	800	800	800	800
64	DRAXX-4	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
65	HUMR-1	Immingham Stage 1	719	719	719	719	719	719	719
66	RATS-4	Ratcliffe-on-Soar	500	500	500	500	500	500	500
67	WBUPS-1	West Burton A	483	483	483	483	483	483	483
68	BAGE-1	Baglan Bay	520	520	520	520	520	520	520
69	COTPS-4	Cottam	495	495	495	495	495	495	495
70	DRAXX-6	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
71	FAWN-1	Fawley CHP	158	158	158	158	158	158	158
72	GYAR-1	Great Yarmouth	420	420	420	420	420	420	420

73	RATS-2	Ratcliffe-on-Soar	500	500	500	500	500	500	500
74	COTPS-2	Cottam	505	505	505	505	505	505	505
75	CNQPS-4	Connah's Quay	345	345	345	345	345	345	345
76	LOCH	Lochay	47	47	47	47	47	47	47
77	MOSS	Mossford	18.7	18.7	18.7	18.7	18.7	18.7	18.7
78	ORRI	Orrin	18	18	18	18	18	18	18
79	PITL	Pitlochry	15	15	15	15	15	15	15
80	QUOD	Quoich	18	18	18	18	18	18	18
81	RANN-1	Rannoch	14.7	14.7	14.7	14.7	14.7	14.7	14.7
82	RANN-2	Rannoch	14.7	14.7	14.7	14.7	14.7	14.7	14.7
83	RANN-3	Rannoch	14.7	14.7	14.7	14.7	14.7	14.7	14.7
84	SHIN-1	Shin	9.3	9.3	9.3	9.3	9.3	9.3	9.3
85	SHIN-2	Shin	9.3	9.3	9.3	9.3	9.3	9.3	9.3
86	TONG-1	Tongland	11	11	11	11	11	11	11
87	TONG-2	Tongland	11	11	11	11	11	11	11
88	TONG-3	Tongland	11	11	11	11	11	11	11
89	SUTB-1	Sutton Bridge A	800	800	800	800	800	800	800
90	BARK-1	Barking	394.5	394.5	394.5	394.5	394.5	394.5	394.5
91	EGGPS-4	Eggborough	487.5	487.5	487.5	487.5	487.5	487.5	487.5
92	KINO-3	Kingsnorth	485	485	485	485	485	485	485
93	RUGPS-6	Rugeley B	498	498	498	498	498	498	498
94	TORN-2	Torness	600	600	600	600	600	600	600
95	WBUPS-3	West Burton A	503	503	503	503	503	503	503
96	MEDP-1	Medway	700	700	700	700	700	700	700
97	CNQPS-1	Connah's Quay	345	345	345	345	345	345	345
98	COSO-1	Coryton	800	800	800	800	800	800	800
99	CNQPS-3	Connah's Quay	345	345	345	345	345	345	345
100	EGGPS-1	Eggborough	482.5	482.5	482.5	482.5	482.5	482.5	482.5
101	KILLPG-2	Killingholme 1	450	450	450	450	450	450	450
102	COCK-4	Cockenzie 4	288	288	288	288	288	288	288
103	DEEP-1	Deeside	496	496	496	496	496	496	496
104	DIDC2	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
105	FERR-2	Ferrybridge C	490	490	490	490	490	490	490
106	RYHPS-1	Rye House	715	715	715	715	715	715	715
107	SEAB-1	Seabank 1	812	812	812	812	812	812	812

108	BAGE-2	Baglan Bay	32	32	32	32	32	32	32
109	DRAXX-5	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
110	COCK-3	Cockenzie 3	288	288	288	288	288	288	288
111	DIDC1	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
112	WBUPS-4	West Burton A	483	483	483	483	483	483	483
113	CNQPS-2	Connah's Quay	345	345	345	345	345	345	345
114		Aberchalder Cluster Wind Farms, Fort Augustus	0	0	0	0	0	0	0
115		Afton	0	0	0	0	77	77	77
116		Aikengall	48	48	48	48	48	48	48
117		Akron Wind (Caithness)	20	20	20	20	20	20	20
118		Andershaw	0	0	45	45	45	45	45
119		Arecleoch	0	150	150	150	150	150	150
120		Auchencorth	0	0	45	45	45	45	45
121		Aultmore Windfarm	0	0	0	0	0	60	60
122		Baillie & Bardnaheigh Wind	0	0	0	0	0	0	57
123		Ballindalloch Muir Wind Farm, Balfron	0	20.8	20.8	20.8	20.8	20.8	20.8
124		Barmoor	0	0	30	30	30	30	30
125		Berry Burn	0	0	0	0	82.5	82.5	82.5
126		Black Craig	0	0	0	0	0	71.3	71.3
127		Black Craig 40MW Windfarm, Dunoon	0	0	0	0	40	40	40
128		Black Craig 90MW Windfarm, Dunoon	0	0	0	0	0	0	90
129		Boyndie Wind, Banff (Add. Cap.)	7	7	7	7	7	7	7
130		Beinn an Tuirc 2	0	0	0	0	60	60	60
131		Cambusmore Wind Farm	0	0	0	0	0	0	0
132		Carscreugh	0	0	0	0	0	21	21
133		Calliachar Wind	0	0	0	0	0	62.2	62.2
134		Camster Windfarm, Caithness	0	0	0	0	0	62.5	62.5

135		Causeymire (Phase 2), Mybster	0	0	0	6.9	6.9	6.9	6.9
136		Clashindarroch Wind, Huntly	0	0	0	0	0	112.7	112.7
137		Clyde	0	519	519	519	519	519	519
138		Crystal Rig 2	0	200	200	200	200	200	200
139		Dersalloch	0	0	0	69	69	69	69
140		Drone Hill	0	0	37.8	37.8	37.8	37.8	37.8
141		Beatrice Pilot	0	0	0	0	10	10	10
142		Dunbeath Wind Farm	0	0	0	0	0	55	55
143		Dun Law Extension	0	29.8	29.8	29.8	29.8	29.8	29.8
144		Edinbane Wind, Skye	0	42	42	42	42	42	42
145		Earlshaugh	0	0	108	108	108	108	108
146		Eishken Estate, Isle of Lewis	0	0	0	0	0	0	300
147		Ewe Hill	0	0	0	66	66	66	66
148		Fairburn Wind (Orrin)	42	42	42	42	42	42	42
149		Fairwind (Orkney) Ltd	0	0	0	0	0	126	126
150		Fallago	0	144	144	144	144	144	144
151		Carraig Gheal	0	75	75	75	75	75	75
152		Gordonbush Wind, Caithness	0	87.5	87.5	87.5	87.5	87.5	87.5
153		Griffin Windfarm, near Aberfeldy	0	0	216	216	216	216	216
154		Greenock	0	0	0	0	0	0	0
155		Harrows Law	0	0	0	140	140	140	140
156		Harestanes	0	0	213	213	213	213	213
157		Hearthstanes B	0	0	81	81	81	81	81
158		Kingsburn Wind Farm, Fintry, Stirling	0	20	20	20	20	20	20
159		Kyle	0	0	0	300	300	300	300
160		Lairg - Achany Wind Farm	62	62	62	62	62	62	62
161		Limmer Hill	0	0	80	80	80	80	80

162		Longpark	0	38	38	38	38	38	38
163		Mark's Hill	99	99	99	99	99	99	99
164		Margree	0	0	0	0	0	70	70
165		Mid Hill Wind, Stonehaven	0	0	0	0	75	75	75
166		Montreathmont Moor Wind	0	0	0	0	0	40	40
167		Neilston	0	0	0	0	100	100	100
168		Newfield	0	0	0	60	60	60	60
169		North Nesting Wind, Shetland	0	0	0	0	0	0	250
170		Novar 2 Windfarm, Alness	0	0	0	0	0	0	32
171		Pairc (South Lochs) Wind, Lewis	0	0	0	0	0	250	250
172		Paul's Hill Wind (Add.Cap)	14	14	14	14	14	14	14
173		Pencloe	0	0	0	0	63	63	63
174		Shira	0	0	0	0	75	75	75
175		Stacain Wind Farm, Sron Mor, Inverary	0	0	0	0	42	42	42
176		Stroupster Windfarm, near Wick, Caithness	0	0	0	0	0	0	31.5
177		Strathy North & South Wind	0	0	0	0	226	226	226
178		Tangy (Add Capacity)	6	6	6	6	6	6	6
179		Toddleburn	0	36	36	36	36	36	36
180		Tomatin Windfarm	0	0	0	0	30	30	30
181		Tormywheel	0	32.4	32.4	32.4	32.4	32.4	32.4
182		Ulzieside	0	0	0	0	69	69	69
183		Waterhead Moor	0	0	0	120	120	120	120
184		Whiteside Hill	0	0	0	0	27	27	27
185		Windy Standard 2	0	0	0	0	60	60	60
186	ARDK	Ardkinglas, Clachan (SRO)	19.3	19.3	19.3	19.3	19.3	19.3	19.3

187	ARHW	Ark Hill Wind Farm, Glamis (SRO)	12	12	12	12	12	12	12
188	BETHW-1	Ben Tharsuinn Wind, E Ross	29	29	29	29	29	29	29
189	BLLA-1	Black Law	134	134	134	134	134	134	134
190	BNAKW-1	Ben Aketil Wind, Dunvegan	28	28	28	28	28	28	28
191	BOYNW-1	Boyndie Wind, Banff	14.3	14.3	14.3	14.3	14.3	14.3	14.3
192	BRDUW-1	Braes of Doune Wind, Braco	74	74	74	74	74	74	74
193	BTUIW-1	Beinn an Tuirc Wind (SRO)	30.4	30.4	30.4	30.4	30.4	30.4	30.4
194	CAIRW-1	Cairn Uish Wind, Rothes	50.6	50.6	50.6	50.6	50.6	50.6	50.6
195	CAUSW-1	Causeymire	48.3	48.3	48.3	48.3	48.3	48.3	48.3
196	CRMHW-1	Cruach Mhor Farm	29.8	29.8	29.8	29.8	29.8	29.8	29.8
197	CRYRW-1	Crystal Rig 1	62.5	62.5	62.5	62.5	62.5	62.5	62.5
198	DALSW-1	Dalswinton	30	30	30	30	30	30	30
199	DEUCW-1	Deucherin Hill Wind	15	15	15	15	15	15	15
200	DRUW	Drumderg Wind Farm, Dalrulzion	32	32	32	32	32	32	32
201	EARBW-1	Earlsburn	35	35	35	35	35	35	35
202	ERED	Eredine Forest Wind (An Suidhe)	30	30	30	30	30	30	30
203	FAARW-1	Farr Wind Farm, Tomatin	46	46	46	46	46	46	46
204	FAARW-2	Farr Wind Farm, Tomatin	46	46	46	46	46	46	46
205	GLOFW-1	Glens of Foudland Wind (SRO)	26	26	26	26	26	26	26
206	HADHW-1	Hadyard Hill	130	130	130	130	130	130	130
207	HOUW	Houstary Wind, Dunbeath	14	14	14	14	14	14	14
208	INSW	Insch Windfarm, Insch	10.4	10.4	10.4	10.4	10.4	10.4	10.4
209	MILWW-1	Millennium Wind, Ceannacroc	50	65	65	65	65	65	65
210	MINSW-1	Minsca	37.5	37.5	37.5	37.5	37.5	37.5	37.5

211	NOVAW-1	Novar (SRO), Alness	18.5	18.5	18.5	18.5	18.5	18.5	18.5
212	PAUHW-1	Paul's Hill Wind	56	56	56	56	56	56	56
213	STRB	Kilbraur Wind Farm	49.5	67	67	67	67	67	67
214	TANBW-1	Tangy (1) Wind, Argyll	12.8	12.8	12.8	12.8	12.8	12.8	12.8
215	TULW	Tullo Wind Farm, Laurencekirk	13.5	13.5	13.5	13.5	13.5	13.5	13.5
216	WHIL	Whitelee	294	322	322	322	322	322	322
217	DAMC-1	Damhead Creek	805	805	805	805	805	805	805
218	AIGA	Aigas	20	20	20	20	20	20	20
219	CAS-BEU01	Torr Achilty	15	15	15	15	15	15	15
220	CAS-CLU01	Clunie	61.2	61.2	61.2	61.2	61.2	61.2	61.2
221	CAS-GAR01	Invergarry	20	20	20	20	20	20	20
222	CASH	Cashlie	11.1	11.1	11.1	11.1	11.1	11.1	11.1
223	CAS-MOR01	Glenmoriston	37	37	37	37	37	37	37
224	CEAN	Ceannacroc	20	20	20	20	20	20	20
225	DEAN	Deanie	38	38	38	38	38	38	38
226	FASN-1	Fasnakyle G1	23	23	23	23	23	23	23
227	FASN2	Fasnakyle G3	23	23	23	23	23	23	23
228	FASN-4	Fasnakyle unit 4	0	0	0	0	0	0	7.5
229	GRUB-1	Grudie Bridge	11	11	11	11	11	11	11
230	GRUB-2	Grudie Bridge	11	11	11	11	11	11	11
231	KIOR	Kilmorack	20	20	20	20	20	20	20
232	LUIC	Luichart	34	34	34	34	34	34	34
233	NANT-1	Nant	15	15	15	15	15	15	15
234	SFIL-1	St Fillans	16.8	16.8	16.8	16.8	16.8	16.8	16.8
235		Rothes Bioplant	0	0	52	52	52	52	52
236		Steven's Croft	45	45	45	45	45	45	45
237	KINO-2	Kingsnorth	485	485	485	485	485	485	485
238	TILB-9	Tilbury B	356	356	356	356	356	356	356
239	SCCL-3	Saltend	366.7	366.7	366.7	366.7	366.7	366.7	366.7
240	DRAXX-1	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
241	RATS-3	Ratcliffe-on-Soar	500	500	500	500	500	500	500
242	DRAXX-2	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5

243	KINO-4	Kingsnorth	485	485	485	485	485	485	485
244	TILB-8	Tilbury B	357	357	357	357	357	357	357
245	COCK-1	Cockenzie 1	288	288	288	288	288	288	288
246	FERR-3	Ferrybridge C	490	490	490	490	490	490	490
247	FERR-4	Ferrybridge C	490	490	490	490	490	490	490
248		Bristol Channel Offshore Windfarm	0	0	0	0	0	0	1512
249		London Array Stage 1	0	0	200	200	200	200	200
250		London Array Stage 2	0	0	800	800	800	800	800
251		Humber Gateway Stage 1	0	0	0	220	220	220	220
252		Humber Gateway Stage 2	0	0	0	80	80	80	80
253		Heysham Offshore Wind	140	140	140	140	140	140	140
254		Greater Gabbard Offshore Windfarm	0	500	500	500	500	500	500
255		Rhigos	0	0	0	299	299	299	299
256		Thanet Offshore Windfarm	0	300	300	300	300	300	300
257		Sheringham Shoal	0	0	315	315	315	315	315
258		Gwynt Y Mor Stage 1	0	0	0	294	294	294	294
259		Gwynt Y Mor Stage 2	0	0	0	0	294	294	294
260		Gwynt Y Mor Stage 3	0	0	0	0	0	147	147
261		Docking Shoal Windfarm	0	0	0	500	500	500	500
262		Lincs Offshore Windfarm	0	250	250	250	250	250	250
263		Race Bank Windfarm	0	0	0	0	0	500	500
264	RATS-1	Ratcliffe-on-Soar	500	500	500	500	500	500	500
265		Port Talbot	0	0	0	350	350	350	350
266	EGGPS-2	Eggborough	482.5	482.5	482.5	482.5	482.5	482.5	482.5
267	BRYP-1	Barry	245	245	245	245	245	245	245
268	FIDL-3	Fiddlers Ferry	485	485	485	485	485	485	485

269	ABTH7	Aberthaw B	547	547	547	547	547	547	547
270	ABTH8	Aberthaw B	547	547	547	547	547	547	547
271	ABTH9	Aberthaw B	547	547	547	547	547	547	547
272	COCK-2	Cockenzie 2	288	288	288	288	288	288	288
273	FERR-1	Ferrybridge C	490	490	490	490	490	490	490
274	FIDL-1	Fiddlers Ferry	485	485	485	485	485	485	485
275	FIDL-2	Fiddlers Ferry	485	485	485	485	485	485	485
276	FIDL-4	Fiddlers Ferry	506	506	506	506	506	506	506
277	LOAN-1	Longannet 1	576	576	576	576	576	576	576
278	LOAN-2	Longannet 2	576	576	576	576	576	576	576
279	LOAN-3	Longannet 3	576	576	576	576	576	576	576
280	LOAN-4	Longannet 4	576	576	576	576	576	576	576
281	DNGB21	Dungeness B	540.5	540.5	540.5	540.5	540.5	540.5	540.5
282	DNGB22	Dungeness B	540.5	540.5	540.5	540.5	540.5	540.5	540.5
283	HEYM11	Heysham 1	607	607	607	607	607	607	607
284	HEYM12	Heysham 1	596	596	596	596	596	596	596
285	HEYM28	Heysham 2	602.5	602.5	602.5	602.5	602.5	602.5	602.5
286	HINB-7	Hinkley Point B	644	644	644	644	644	644	644
287	HINB-8	Hinkley Point B	617	617	617	617	617	617	617
288	HRTL-1	Hartlepool	603.5	603.5	603.5	603.5	603.5	603.5	603.5
289	HRTL-2	Hartlepool	603.5	603.5	603.5	603.5	603.5	603.5	603.5
290	HUNB-7	Hunterston	605	605	605	605	605	605	605
291	HUNB-8	Hunterston	605	605	605	605	605	605	605
292	OLDS1	Oldbury	228.2	0	0	0	0	0	0
293	TORN-1	Torness	600	600	600	600	600	600	600
294	CRUA-1	Cruachan	120	120	120	120	120	120	120
295		Glendoe Hydro, Fort Augustus	0	0	0	0	100	100	100
296	ERRO-1	Errochty	25	25	25	25	25	25	25
297	ERRO-2	Errochty	25	25	25	25	25	25	25
298	ERRO-3	Errochty	25	25	25	25	25	25	25
299	SLOY-2	Sloy G2	40	40	40	40	40	40	40
300	SLOY-3	Sloy G3	40	40	40	40	40	40	40
301	TUMB	Tummel	34	34	34	34	34	34	34
302	SHOS-1	Shoreham	420	420	420	420	420	420	420

303	KILLPG-1	Killingholme 1	450	450	450	450	450	450	450
304	EGGPS-3	Eggborough	487.5	487.5	487.5	487.5	487.5	487.5	487.5
305	COTPS-3	Cottam	505	505	505	505	505	505	505
306	SHBA-2	South Humber Bank 2	516	516	516	516	516	516	516
307	DINO-5	Dinorwig	274	274	274	274	274	274	274
308	CDCL-1	CDCL	395	395	395	395	395	395	395
309	COTPS-1	Cottam	495	495	495	495	495	495	495
310	SHBA-1	South Humber Bank 1	769	769	769	769	769	769	769
311	SCCL-1	Saltend	366.7	366.7	366.7	366.7	366.7	366.7	366.7
312	ROOS-1	Roosecote	229	229	229	229	229	229	229
313	DINO-4	Dinorwig	274	274	274	274	274	274	274
314	CORB-1	Corby	401	401	401	401	401	401	401
315	IRNPS-2	Ironbridge B	482	482	482	482	482	482	482
316	KINO-1	Kingsnorth	485	485	485	485	485	485	485
317	CRUA-2	Cruachan	120	120	120	120	120	120	120
318	DIDCB5	Didcot B	775	775	775	775	775	775	775
319	TILB10	Tilbury B	356	356	356	356	356	356	356
320	DIDC3	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
321	ALCN-1	Alcan Lynemouth	420	420	420	420	420	420	420
322	PETEM1	Peterborough	405	405	405	405	405	405	405
323	USKM-13	Uskmouth	121	121	121	121	121	121	121
324	DINO-1	Dinorwig	274	274	274	274	274	274	274
325	USKM-14	Uskmouth	121	121	121	121	121	121	121
326	EECL-1	Brimsdown	408	408	408	408	408	408	408
327	CASS-1	Cassley	2.5	2.5	2.5	2.5	2.5	2.5	2.5
328	CASS-2	Cassley	7.5	7.5	7.5	7.5	7.5	7.5	7.5
329	CLAC-1	Clachan	40	40	40	40	40	40	40
330	CULL	Culligran	19.1	19.1	19.1	19.1	19.1	19.1	19.1
331	FASN2	Fasnakyle G2	23	23	23	23	23	23	23
332	FINL-1	Finlarig	16.5	16.5	16.5	16.5	16.5	16.5	16.5
333	INAW-1	Inverawe	25	25	25	25	25	25	25
334	KILO	Kinlochleven	30	30	30	30	30	30	30
335	LIVI	Livishie	15	15	15	15	15	15	15
336	FOYE-1	Foyers	150	150	150	150	150	150	150

337	CRUA-4	Cruachan	100	100	100	100	100	100	100
338	USKM-15	Uskmouth	121	121	121	121	121	121	121
339	BRGG-1	Brigg	268	268	268	268	268	268	268
340	CRUA-3	Cruachan	100	100	100	100	100	100	100
341	SEAB-2	Seabank 2	422	422	422	422	422	422	422
342	DIDC4	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
343	FOYE-2	Foyers	150	150	150	150	150	150	150
344	SLOY-1	Sloy G1	36.3	36.3	36.3	36.3	36.3	36.3	36.3
345	SLOY-4	Sloy G4	36.3	36.3	36.3	36.3	36.3	36.3	36.3
346	FIFE-1	Fife Energy	123	123	123	123	123	123	123
347	DINO-2	Dinorwig	274	274	274	274	274	274	274
348	KILNS-1	Killingholme 2	665	665	665	665	665	665	665
349	DINO-3	Dinorwig	274	274	274	274	274	274	274
350	BARKB2	Barking	605.5	605.5	605.5	605.5	605.5	605.5	605.5
351	KLYN-A-1	Kings Lynn	340	340	340	340	340	340	340
352	DINO-6	Dinorwig	274	274	274	274	274	274	274
353	FFES-3	Ffestiniog	90	90	90	90	90	90	90
354	FFES-2	Ffestiniog	90	90	90	90	90	90	90
355	INDQ-1	Indian Queens	140	140	140	140	140	140	140
356	GRAI-1	Grain	650	650	650	650	650	650	650
357	GRAI-4	Grain	650	650	650	650	650	650	650
358	FFES-4	Ffestiniog	90	90	90	90	90	90	90
359	FFES-1	Ffestiniog	90	90	90	90	90	90	90
360	FAWL1	Fawley	496	496	496	496	496	496	496
361	LITTD1	Littlebrook D	570	570	570	570	570	570	570
362	LITTD2	Littlebrook D	570	570	570	570	570	570	570
363	FAWL3	Fawley	506	506	506	506	506	506	506
364	PEHE-3	Peterhead	0	0	0	0	0	0	0
365	PEHE-4	Peterhead	0	0	0	0	0	0	0
366	RUGGT-6	Rugeley B	22	22	22	22	22	22	22
367	WBUGT-1	West Burton A	7.5	7.5	7.5	7.5	7.5	7.5	7.5
368	TAYL2G	Taylors Lane	72	72	72	72	72	72	72
369	TAYL3G	Taylors Lane	72	72	72	72	72	72	72
370	WBUGT-2	West Burton A	7.5	7.5	7.5	7.5	7.5	7.5	7.5
371	LITT2G	Littlebrook D	35	35	35	35	35	35	35

372	LITT1G	Littlebrook D	35	35	35	35	35	35	35
373	LITT3G	Littlebrook D	35	35	35	35	35	35	35
374	GRAI1G	Grain	27.5	27.5	27.5	27.5	27.5	27.5	27.5
375	GRAI4G	Grain	27.5	27.5	27.5	27.5	27.5	27.5	27.5
376	ABTH7G	Aberthaw B	17	17	17	17	17	17	17
377	FAWL1G	Fawley	17	17	17	17	17	17	17
378	FAWL3G	Fawley	17	17	17	17	17	17	17
379	ABTH8G	Aberthaw B	17	17	17	17	17	17	17
380	ABTH9G	Aberthaw B	17	17	17	17	17	17	17
381	COWE1	Cowes	72.5	72.5	72.5	72.5	72.5	72.5	72.5
382	FIDL-2G	Fiddlers Ferry	13	13	13	13	13	13	13
383	FIDL-3G	Fiddlers Ferry	13	13	13	13	13	13	13
384	KINO1G	Kingsnorth	13	13	13	13	13	13	13
385	KINO4G	Kingsnorth	13	13	13	13	13	13	13
386	RATSGT-2	Ratcliffe-on-Soar	10	10	10	10	10	10	10
387	COWE2	Cowes	72.5	72.5	72.5	72.5	72.5	72.5	72.5
388	FERR-8G	Ferrybridge C	10.5	10.5	10.5	10.5	10.5	10.5	10.5
389	DRAXX-9G	Drax	15	15	15	15	15	15	15
390	RATSGT-4	Ratcliffe-on-Soar	11	11	11	11	11	11	11
391	TILB9G	Tilbury B	13	13	13	13	13	13	13
392	DIDC1G	Didcot A GT	25	25	25	25	25	25	25
393	DIDC3G	Didcot A GT	25	25	25	25	25	25	25
394	DIDC4G	Didcot A GT	25	25	25	25	25	25	25
395	FERR-5G	Ferrybridge C	10.5	10.5	10.5	10.5	10.5	10.5	10.5
396	DIDC2G	Didcot A GT	25	25	25	25	25	25	25
397	OLDS2	Oldbury	242.2	0	0	0	0	0	0
398	TILB8G	Tilbury B	13	13	13	13	13	13	13

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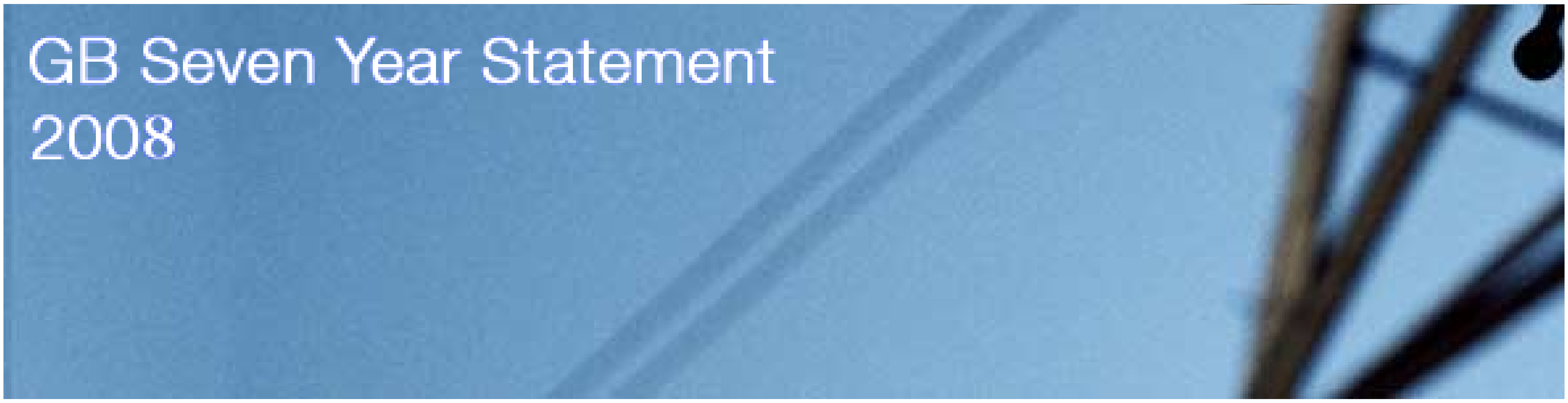

Introduction to Chapter 5

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. Indeed National Grid believes that the relatively high margins presented in the various tables and figures of this chapter are unlikely to occur in practice for a number of reasons which are discussed in the main text.

The plant margins presented have been evaluated on the basis of a range of different backgrounds. These backgrounds take some account of the uncertainties relating to future generation, which include: the relative likelihood of prospective new future generation projects proceeding to completion; as yet un-notified future generation disconnections (closures); 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.

- Back to top
- Next

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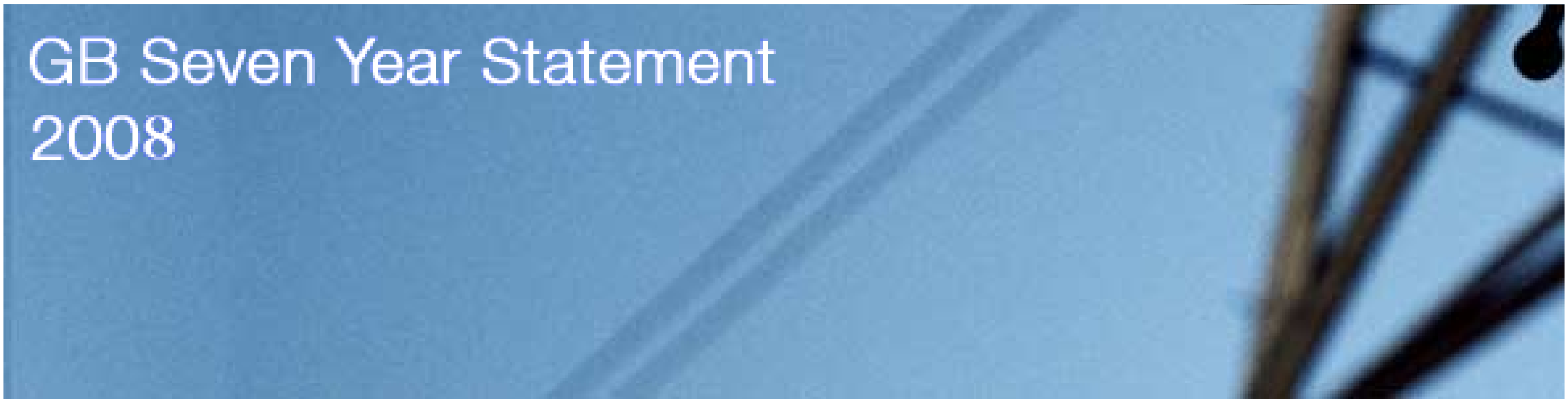

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Table 7.2 - SYS Study Zones, Studied Zonal Generation, Demand and Transfer (MW)

Zone	Zone Name	Quantity	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z1	North West (SHETL)	Effective Generation	914	1045.4	1034.9	911.5	1264.4	1366.4	1624.7
Z1	North West (SHETL)	Demand	531.4	568.8	569.9	544.9	511.3	524.6	534.2
Z1	North West (SHETL)	Planned Transfer	382.6	476.6	465	366.6	753.1	841.8	1090.5
Z2	North (SHETL)	Effective Generation	1300.7	1282.2	1268.8	1266.1	1319.6	1353.3	1500.7
Z2	North (SHETL)	Demand	582.5	591.2	598.2	599.9	607.1	615.1	628.3
Z2	North (SHETL)	Planned Transfer	718.2	691	670.6	666.2	712.5	738.2	872.4
Z3	Sloy	Effective Generation	275.8	316.1	312.9	254.1	365.4	330.3	330.6
Z3	Sloy	Demand	66.4	68.8	69.9	70.3	73.2	75	74.9
Z3	Sloy	Planned Transfer	209.4	247.3	243	183.8	292.2	255.3	255.7
Z4	South (SHETL)	Effective Generation	332.3	327.6	457.5	456.4	463.1	517.8	498.3

Z4	South (SHETL)	Demand	512.3	517.4	527.9	530.8	531.4	539.6	553.5
Z4	South (SHETL)	Planned Transfer	-180	-189.8	-70.4	-74.4	-68.3	-21.8	-55.2
Z5	North (SPT)	Effective Generation	2368.2	2379.7	2395.9	2295.9	2216.5	2125.2	2023.7
Z5	North (SPT)	Demand	1237.5	1248.1	1253.9	1262.8	1271	1276.7	1293.1
Z5	North (SPT)	Planned Transfer	1130.7	1131.6	1142	1033.1	945.5	848.5	730.6
Z6	South (SPT)	Effective Generation	3514	4193	4471	4888	5198	5254	5256
Z6	South (SPT)	Demand	3173	3200	3223	3236	3277	3300	3337
Z6	South (SPT)	Planned Transfer	341	993	1248	1652	1921	1954	1919
Z7	North & NE England	Effective Generation	3028.4	2579	3096.4	3739.2	3814.2	3850.9	5855.4
Z7	North & NE England	Demand	3101	3125	3187	3208	3297	3344	3569
Z7	North & NE England	Planned Transfer	-72.6	-546	-90.6	531.2	517.2	506.9	2286.4
Z8	Yorkshire	Effective Generation	11537.3	11081.9	11293.3	11647.9	11843.6	11512.6	11482.8
Z8	Yorkshire	Demand	5920	5953	6010	6312	6368	6407	6492
Z8	Yorkshire	Planned Transfer	5617.3	5128.9	5283.3	5335.9	5475.6	5105.6	4990.8
Z9	NW England & N Wales	Effective Generation	8374.8	7688	7268.9	6924.1	7430.4	7441.7	6984.5
Z9	NW England & N Wales	Demand	8043	8117	8293	8874	8914	9050	9116
Z9	NW England & N Wales	Planned Transfer	331.8	-429	-1024.1	-1949.9	-1483.6	-1608.3	-2131.5
Z10	Trent	Effective Generation	4303.5	5472.4	5925.5	6552.9	6664.4	6597.8	6581.5
Z10	Trent	Demand	623	638	654	671	694	689	724
Z10	Trent	Planned Transfer	3680.5	4834.4	5271.5	5881.9	5970.4	5908.8	5857.5
Z11	Midlands	Effective Generation	3433.8	4267	4348.8	4301.5	4374.2	4330.8	3936.3
Z11	Midlands	Demand	7687	7728	7867	7928	8010	8058	8124
Z11	Midlands	Planned Transfer	-4253.2	-3461	-3518.2	-3626.5	-3635.8	-3727.2	-4187.7
Z12	Anglia & Bucks	Effective Generation	3616.9	3490.1	3738.1	5021	5489.3	5722.8	5065.4
Z12	Anglia & Bucks	Demand	5771	5377	5959	5570	5670	5725	6324

Z12	Anglia & Bucks	Planned Transfer	-2154.1	-1886.9	-2220.9	-549	-180.7	-2.2	-1258.6
Z13	S Wales & Central England	Effective Generation	6307.1	7970.3	8462.2	8820.2	7547.4	8334.7	8080.6
Z13	S Wales & Central England	Demand	5373	5411	5476	5541	5601	5701	5779
Z13	S Wales & Central England	Planned Transfer	934.1	2559.3	2986.2	3279.2	1946.4	2633.7	2301.6
Z14	London	Effective Generation	1727.4	1182.4	1205.3	1192.7	896	888	885.1
Z14	London	Demand	10175	10409	10546	10816	11014	11118	11217
Z14	London	Planned Transfer	-8447.6	-9226.6	-9340.7	-9623.3	-10118	-10230	-10331.9
Z15	Thames Estuary	Effective Generation	8282.7	6758.9	5568.1	4211.5	4279.2	4240.8	3768.3
Z15	Thames Estuary	Demand	2180	2758	2273	2876	2880	2906	2357
Z15	Thames Estuary	Planned Transfer	6102.7	4000.9	3295.1	1335.5	1399.2	1334.8	1411.3
Z16	Central S Coast	Effective Generation	960.8	1164.4	1186.3	1173.7	1193.1	1182	1178.1
Z16	Central S Coast	Demand	4275	4312	4353	4392	4423	4457	4482
Z16	Central S Coast	Planned Transfer	-3314.2	-3147.6	-3166.7	-3218.3	-3229.9	-3275	-3303.9
Z17	South West England	Effective Generation	1775.4	1706	1738.9	1720	1749.1	1730.9	2570.2
Z17	South West England	Demand	2802	2882	2912	2944	2966	2994	3017
Z17	South West England	Planned Transfer	-1026.6	-1176	-1173.1	-1224	-1216.9	-1263.1	-446.8
All	Total	Effective Generation	62053.1	62904.3	63772.8	65376.7	66108	66780	67622
All	Total	Demand	62053.1	62904.3	63772.8	65376.7	66108	66780	67622
All	Total	Planned Transfer	0	0	0	0	0	0	0

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Table 7.3 - Studied Boundary Generation, Demand and Transfer (MW)

Boundary	Boundary NAme	Quantity	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B1	SHETL North West	Effective Generation	914	1045.4	1034.9	911.5	1264.4	1366.4	1624.7
B1	SHETL North West	Demand	531.4	568.8	569.9	544.9	511.3	524.6	534.2
B1	SHETL North West	Planned Transfer	382.6	476.6	465	366.6	753.1	841.8	1090.5
B2	SHETL North - South	Effective Generation	2214.7	2327.6	2303.7	2177.6	2584	2719.7	3125.4
B2	SHETL North - South	Demand	1113.9	1160	1168.1	1144.8	1118.4	1139.7	1162.5
B2	SHETL North - South	Planned Transfer	1100.8	1167.6	1135.6	1032.8	1465.6	1580	1962.9
B3	Sloy	Effective Generation	275.8	316.1	312.9	254.1	365.4	330.3	330.6
B3	Sloy	Demand	66.4	68.8	69.9	70.3	73.2	75	74.9
B3	Sloy	Planned Transfer	209.4	247.3	243	183.8	292.2	255.3	255.7

B4	SHETL - SPT	Effective Generation	2822.8	2971.3	3074.1	2888.1	3412.5	3567.8	3954.3
B4	SHETL - SPT	Demand	1651.5	1682.9	1705.1	1711.2	1723	1754.3	1790.9
B4	SHETL - SPT	Planned Transfer	1171.3	1288.4	1369	1176.9	1689.5	1813.5	2163.4
B5	SPT North - South	Effective Generation	5191	5351	5470	5184	5629	5693	5978
B5	SPT North - South	Demand	2889	2931	2959	2974	2994	3031	3084
B5	SPT North - South	Planned Transfer	2302	2420	2511	2210	2635	2662	2894
B6	SPT - NGET	Effective Generation	8705	9544	9941	10072	10827	10947	11234
B6	SPT - NGET	Demand	6062	6131	6182	6210	6271	6331	6421
B6	SPT - NGET	Planned Transfer	2643	3413	3759	3862	4556	4616	4813
B7	Upper North	Effective Generation	11731	12120	13034	13809	14641	14798	17089
B7	Upper North	Demand	9163	9256	9369	9418	9568	9675	9990
B7	Upper North	Planned Transfer	2568	2864	3665	4391	5073	5123	7099
B8	North - Midlands	Effective Generation	31627	30868	31576	32370	33914	33753	35555
B8	North - Midlands	Demand	23126	23326	23672	24604	24850	25132	25598
B8	North - Midlands	Planned Transfer	8501	7542	7904	7766	9064	8621	9957
B9E	Midlands - South (Export)	Effective Generation	39358	40596	41839	43218	44952	44682	46072
B9E	Midlands - South (Export)	Demand	31436	31692	32193	33203	33554	33879	34446
B9E	Midlands - South (Export)	Planned Transfer	7922	8904	9646	10015	11398	10803	11626
B9I	Midlands - South (Import)	Effective Generation	22652	22246	21875	22126	21153	22100	21546
B9I	Midlands - South (Import)	Demand	30576	31149	31519	32139	32554	32901	33176

B9I	Midlands - South (Import)	Planned Transfer	-7924	-8903	-9644	-10013	-11401	-10801	-11630
B10	South Coast	Effective Generation	2734	2867	2922	2892	2942	2913	3748
B10	South Coast	Demand	7077	7194	7265	7336	7389	7451	7499
B10	South Coast	Planned Transfer	-4343	-4327	-4343	-4444	-4447	-4538	-3751
B11	North East & Yorkshire	Effective Generation	23259	23189	24315	25450	26484	26311	28571
B11	North East & Yorkshire	Demand	15083	15209	15379	15730	15936	16082	16482
B11	North East & Yorkshire	Planned Transfer	8176	7980	8936	9720	10548	10229	12089
B12	South & South West	Effective Generation	9036	10828	11375	11707	10489	11248	11828
B12	South & South West	Demand	12450	12605	12741	12877	12990	13152	13278
B12	South & South West	Planned Transfer	-3414	-1777	-1366	-1170	-2501	-1904	-1450
B13	South West	Effective Generation	1774	1704	1737	1719	1749	1731	2570
B13	South West	Demand	2802	2882	2912	2944	2966	2994	3017
B13	South West	Planned Transfer	-1028	-1178	-1175	-1225	-1217	-1263	-447
B14	London	Effective Generation	1726	1181	1204	1192	896	888	885
B14	London	Demand	10175	10409	10546	10816	11014	11118	11217
B14	London	Planned Transfer	-8449	-9228	-9342	-9624	-10118	-10230	-10332
B15	Thames Estuary	Effective Generation	8276	6751	5562	4209	4279	4241	3768
B15	Thames Estuary	Demand	2180	2758	2273	2876	2880	2906	2357
B15	Thames Estuary	Planned Transfer	6096	3993	3289	1333	1399	1335	1411
B16	North East, Trent & Yorkshire	Effective Generation	27559	28655	30234	31999	33148	32909	35152
B16	North East, Trent & Yorkshire	Demand	15706	15847	16033	16401	16630	16771	17206

B16	North East, Trent & Yorkshire	Planned Transfer	11853	12808	14201	15598	16518	16138	17946
B17	Midlands	Effective Generation	3431	4262	4344	4299	4374	4331	3936
B17	Midlands	Demand	7687	7728	7867	7928	8010	8058	8124
B17	Midlands	Planned Transfer	-4256	-3466	-3523	-3629	-3636	-3727	-4188

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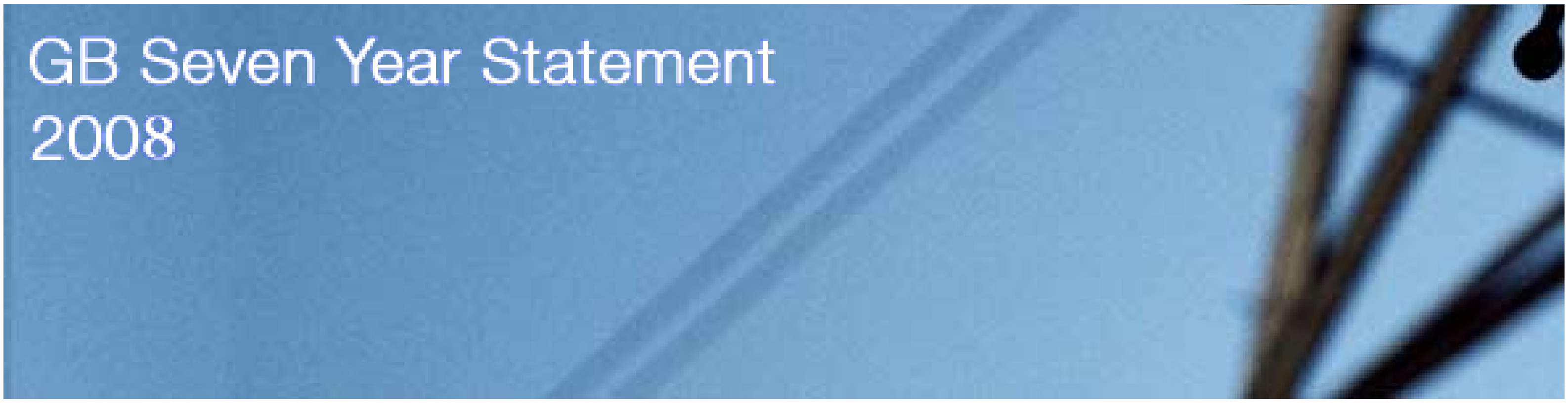

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Table 7.4 - System Power Losses at Peak

Category	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Transmission Heating Losses excluding GSP Transformers (MW)	880.9	866.3	997.7	1132.2	1366.5	1363.6	1558.2
Fixed Losses (MW)	272	273	276	278	278	278	280
GSP Transformer Heating Losses (MW)	123.4	129	130.5	135.2	144.7	155.7	168.9
Generator Transformer Heating Losses (MW)	122.2	117.3	128.7	166.6	165.4	170.8	176.6
Total Losses	1398.5	1385.6	1532.9	1712	1954.6	1968.1	2183.7
ACS Peak Demand (MW) excluding Losses and Station Demand	60874.5	61696.4	62459.2	63205.9	63765.5	64397.7	64918.4
Total Losses as percentage of Demand	2.3	2.25	2.45	2.71	3.07	3.06	3.4

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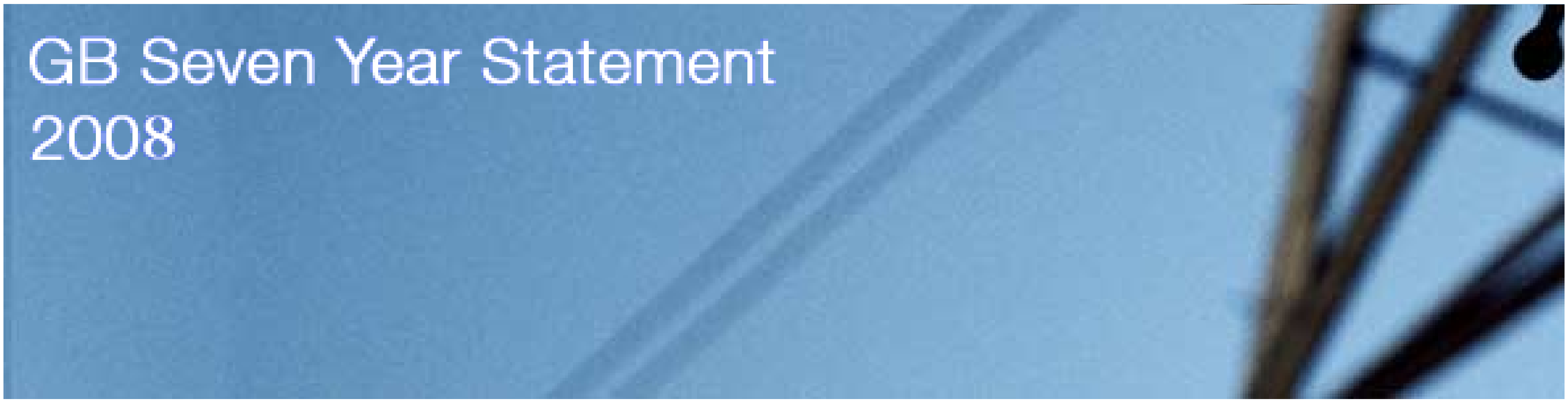

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Table 7.5 - Effectiveness of Marginal Generation due to Transmission Losses

Zone Number	Zone Name	Licensee	Effectiveness(%)
Z1	North West (SHETL)	SHETL	<90
Z2	North (SHETL)	SHETL	<90
Z3	South (SHETL)	SHETL	<90
Z4	Sloy (SHETL)	SHETL	<90
Z5	North (SPT)	SPT	94
Z6	South (SPT)	SPT	97
Z7	North & NE England	NGET	101
Z8	Yorkshire	NGET	101
Z9	NW England & N Wales	NGET	103
Z10	Trent	NGET	108
Z11	Midlands	NGET	101
Z12	Anglia & Bucks	NGET	107
Z13	S Wales & Central England	NGET	110
Z14	London	NGET	107
Z15	Thames Estuary	NGET	106
Z16	Central S Coast	NGET	103

Z17	South West England	NGET	104

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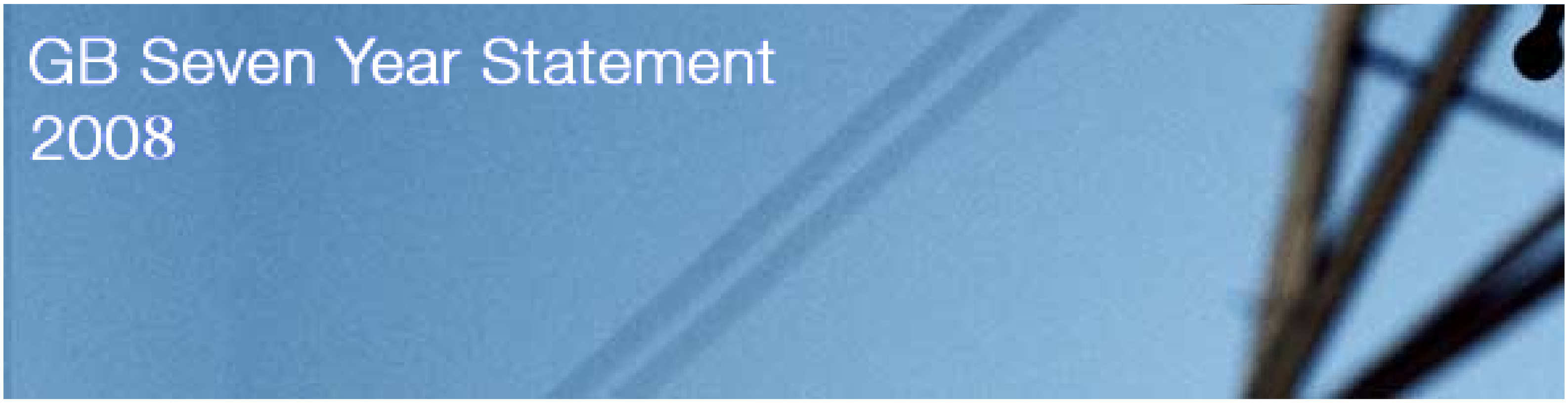


Introduction to Chapter 8

This chapter describes the capability of the GB transmission system to transport power at the time of the system ACS peak. The power system analyses underlying many of the results discussed in this chapter have been conducted on the basis of the deterministic SYS background. The deterministic SYS background comprises the customer based demand forecasts of Electricity Demand , the existing and future transmission contracted generation of Generation and the existing and planned transmission network described in GB Transmission System. It should be noted that calculated system capabilities are a function of the generation, demand and transmission background against which they are assessed. Accordingly, the computed capabilities reported in this chapter are those which would arise should the SYS background be realised at the time of system peak. At other times and/or against other backgrounds different transmission capabilities may arise.

As explained in previous chapters, there is uncertainty associated with the demand forecasts and with future generation developments. Thus, it should be recognised that the SYS background does not necessarily represent the most likely outcome, nor should it be regarded as a 'forecast' of the outcome. Uncertainties in demand and generation developments will affect future power transfers, transmission system capabilities, the need or otherwise for transmission system reinforcements and the opportunities for making new or further use of the transmission system.

In view of this, the transfers and capabilities arising from the deterministic SYS background have been presented against the backdrop of a range of probabilistic transfers. These probabilistic transfers reflect, in part, our current views on a range of criteria, which influence the likely future outcome given the various generation and demand uncertainties. This presentation is intended to provide a more meaningful view of future transfers, promote a better appreciation of the future uncertainty we face in planning the system and enable the reader to make more informed judgements on the opportunities for making new or further use of the transmission system.

The chapter also identifies those reinforcements which could be required, in addition to the planned reinforcements presented in GB Transmission System, to achieve compliance with the Licence Standard on the basis of the SYS background. These additional reinforcements are subject to variation and should be regarded as indicative only.

The probabilistic range of transfers, which are presented in this chapter, have been derived using a National Grid program called the Generation Uncertainty Model (GUM). To provide a greater understanding of the probabilistic results presented and how they should be interpreted, the chapter includes a high level description of GUM.

System Boundaries

An understanding of the capability of the GB transmission system to transport power leads to an understanding of the ability of the GB transmission system to accommodate further generation and demand in different zones across the system. When considering the capability of the system, it is useful to consider the limits on the bulk transfer of power across certain system boundaries.

Accordingly, this chapter reports on a number of key boundary capabilities and, for this purpose, the 17 SYS boundaries described in SYS Boundaries and SYS Study Zones and shown in Figure A.1.6. These boundaries are also shown in Figure A.2.3 for SHETL, Figure A.3.3 for SPT and Figure A.4.3 for NGET. These 17 boundaries have historically reflected some of the main weaknesses on the interconnected system. Such weaknesses can lead to the need to restrict power flows across the system; possibly through the potentially uneconomic constrained operation of generating plant. Alternatively, transmission weaknesses may be removed through some form of transmission reinforcement. Although the most critical boundaries may not now be precisely the same as those studied, the 17 boundaries which have been used remain relevant for illustrating system trends and limitations.

Consideration of the range of possible future transfers across each of the 17 boundaries enables us to describe the type of reinforcement schemes, which may be required in order to ensure continued compliance with the Licence Standard.

Boundary Capabilities and Required Capabilities

Two types of system limitation, relating to the transfer of power across a boundary, have been considered. The first relates to thermal capability and the second to voltage capability. The boundary capabilities have been evaluated for the time of the system winter peak demand of 2008/09, 2010/11, 2012/13 and 2014/15 and are on the basis of the SYS background. These capabilities will, of course, potentially change at off-peak times but, as explained in Off-Peak Power Flows, in the 'real time' operational time-phase, the system is managed such that it complies at all times with operational criteria of the Licence Standard.

As mentioned above, the Licence Standard defines certain unacceptable conditions, which shall not occur as a result of specific secured events. The unacceptable conditions referred to include:

- loss of supply capacity (except as permitted by specific demand connection criteria);
- unacceptable overloading of any primary transmission equipment;
- unacceptable voltage conditions or insufficient voltage performance margins; and
- system instability.

For example, in the case of planning the development of the Main Interconnected Transmission System, a boundary in which a single circuit is out of service due to a fault, must be capable of transferring the Planned Transfer (as defined in the Licence Standard) plus an allowance (also specified in the Licence Standard) to take account of non-average conditions (e. g. relating to power station availability, weather and demand) without any of the above unacceptable conditions arising. The allowance, referred to, is calculated by an empirical method described in the Licence Standard and is called the "Interconnection Allowance".

Similarly, the Licence Standard also requires that a boundary, in which two circuits are out of service (i.e. N-2 or N-D as appropriate), must be able to transfer the Planned Transfer plus half the calculated Interconnection Allowance without any unacceptable conditions arising.

Accordingly, the boundary thermal capability is the power flow that can be transferred across the boundary without causing any unacceptable conditions following the outage of two circuits (i.e. N-2 or N-D) as defined in the Licence Standard. The overall boundary capability is the lower of the thermal (MW) and voltage capabilities. Known stability limitations are also reported in the Boundary Commentary section which is presented later in this chapter. The required capability is simply the Planned Transfer plus half the Interconnection Allowance.

Please note, however, that application of the Interconnection Allowance (or part thereof) relates only to those boundaries, which divide the system into two contiguous parts, the smaller of which contains more than 1500MW of demand. In the case of the boundaries, which have been defined for the NGET and SPT systems, this is always the case. However, for a number of boundaries in the SHETL system (namely: boundaries B1, B2 and B3), this is not the case and, in these instances, the required capability quoted is simply the Planned Transfer.

The boundary capabilities reported in this chapter give an indication of the maximum boundary transfer that can be supported without contravening any of the above unacceptable conditions following a secured event. A boundary capability that is less than the required capability indicates a need for transmission reinforcement. A boundary capability that is greater than the required capability shows only that the security criteria are satisfied for the particular transfer conditions and background studied.

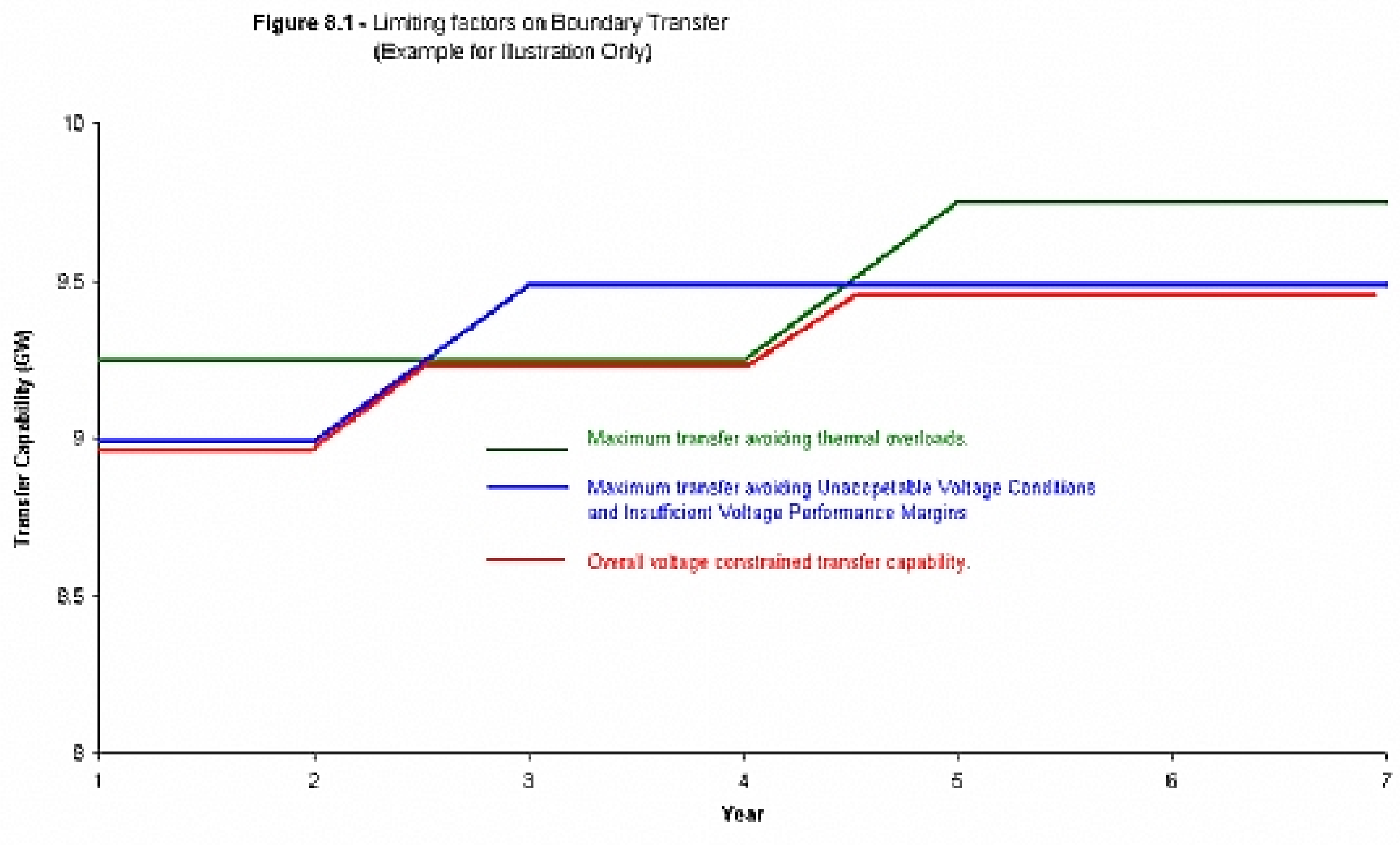
While not identical (particularly for voltage control and fault levels), in terms of flows on the system, the withdrawal of generation will have a broadly similar effect to the addition of demand and vice versa. The amount by which a boundary capability exceeds the required capability gives an indication of the approximate extent of 'spare' transfer capacity on that boundary. However, this does not necessarily mean that an equivalent volume of additional generation on the exporting side of the boundary (or an equivalent volume of additional demand on the importing side) can be readily accommodated. This can be due to a number of reasons including:

- there may be a need for 'local' reinforcements not directly related to the boundary;
- as additional generation or demand is connected to the system, the background against which both the required capability and boundary capability are assessed changes; and
- the security criteria must be satisfied for all system boundaries indicated by the Licence Standard, i.e. while a particular connection may satisfy conditions for one boundary, it may fail to do so for another.

The nature of a boundary capability can be illustrated by separately establishing the voltage capability and the thermal capability. The way in which voltage or thermal considerations might be the limiting factor in different years is illustrated in Figure 8.1. The voltage capability is shown as a blue line (this may arise either because of unacceptable voltage conditions or insufficient voltage performance margin, whichever limit arises first), and the thermal capability as a green line. The net boundary capability is shown by the red line.

Figure 8.1

Click to load a larger version of Figure8.1 image



Deterministic Transfers

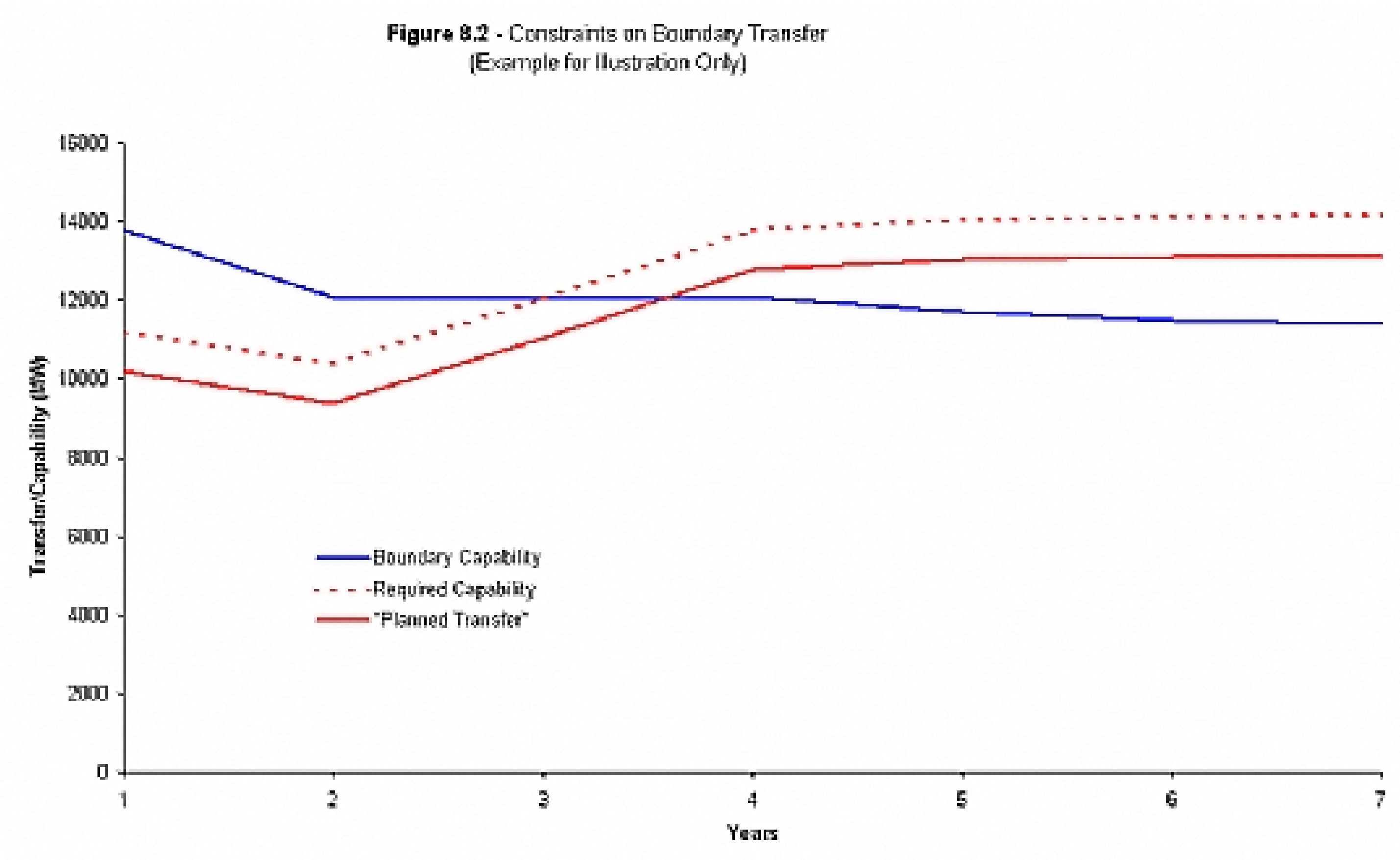
The power flows presented in this chapter are based on the deterministic SYS background. There is inherent uncertainty associated with the assumptions underlying any deterministic background. For example demand and generation may, in the event, deviate from any of the deterministic assumptions underlying the background. Uncertainty must also therefore be attributed to both the resultant deterministic power flows and any consequent perceived need for transmission reinforcement. The SYS background is no exception and, while it has been selected as the most reasonable deterministic background for the purposes of Chapter 7, it should not be assumed that it represents the most likely future outcome.

For ease of explanation, the boundary commentaries presented later in this chapter include a series of figures (Figure 8.B1 , Figure 8.B2 , Figure 8.B3 , Figure 8.B4 , Figure 8.B5 , Figure 8.B6 , Figure 8.B7 , Figure 8.B8 , Figure 8.B9 , Figure 8.B10 , Figure 8.B11 , Figure 8.B12 , Figure 8.B13 , Figure 8.B14 , Figure 8.B15 , Figure 8.B16 and Figure 8.B17). Amongst other things, each of these figures shows the planned transfer, the required capability and the actual calculated capability for the relevant boundary. These values are all calculated on the basis of the deterministic SYS background and, in view of this, they are often referred to as the "SYS Transfer", the "SYS Required Transfer" and the "SYS Capability" respectively.

As specified by the Licence Standard, for a particular generation and demand background, the required capability is simply the planned transfer enhanced by the appropriate Interconnection Allowance for the boundary in question. Where the required capability is less than the actual boundary capability, there is no need for further reinforcement in respect of that particular boundary. An example of this is given in Figure 8.2, which illustrates that the required capability exceeds the actual capability from around year 3 onwards indicating a potential need for further reinforcement on the basis of the SYS background.

Figure 8.2

Click to load a larger version of Figure8.2 image



The boundary capabilities quoted in this chapter relate to planning the medium to long term future development of the system and are not necessarily appropriate to the real time operation of the system. Operational boundary capabilities are a function of the real time transfer, which can be achieved within operational timescales for a given pattern of system outages, demand and generation availability. In operational timescales each of these factors is known with a relatively high degree of certainty, which is unlike in the planning time phase where there is a need to consider a great many more uncertainties.

The boundary capabilities reported in this chapter do, nevertheless, provide a good broad appreciation of the overall capability of the GB transmission system to transport power. An apparent surplus of boundary capability over the required capability generally shows the exporting side to have at least some potential for additional generation and the importing side to have some potential for additional demand. A deficit of boundary capability against the required capability provides an indication that, were the SYS background to be realised, either investment to reinforce the system and thereby enhance the capability may be appropriate, or alternatively constrained operation of generation is required in order to limit the boundary transfers to within acceptable levels.

The possible need, or otherwise, for transmission reinforcement is discussed under Boundary Commentary.

Finally, for the purpose of providing the power flow information reported in this chapter and in Chapter 7, it is first necessary to be able to obtain a converged AC power flow study at least for the intact system and for the Planned Transfer Condition. Under the SYS background there are a number of boundaries for which the boundary capability is substantially lower than the planned transfer in a number of years. In those cases where such deficits are large, convergence of the AC power flow program may be inhibited. In such cases it may be necessary to add a minimum number of indicative system reinforcements solely for the purpose of obtaining convergence of the Planned Transfer Condition. These 'indicative convergence works' (e.g. reactive compensation to achieve acceptable voltage conditions) are not necessarily sufficient for compliance with the

Licence Standard, and the boundary capabilities have been quoted with them included.

Probabilistic Transfers

The Generation Uncertainty Model (GUM)

Deterministically derived boundary transfers are useful but have limited value since they do not consider the uncertainties associated with projected future demand and generation developments. It is important to take account of the potential impact of these uncertainties on power transfers across key transmission boundaries when considering the merits of transmission reinforcements.

For a given set of assumptions relating to demand and generation, the Generation Uncertainty Model (GUM) provides a probabilistic representation of the electricity market. GUM employs a Monte Carlo model in which openings of new generating stations and closures of existing stations are randomly selected (subject to the influence of the input assumptions) against a background of uncertain demand growth. The resultant probabilistic transfers reflect our current view of how the planned transfers across each of the 17 boundaries at the time of system peak are likely to develop over the next seven years.

Factors which have been taken into account in compiling the input data for GUM include but are not limited to the possible:

- variations in demand growth;
- variations in Plant Margin;
- generation closure and placing in reserve (station CEC=TEC=0 or TEC < station CEC). Within GUM these are referred to as "closures";
- return to service of plant currently held in reserve. Within GUM these are referred to as "re-openings";
- new power stations, which have received approval, proceeding to completion. Within GUM these are referred to as "openings";
- additional proposed new power stations receiving approval and proceeding to completion. Within GUM these are again referred to as "openings";
- termination or modification to current generation connection agreements; and
- variations (including exports) in transfers over the External Interconnections with External Utilities.

It is not possible to provide the detail of the input assumptions we have made since this would breach our obligations on commercial confidentiality. The probabilistic transfer information is provided without prejudice and reflects our current view of future uncertainty. Clearly, this view may change as developments in the electricity market in Great Britain unfold, but nevertheless it should prove a useful complement to the simple deterministic SYS background approach.

The purpose of presenting this additional information is to:

- provide a more meaningful view of the possible range of future boundary transfers given an unconstrained transmission system;
- place the deterministic SYS background based boundary transfers and capabilities in the context of what we currently believe to be the likely range of future transfers;
- promote an appreciation of the future uncertainty in relation to planning the development of the transmission system; and
- enable the reader to make more informed judgements on the opportunities for making new or further use of the transmission system without incurring the need for major inter-zonal transmission reinforcement.

Overview of GUM Analyses

For each year within the period of study, GUM models the system at the time of peak demand on the GB transmission system. This is consistent with the deterministic boundary transfer and capability analyses. The program does not simulate the system year-round; its purpose is to model the generating capacity that might be available to meet the likely peak demand.

The input information provided to GUM reflects our current views on the various generation and demand uncertainties. Our market intelligence in this area is largely based on material in the public domain. In compiling the input assumptions we have tried to avoid introducing any bias. Clearly, our views may change as developments in the electricity market in Great Britain unfold. Nevertheless, the results obtained from GUM analyses should prove more stable than a simple deterministic approach.

There are currently more generation projects proposed than are essential to meet forecast demand. From experience, we consider it unlikely that all of these projects will be completed as planned. Some may slip from their planned commissioning dates while others will be terminated. At the same time, some existing plant can be expected to close down due to age alone while some may close due to competitive pressure from more efficient new market entrants or due to increasing pressure due to environmental constraints. We are not attempting to predict specific generation openings and closures, yet we need to know their probable effects on the power flows on the transmission system. GUM can be used to provide us with this information.

To estimate the probable ranges of power transfer, GUM randomly selects generator openings and closures, balancing the probable generation capacity against probable peak demand and probable Plant Margin. The random selections are weighted according to a range of input information and criteria, which influence the likelihood of the station opening or closing. Weightings for station openings consider, but are not limited to, the stage of development activity for the stations (which includes issues such as consents status), environmental impact, thermal efficiency, fuel type, and availability of fuel, water, and transmission. Weightings for station closure include, but are not limited to, age, thermal efficiency, fuel delivery, fuel type, availability and environmental impact.

By making random selections of demand and generation according to the given probability functions and weightings, GUM generates up to 10,000 demand/generation permutations or backgrounds. Each single background represents a time sequence of demand growth, plant openings and plant closures running from 2008/09 to 2014/15

However, a typical GUM analysis does not model every possible future; rather it represents a possible range of variations around the overall demand growth forecast and range of possibilities within the current list of generation projects. Changing the underlying assumptions (for example, a major change in relative fuel costs, or changes in the location and timing of new generation projects) would have some effect on the power transfer ranges.

GUM Boundaries and Zones

For each of the 10,000 backgrounds, GUM calculates the net generation capacity surplus or deficit for each specified GUM zone or group of GUM zones. This surplus or deficit then permits the calculation of the range of possible transfers out of or into each specified zone or group of zones for each sampled generation background. By calculating the net transfer for each of the 10,000 backgrounds within each year of the study period, it is possible to show probabilistic ranges of net transfers into or out of each specified zone, or group of zones, year by year. The program only considers net transfers. Since GUM does not incorporate a network model, it does not in itself calculate power flows across individual circuits.

As with the deterministic analyses, it is useful to consider probabilistic power transfers across certain critical boundaries. The GUM analyses presented in this chapter are based around the SYS Boundaries and SYS Study Zones introduced in SYS Boundaries and SYS Study Zones. Since GUM calculates net imports and exports for zones and groups of zones, all GUM boundaries are defined in terms of the complete boundary surrounding specified single zones or groups of zones.

Accordingly, each boundary under study is defined in terms of the zones on one side of that boundary. Table 8.1 lists the defining zones on one side of each of the main SYS boundaries. For boundaries B10 & B12 the defining zones are south of the boundary. For boundaries B3, B13, B14, B15 & B17 the defining zones are those encompassed by the boundary. For all other boundaries, the defining zones are north of the boundary.

Presentation of Results

The Fan Diagram

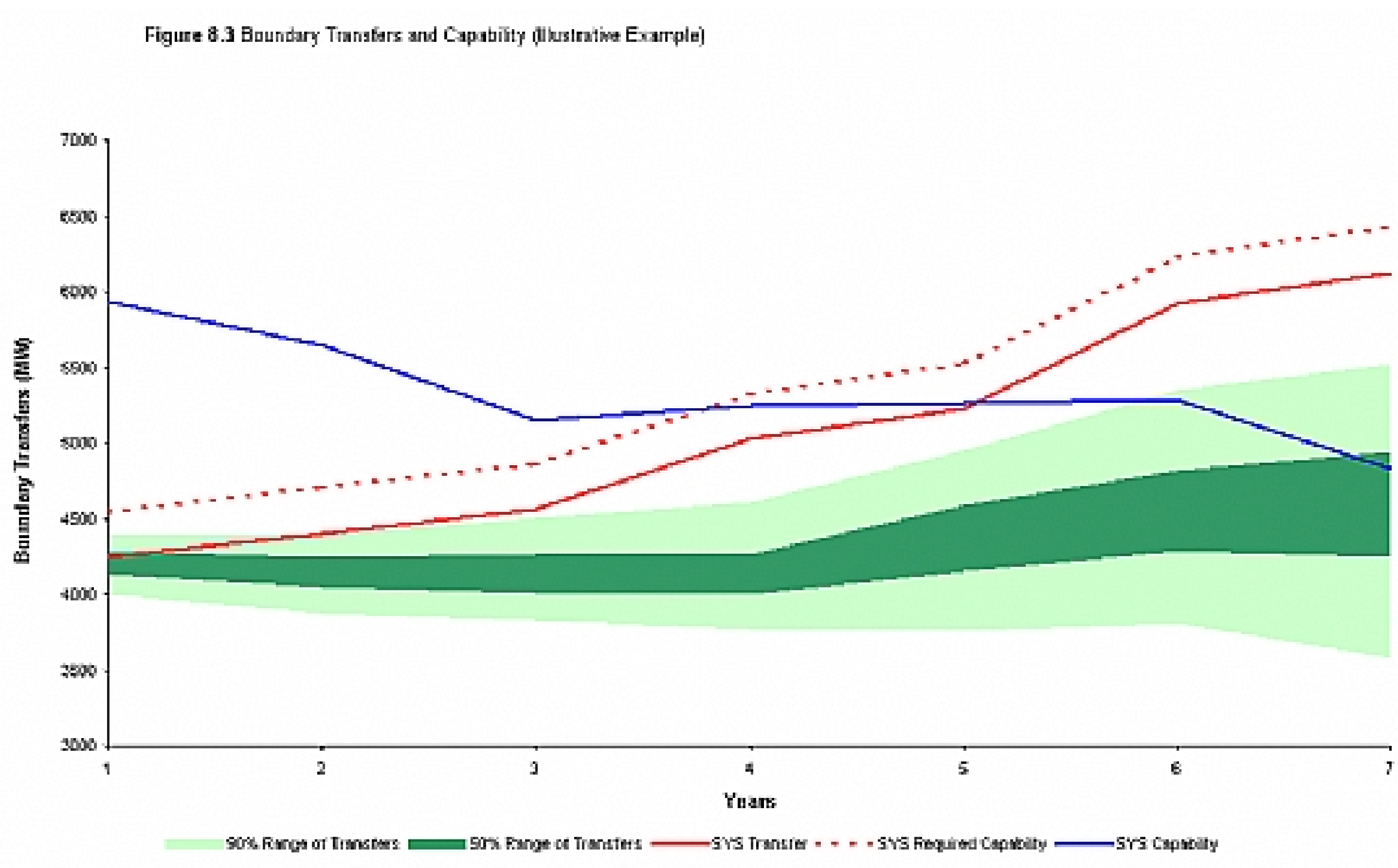
A key output of GUM is the probabilistic range of transfers over a given period for each defined boundary. For each year of the study, GUM calculates probabilistic distributions of power transfers for each boundary under peak load conditions. These distributions could be plotted as separate charts for each boundary for each year. However, a concise and convenient method of presenting the results is to plot percentiles of the distributions to show how the range of probable transfers varies year by year for each boundary.

The resultant plots typically display a narrower range of transfers in the earlier years than in the later years, since there is greater certainty associated with the earlier years. The characteristic shape is therefore generally in the form of a fan and, in view of this, the diagrams are often referred to as "fan diagrams".

An illustrative example is given in Figure 8.3. The green shaded area shows the range of probabilistically derived transfers arising out of the GUM analyses. The deterministic SYS planned transfer, the deterministic SYS required capability and the deterministic SYS capability have been superimposed on top of the "fan" of probabilistic transfers for comparison.

Figure 8.3

Click to load a larger version of Figure8.3 image



In the illustrative example of Figure 8.3, the darker shaded central band extends (on the vertical axis) from the 25th to the 75th percentiles of the range of probabilistically derived transfers, and thus includes 50% of all such transfers across the boundary at the time of system peak. The wider area, encompassed by the lighter shaded bands runs from the 5th to the 95th percentile and thus, together with the dark band, includes 90% of transfers. The remaining 10% lie outside the shaded range. The fan of probabilistically derived transfers can be compared with the deterministic planned transfer for the single deterministic SYS background.

It does not follow that the probabilistic transfer arising from a background considered to be likely will necessarily be captured within the envelope range shown on the diagram. Nor does it follow that all the most commonly occurring transfers have highly probable backgrounds. In GUM, all backgrounds are equally probable. Nevertheless, the range of transfers displayed in the fan diagram does provide a very useful indicator of the most probable future planned transfer across the boundary given the possible combined effects of the various sources of generation and demand uncertainty. GUM can then be interrogated to reveal the details of any background underlying any transfer (point on the fan diagram) for further detailed analysis.

GUM takes as its starting point the existing pattern of zonal demand and generation at the time of the 2007/08 winter peak. Conditions in the following year should be fairly predictable, nevertheless there are uncertainties that are represented in GUM's probabilistic analysis. For example, a power station may be scheduled to commission by the 2008/09 winter peak, but construction may slip such that it is unable to contribute to the system peak demand until 2010/11. Variations and uncertainties relating to transfers across the External Interconnections with External Systems are included in the probabilistic analyses. This can account for a significant part of the range of uncertainty displayed in the fan diagrams.

Interpretation

In the arbitrary example given in Figure 8.3 the deterministic SYS required capability exceeds the SYS boundary capability by year four, which implies that there are no opportunities for additional generation on the exporting side of the boundary from that year without reinforcement. The probabilistic transfers, indicated by the fan, imply that the need for reinforcement is unlikely until the later years, if at all. Any reinforcement can therefore be delayed until the later years when the need becomes more certain.

However, as noted previously, these kinds of conclusions must be qualified by recognition that the boundary capability is dependent on the exact disposition of generation and demand in the background against which it is assessed. For example, interactions of generation openings and closures and changes in demand all on the same side of a boundary, or on opposite sides, can lead to little or no change in the 'Planned' boundary transfer but, nevertheless could give rise to a need for significant reinforcements in order to maintain system security. Nor would two backgrounds, which, result in similar transfers across a particular boundary necessarily, give rise to the need for the same transmission reinforcement across that boundary since the boundary capability is a function of how the boundary transfer is shared between the boundary circuits, which is in turn a function of the particular background under consideration.

An important message is that the requirement for transmission system reinforcement does not simply correspond to a given boundary transfer. The need for system reinforcement can still arise at transfers below the 'SYS capability' levels displayed in the series of figures (i.e. Figure 8.B1 to Figure 8.B17) included in the next section of this chapter.

Boundary Commentary

Background

For a better understanding of the results presented in this section the reader is advised to first read the previous sections of this chapter. In particular the format of the figures used is as presented in Figure 8.3. The SYS background transfers presented are consistent with the power flow studies discussed in GB Transmission System Performance which were also based on the generation ranking order of operation given in Table 7.1.

Please note that the transfers displayed in the series of figures which follow (i.e. Figure 8.B1 to Figure 8.B17) relate to the time of system peak demand. The capabilities shown are the transfer levels beyond which either thermal or voltage limitations become apparent on the Main Interconnected Transmission System. These SYS capabilities have been evaluated for the spot years 2008/09, 2010/11, 2012/13 and 2014/15 only. It is stressed that the SYS capabilities are appropriate for the SYS background and do not necessarily correspond to any of the many backgrounds appropriate to the probabilistic transfer range. The SYS capability does nevertheless provide a useful reference and initial indicator of overall capability.

The probabilistic transfer ranges shown are considered to be a more realistic representation of the likely transfer range than the single deterministic SYS background transfers and naturally receive attention in the commentary that follows. However, apart from a high level comparison, it is not possible to provide a detailed commentary on the probabilistic ranges since to do so could breach our obligations to our customers on commercial confidentiality. For the single deterministic SYS background transfers this is not a concern and accordingly greater detail has been included in the commentary.

In considering each of the following boundary commentaries it is useful to cross reference a number of tables presented elsewhere which are relevant to the SYS background transfers. Table 7.3 presents the SYS background studied generation, demand and transfer for each boundary. For ease of reference, each of the following boundary commentaries includes the relevant extract of Table 7.3 . Please refer to Table 3.7 for details of generation capacity changes under the SYS background over the period from 2000/01 to 2014/15, Table 3.10 for generation disconnections since 2000/01 and to Table 3.11 for generating units declared unavailable.

Overview

As explained in Chapter 3, access to the GB transmission system is provided through arrangements with National Grid, acting as GBSO, under the Connection and Use of System Code (CUSC). The CUSC sets out the contractual framework for connection to, and use of, the GB transmission system. The CUSC has applied across the whole of Great Britain since BETTA "go-live" (1 April 2005).

The removal, under BETTA, of the previous commercial arrangements for the use of the circuits connecting Scotland and England has given wider rights of GB system access than previously was the case. However, the volume of requirements for connection to and use the GB transmission system has meant that:

- there is a potential shortage of transmission system capacity, and
- as yet unplanned transmission reinforcement is required to maintain compliance with the Licence Standard.

The results, reported in this chapter, demonstrate this potential transmission capacity shortage under the SYS background. As a consequence, there is a potential need for significant reinforcement of the system in addition to those identified in Table 6.2.

After the introduction of BETTA , which brought about the removal of the administered Interconnection arrangements between England and Scotland, an extensive reinforcement programme is required to accommodate the required capabilities determined by the SYS background for boundaries in the border area. The projected commissioning of some 2GW of new transmission contracted generation in Scotland, substantially made up of wind farms, is dependant on the completion of the schemes which make up the planned Beauly/Denny transmission reinforcement. The Beauly/Denny reinforcement is included as part of the SYS background for commissioning by 2012/13. 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 this chapter.

Examination of the boundary transfer levels over the seven year period for the 'SYS background' indicates that:

- The major North-South flow boundaries B1 (SHETL North West Export), B2 (North to South SHETL), B4 (SHETL to SPT), B5 (North to South SPT), B6 (SPT – NGET), B7 (Upper North), B11 (Northeast & Yorkshire) and B16 (Northeast, Trent & Yorkshire) all show steady growth in power transfers throughout in the SYS period. This is a result of an increased power export through Scotland and into England, due primarily to contracted renewable energy developments throughout Scotland;
- For B8 (North to Midlands) the power transfer fluctuates considerably with generation changes north of the boundary however there is a general trend of increasing power transfer across the boundary.
- A steady increase in power transfer characterises B9 (Midlands to South) as new generation connects north of the boundary.
- Central London import (B14) show a trend of steadily increasing transfers reflecting the increasing demands and lack of new generation projects within this zone;
- West Midlands import (B17) show very little change after 2008/09 due to a balance between increasing demands and some generator openings;
- There is a general trend with reducing transfers across South & Southwest import (B12), while the South Coast import (B10) and South West import (B13) remain steady, throughout the SYS period, reflecting new plant that might be expected to commission in the South and Southwest in line with present contractual positions.

Comparison of the SYS Planned Transfers with the probabilistic ranges reveals that:

- for Boundaries 2, 6, 7, 8, 9, and 14 the SYS transfers generally lie towards the top of the likely transfer range;
- for Boundaries 3, 4, 5, 10, 11, 16 and 17, the SYS transfers generally lie towards the middle of the likely transfer range;
- for Boundaries 1, 12, 13 and 15 the SYS transfers generally lie towards the bottom of the likely transfer range.

Examination of Figure 8.B1 to Figure 8.B17 reveals a wide range in the width of the probabilistic transfer envelope across the various boundaries. For boundaries cutting large importing or exporting areas such as Boundary 8 (North to Midlands) and Boundary 9 (Midlands to South), the width of the probabilistic transfer envelope reflects, inter alia, the higher uncertainty associated with the larger tranche of generating plant on the exporting side. For other boundaries, such as Boundary 14 (London) which is an importing boundary dominated by a large demand with little generation, the width of the probabilistic transfer envelope is relatively narrow reflecting a higher degree of certainty.

Boundaries B6 (SPT – NGET), B7 (Upper North), B8 (North to Midlands), B9 (Midlands to South), B10 (South Coast import), B11 (Northeast & Yorkshire), B14 (London), B16 (Northeast, Trent & Yorkshire) and B17 (West Midlands) would all require reinforcement to be Licence Compliant for the SYS background.

Commentary

Boundary 1: SHETL North West

Figure 8.B1

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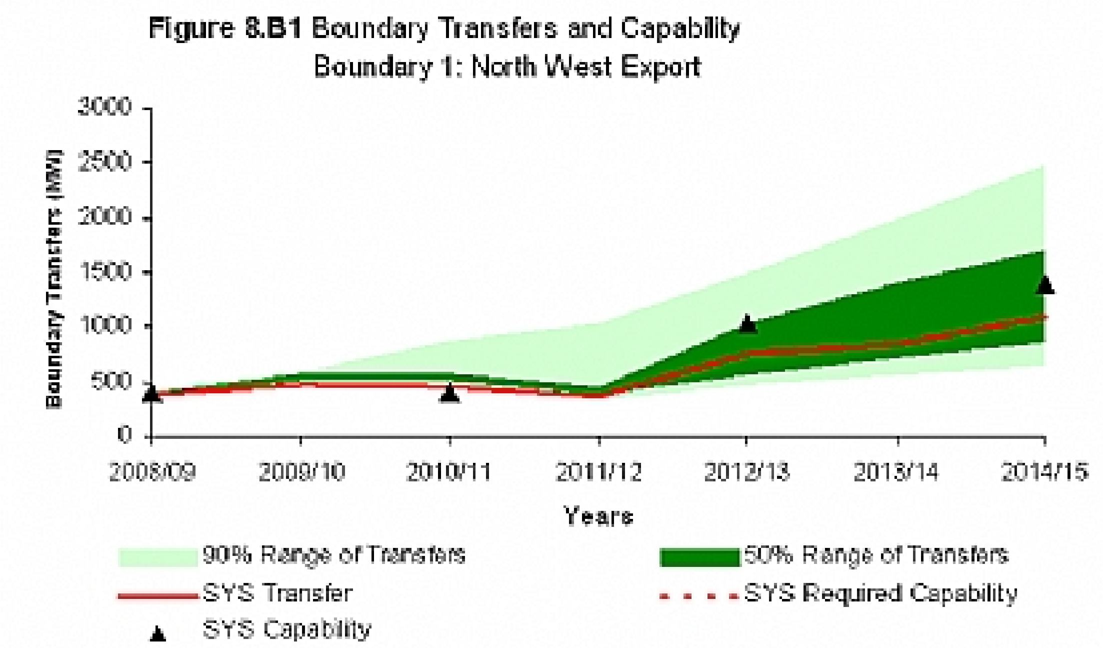

Figure 8.B1 Boundary Transfers and Capability
Boundary 1: North West Export

Figure 8.T1

Click to load a larger version of Figure8.T1 image

Figure 8-T1 - Boundary B1 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B1E	SHETL NORTH WEST (EXPORT)							
	Effective Generation	914	1045	1035	912	1264	1368	1625
	Demand	531	569	570	545	511	525	534
	Planned Transfer	383	477	465	367	753	842	1091
B1I	SHETL NORTH WEST (IMPORT)							
	Effective Generation	61139	61859	62738	64465	64844	65414	65997
	Demand	61522	62336	63203	64832	65597	66255	67088
	Planned Transfer	-383	-477	-465	-367	-753	-842	-1091

Generation to the north of this boundary is increasing at a significant rate due to the high volume of new wind based generation seeking connection in the area. Consequently, the boundary transfers are also increasing at a similar rate.

Please note that application of the Interconnection Allowance (or part thereof) relates only to those boundaries, which divide the system into two contiguous parts, the smaller of which contains more than 1500MW of demand. For this boundary (as with boundaries B2 and B3), this is not the case and accordingly the required capability is equal to the Planned Transfer.

The 2008/09 required capability for this boundary is just within the actual boundary capability. However, in 2009/10 the planned transfer exceeds the actual boundary capability indicating the need for transmission reinforcement. In practice, generation will only be connected up to the limit of the boundary until the transmission reinforcement has been completed.

The first of the proposed reinforcements for this boundary is the replacement of the existing 132kV double circuit tower line between Beauly, Fort Augustus, Errochty and Bonnybridge, by a new 400kV double circuit tower line terminating at Denny near Bonnybridge. Subject to wayleave and planning consents, this reinforcement referred to as Beauly-Denny will increase this boundary capability from 400MW to 1050MW. The additional generation connecting to the north of this boundary means that further reinforcement of this boundary will be required in the future. The proposed reinforcement in this case is strengthening of the transmission infrastructure between Beauly (near Inverness) and Keith/Blackhillock. As a first step the boundary capability can be raised to around 1400MW by reconductoring the existing 275kV transmission line between Beauly and Blackhillock. If required, further reinforcement between Beauly and Keith/Blackhillock could be provided in the form of a new transmission line. Furthermore, if the generation volumes warrant it then the transmission capacity can be increased by completion of a 400kV ring from Denny to Kincardine (via Errochty, Fort Augustus, Beauly, Keith, Kintore and Tealing). The 400kV ring can be achieved by making use of the proposed new line routes established between Beauly and Denny and between Beauly and Keith/Blackhillock as mentioned above, and using existing infrastructure from Keith down the east coast to Kincardine which is already constructed to 400kV.

Within the north west boundary, additional transmission reinforcements will be required to connect the proposed new generation. For example, to the north of Beauly, additional works between Beauly and Dounreay (near Thurso) will be required. This will comprise conductoring the spare side of the existing 275kV double circuit line between Beauly and Dounreay and installation of a 275kV busbar and a second 275/132kV transformer at Dounreay. Further reinforcement north of Beauly may be required depending on the location and volume of generation connections.

The significant interest from generation developers on the large Island groups of the Western Isles, Orkney and Shetland means that infrastructure will be required to connect these to the mainland transmission network.

The routes for all new transmission infrastructures will undergo detailed environmental impact assessment and will be subject to consents and planning approval.

Boundary 2: SHETL North - South

Figure 8.B2

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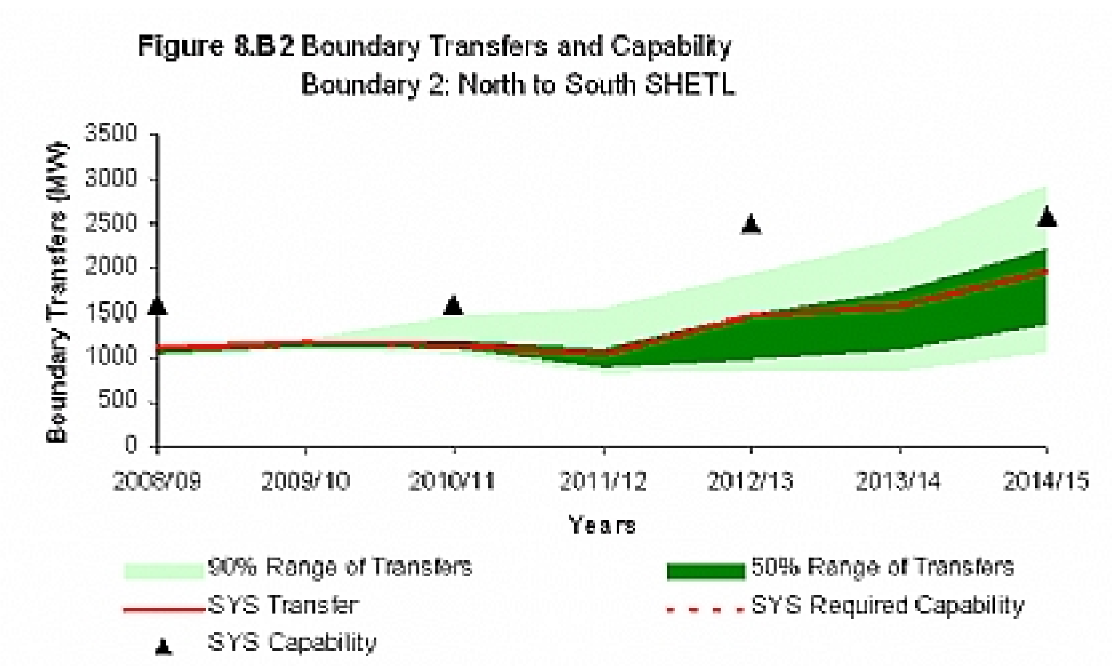

Figure 8.T2

Click to load a larger version of Figure8.T2 image

Figure 8-T2 - Boundary B2 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B2E	**SHETL NORTH - SOUTH (EXPORT)**							
	Effective Generation	2215	2328	2304	2178	2584	2720	3125
	Demand	1114	1160	1168	1145	1118	1140	1163
	Planned Transfer	1101	1168	1136	1033	1466	1580	1963
B2I	**SHETL NORTH - SOUTH (IMPORT)**							
	Effective Generation	59838	60577	61469	63199	63524	64060	64497
	Demand	60939	61744	62605	64232	64990	65640	66460
	Planned Transfer	-1101	-1168	-1136	-1033	-1466	-1580	-1963

Generation to the north of this boundary is increasing at a significant rate due to the high volume of new renewable generation seeking connection to the north of this boundary. Consequently, the boundary transfers are also increasing at a similar rate.

Please note that application of the Interconnection Allowance (or part thereof) relates only to those boundaries, which divide the system into two contiguous parts, the smaller of which contains more than 1500MW of demand. For this boundary (as with boundaries B1 and B3), this is not the case and accordingly the required capability is equal to the Planned Transfer.

The required capability of this boundary over the seven yesr period generally indicates the need to reinforce the transmission system in this location. The proposed Beauly to Denny reinforcement required for the north west boundary also provides the necessary increased capacity for this boundary. The reinforcement comprises the replacement of the existing 132kV double circuit tower line between Beauly, Fort Augustus, Errochty and Bonnybridge, by a new 400kV double circuit tower line terminating at Denny near Bonnybridge. Subject to wayleave and planning consents, this reinforcement will increase the north south boundary capability from 1600MW to 2500MW by 2012/13. Depending on the volume of future renewable generation applications, additional reinforcement of this boundary may be required. This could include the creation of a 400kV ring from Denny to Kincardine (via Errochty, Fort Augustus, Beauly, Keith, Kintore and Tealing). As described above, the 400kV ring can be achieved by making use of the proposed new line routes established between Beauly and Denny and between Beauly and Keith/Blackhillock, and using existing infrastructure from Keith down the east coast to Kincardine which is already constructed to 400kV.

Boundary 3: SHETL Sloy

Figure 8.B3

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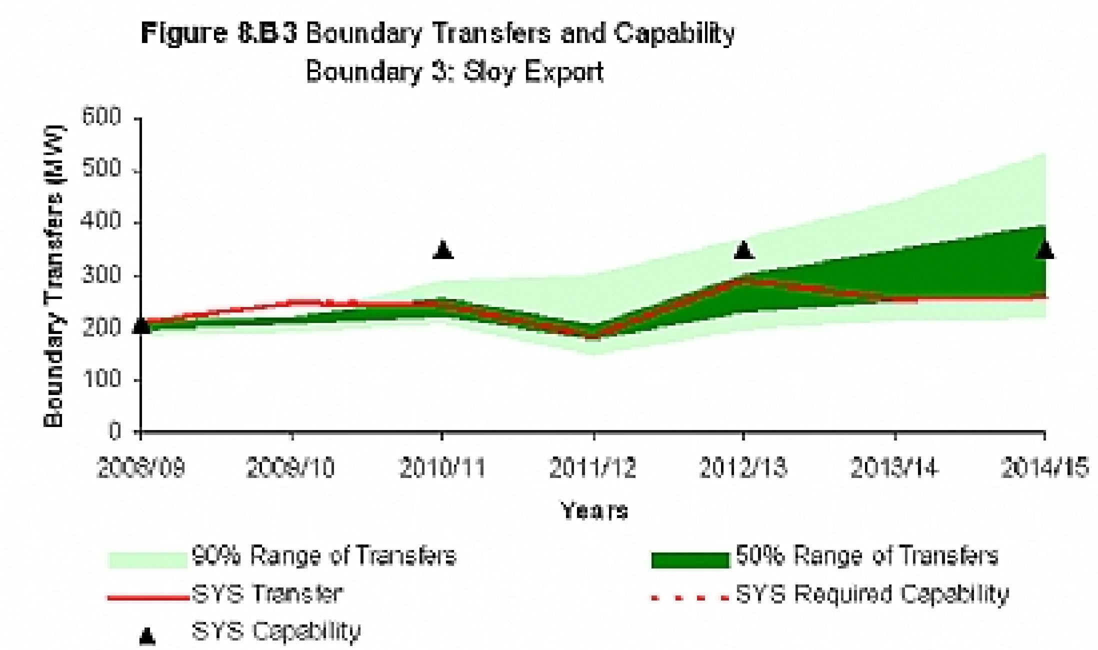

Figure 8.T3

Click to load a larger version of Figure8.T3 image

Figure 8-T3 - Boundary B3 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B3E	SLOY (EXPORT)							
	Effective Generation	276	316	313	254	365	330	331
	Demand	66	69	70	70	73	75	75
	Planned Transfer	209	247	243	184	292	255	256
B3I	SLOY (IMPORT)							
	Effective Generation	61777	62588	63460	65123	65743	66450	67291
	Demand	61987	62836	63703	65306	66035	66705	67547
	Planned Transfer	-209	-247	-243	-184	-292	-255	-256

Please note that application of the Interconnection Allowance (or part thereof) relates only to those boundaries, which divide the system into two contiguous parts, the smaller of which contains more than 1500MW of demand. For this boundary (as with boundaries B1 and B2), this is not the case and accordingly the required capability is equal to the Planned Transfer.

New renewable generation in Kintyre and Argyll is increasing over time and reinforcement is needed to accommodate the required capability from 2009/10. The proposed reinforcement to increase the boundary capability from 210MW to 350MW is a new 275/132kV substation which links the Killin to Sloy 132kV line with the 275kV line which runs from Windyhill to Dalmally. The substation, referred to as Inverarnan and due for completion in 2009/10, will be located at a point near to where the lines cross at the north end of Loch Lomond.

Additional generation applications within this boundary have been received which, if contracted, will require additional reinforcement within this area. A number of reinforcement schemes are being considered to provide additional transmission capacity in the area.

Boundary 4: SHETL - SPT

Figure 8.B4

Click to load a larger version of Figure8.B4 image

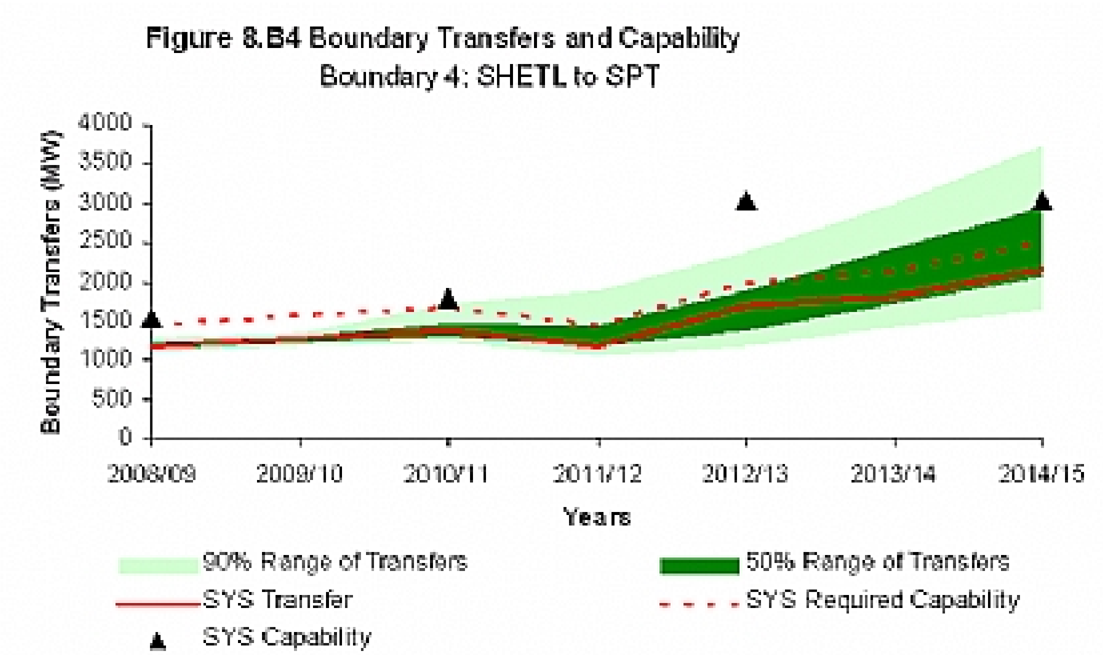

Figure 8.T4

Click to load a larger version of Figure8.T4 image

Figure 8-T4 - Boundary B4 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B4E	**SHETL - SPT (EXPORT)**							
	Effective Generation	2823	2971	3074	2888	3413	3568	3954
	Demand	1652	1683	1705	1711	1723	1754	1791
	Planned Transfer	1171	1288	1369	1177	1690	1814	2163
B4I	**SHETL - SPT (IMPORT)**							
	Effective Generation	59230	59933	60699	62489	62696	63212	63668
	Demand	60402	61221	62068	63666	64385	65026	65831
	Planned Transfer	-1171	-1288	-1369	-1177	-1690	-1814	-2163

The SHETL to SPT boundary defines the asset ownership boundary between SHETL and SPT and runs from the firth of Tay in the east to near the head of Loch Long in the west. This boundary encompasses all the generation and demand (except for Dunoon and Strathleven) in the SHETL area and is normally an exporting boundary.

Generation to the north of this boundary is increasing over time due to the high volume of new renewable generation seeking connection in the SHETL area. Consequently, the boundary transfers are also increasing with time.

Please note that application of the Interconnection Allowance (or part thereof) relates only to those boundaries, which divide the system into two contiguous parts, the smaller of which contains more than 1500MW of demand. For this boundary, Interconnection allowance is applicable and is added to the Planned Transfer to give the required capability for the boundary.

The required transfer capability from 2009/10 indicates the need to reinforce the transmission system in this location. The new Inverarnan substation, described under Boundary B3 and due for completion in 2009/10, provides some additional capacity for Boundary B4. The proposed Beauly to Denny reinforcement outlined for the north west boundary, due for completion in 2012, will substantially increase the capacity of this boundary. The Beauly to Denny reinforcement comprises the replacement of the existing 132kV double circuit tower line between Beauly, Fort Augustus, Errochty and Bonnybridge, by a new 400kV double circuit tower line terminating at Denny near Bonnybridge. These reinforcements will increase the boundary capability from 1500MW to around 1800MW by 2009, and to around 3000MW by 2012.

The increasing volume of renewable generation in the SHETL area suggests that further reinforcement of this boundary may be required. This could include the development of a 400kV ring from Denny to Kincardine (via Errochty, Fort Augustus, Beauly, Keith, Kintore and Tealing). As described above, the 400kV ring can be achieved by making use of the proposed new line routes established between Beauly and Denny and between Beauly and Keith/Blackhillock, and using existing infrastructure from Keith down the east coast to Kincardine which is already constructed to 400kV.

Boundary 5: SPT North - South

Figure 8.B5

Click to load a larger version of Figure8.B5 image

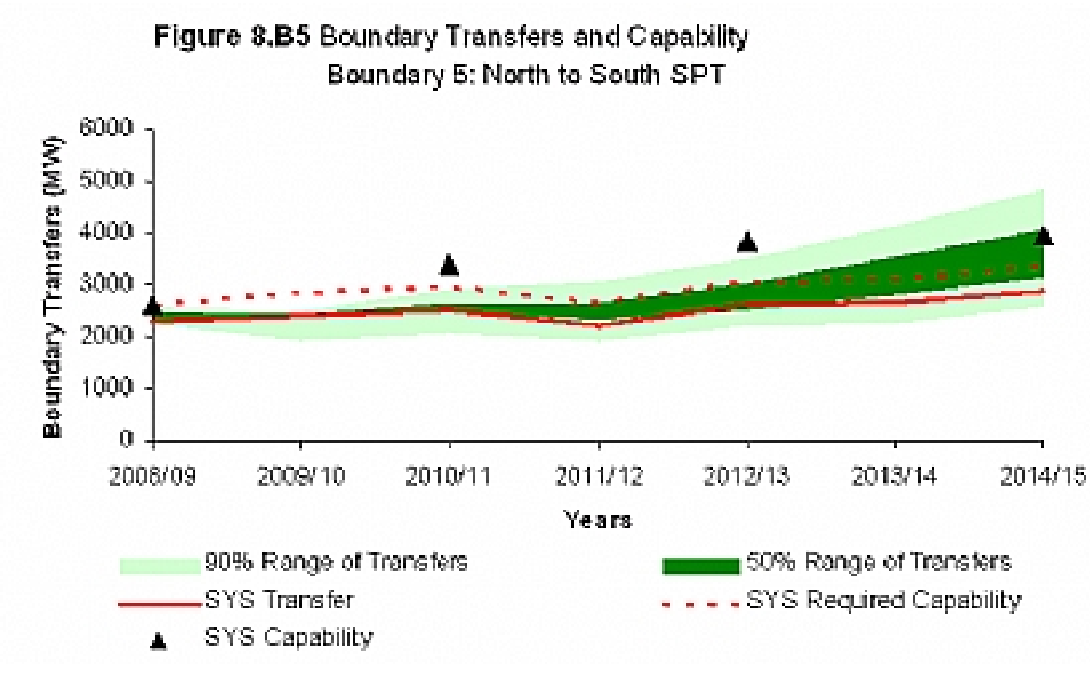

Figure 8.T5

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Figure 8-T5 - Boundary B5 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B5E	**SPT NORTH - SOUTH (EXPORT)**							
	Effective Generation	5191	5351	5470	5184	5629	5693	5978
	Demand	2889	2931	2959	2974	2994	3031	3084
	Planned Transfer	2302	2420	2511	2210	2635	2662	2894
B5I	**SPT NORTH - SOUTH (IMPORT)**							
	Effective Generation	56862	57553	58303	60193	60479	61087	61644
	Demand	59164	59973	60814	62403	63114	63749	64538
	Planned Transfer	-2302	-2420	-2511	-2210	-2635	-2662	-2894

The north to south transfer across this boundary in the central belt of Scotland shows a rise through the years of this statement, due primarily to contracted renewable energy developments in the north of Scotland. The required capability rises to a level in excess of the current capability, indicating a strong need for reinforcement. The extent of this rise in later years is reduced as a result of some existing generation becoming non-contributory.

Works to reinforce this boundary are in the construction phase. These works will enhance the thermal capability of the Longannet to Easterhouse and Longannet to Clyde’s Mill 275kV circuits via switchgear replacement at Easterhouse and Clyde’s Mill 275kV substations. A series reactor will be installed at Windyhill 275kV Substation on the Neilston 275kV circuit.

Together with a second 400/275kV transformer at Strathaven and additional reactive compensation plant (which are not yet sanctioned), the works described above will deliver a boundary capability of approximately 3850MW by 2011/12.

Boundary 6: SPT - NGET

Figure 8.B6

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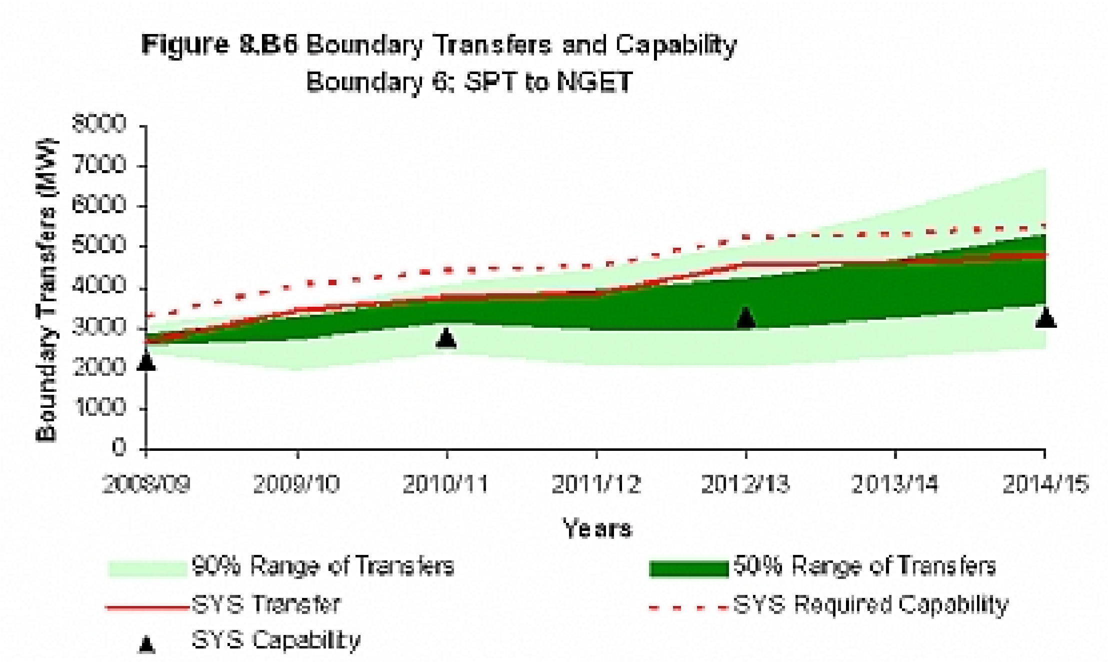

Figure 8.T6

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Figure 8-T6 - Boundary B6 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B6E	SPT - NGET (EXPORT)							
	Effective Generation	8705	9544	9941	10072	10827	10947	11234
	Demand	6062	6131	6182	6210	6271	6331	6421
	Planned Transfer	2643	3413	3759	3862	4556	4616	4813
B6I	SPT - NGET (IMPORT)							
	Effective Generation	53348	53360	53832	55305	55281	55833	56388
	Demand	55991	56773	57591	59167	59837	60449	61201
	Planned Transfer	-2643	-3413	-3759	-3862	-4556	-4616	-4813

The north to south transfer across the boundary between SPT and NGET shows a significant rise throughout all years of this statement, due primarily to contracted renewable energy developments throughout Scotland. As a consequence, the required capability rises to a level significantly in excess of the current capability, indicating a strong and urgent need for reinforcement.

Due to the fact that the required capability currently exceeds the actual capability, SPT and NGET have been granted relief from Licence Condition D3 in respect of the circuits connecting the SPT system to that of NGET.

In order to achieve the required capability of approximately 2,800MW by 2010/11 and 3,300MW by 2011/12, SPT and NGET are undertaking an extensive reinforcement programme.

The existing 275kV link from Strathaven to Harker will be uprated to 400kV operation. The overhead line conductor on the Eccles to Stella West 400kV circuits will be replaced with a conductor bundle that gives a higher continuous rating and lower impedance, enhancing boundary thermal and stability performance.

New transformers will be installed at Blyth connecting into the Eccles to Stella West circuits. The network will be reconfigured at Hawick and the quadrature booster at Tongland replaced with a unit of higher rating. Strathaven 400kV substation will be reconfigured and reactive compensation will be installed at a number of strategic locations on the SPT network.

Upon completion of the planned reinforcement programme, the boundary continues to show insufficient transfer capability for the given SYS Background, indicating further reinforcement may be required.

It should be remembered that the planned transfer figures derived from the SYS Background reflect the current contracted generation position (which includes 7600MW of large wind generation in Scotland by 2014/15) and take no account of future uncertainty. As mentioned previously, it is reasonable to assume that some existing contracts for generation connections may be modified or terminated and some existing power stations may close.

The SYS Planned Transfer lies above the 50% range of Planned Transfers while the SYS capability is in the lower parts. Accordingly, there is a chance of lower peak flows than suggested by the SYS background; however, significant reinforcements will nevertheless be required in the very near future to facilitate even the lower parts of the range of probabilistic transfers.

A range of indicative reinforcements to ensure continued compliance with the License Standard at the time of peak for the given SYS background are listed in Table 8.2.

Boundary 7: NGET Upper North

Figure 8.B7

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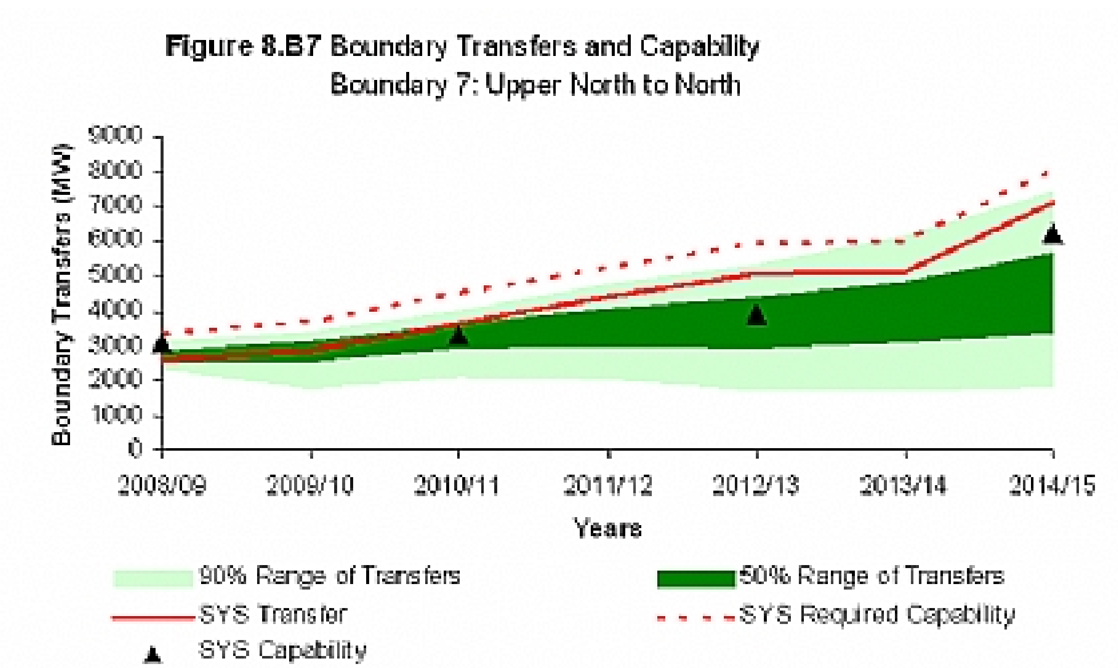

Figure 8.T7

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Figure 8-T7 - Boundary B7 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B7E	UPPER NORTH (EXPORT)							
	Effective Generation	11731	12120	13034	13809	14641	14798	17089
	Demand	9163	9256	9369	9418	9568	9675	9990
	Planned Transfer	2568	2864	3665	4391	5073	5123	7099
B7I	UPPER NORTH (IMPORT)							
	Effective Generation	50279	50722	50680	51535	51464	51984	50529
	Demand	52849	53585	54343	55924	56540	57105	57632
	Planned Transfer	-2570	-2863	-3663	-4389	-5076	-5121	-7103

New generation openings in Scotland result in a significant export transfer across this boundary from 2008/09 onwards. This boundary shows insufficient transfer capability and remains below the planned system transfer from 2010/11 throughout the SYS period to 2014/15.

The planned transfer lies almost entirely between the 50% and 90% range of probabilistic transfers up to 2011/2012. Beyond this point uncertainty exists on future large generation projects. From 2009/2010 the boundary capability is insufficient to accommodate most of the probabilistic range of transfers indicating a likely need for additional reinforcements; however the required transfer is completely outside the 90% of probabilistic transfers which indicates that the chance of this transfer being exceeded is low.

Boundary 8: NGET North to Midlands

Figure 8.B8

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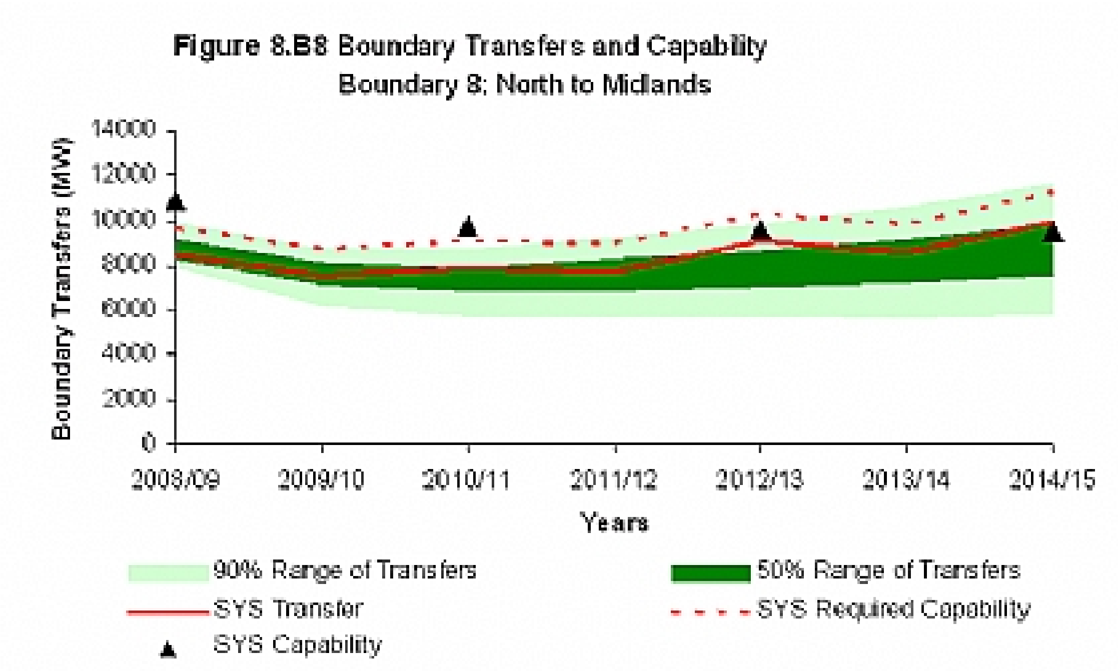

Figure 8.T8

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Figure 8-T8 - Boundary B8 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B8E	NORTH TO MIDLANDS (EXPORT)							
	Effective Generation	31627	30868	31576	32370	33914	33753	35555
	Demand	23126	23326	23672	24604	24850	25132	25598
	Planned Transfer	8501	7542	7904	7766	9064	8621	9957
B8I	NORTH TO MIDLANDS (IMPORT)							
	Effective Generation	30383	31974	32138	32974	32191	33029	32063
	Demand	38886	39515	40040	40738	41258	41648	42024
	Planned Transfer	-8503	-7541	-7902	-7764	-9067	-8619	-9961

The SYS capability decreases year on year from 2008/09 to 20014/15 as the existing transmission infrastructure reaches its limits and local generation change in output.. SYS transfer decreases between 2008/09 & 2010/2011 and increases from 10/11 onwards. Causing increased flow across the heavily loaded lines in the boundary and stressing the system further.

SYS transfer lies within the likely range of probabilistic transfer and does not meet required transfer for the entire SYS period. Reinforcements will be needed to meet the SYS required capability.

Boundary 9: NGET Midlands to South

Figure 8.B9

Click to load a larger version of Figure8.B9 image

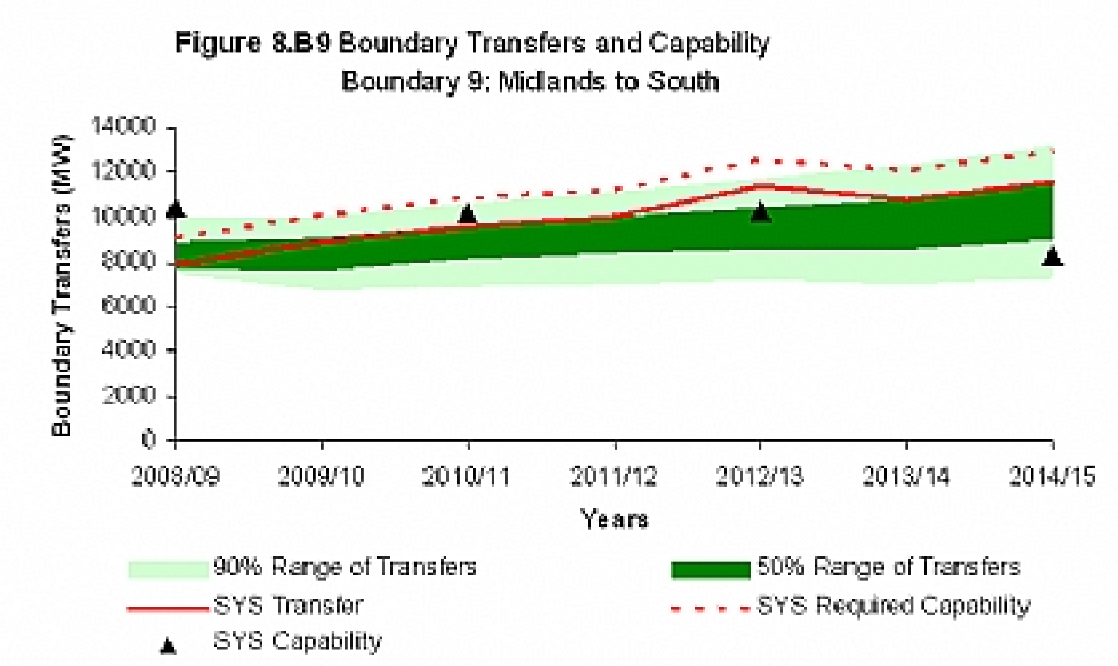

Figure 8.B9 Boundary Transfers and Capability
Boundary 9: Midlands to South

Figure 8.T9

Click to load a larger version of Figure8.T9 image

Figure 8-T9 - Boundary B9 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B9E	MIDLANDS - SOUTH (EXPORT)							
	Effective Generation	39358	40596	41839	43218	44952	44682	46072
	Demand	31436	31692	32193	33203	33554	33879	34446
	Planned Transfer	7922	8904	9646	10015	11398	10803	11626
B9I	MIDLANDS - SOUTH (IMPORT)							
	Effective Generation	22652	22246	21875	22126	21153	22100	21546
	Demand	30576	31149	31519	32139	32554	32901	33176
	Planned Transfer	-7924	-8903	-9644	-10013	-11401	-10801	-11630

The general trend for this boundary shows a gradual increase in SYS transfer from 2008/09 to 2012/13, from which point the trend remains fairly constant until the end of the SYS period 2014/15. The initial increase until 2012/13 is mainly due to new generation being connected to the North of the boundary and an increase in demands South of the boundary.

The boundary capability is shown to be higher than the required transfer in 2008/09. From 2010/11 the boundary is marginally below the SYS required capability and from 2012/13 onwards the capability is below both the SYS transfer and the SYS required capability, significantly so in 2014/15.

In order to satisfy boundary compliance in this area significant reinforcements beyond the already significantly planned reinforcements will be required in order facilitate higher flows.

Boundary 10: NGET South Coast

Figure 8.B10

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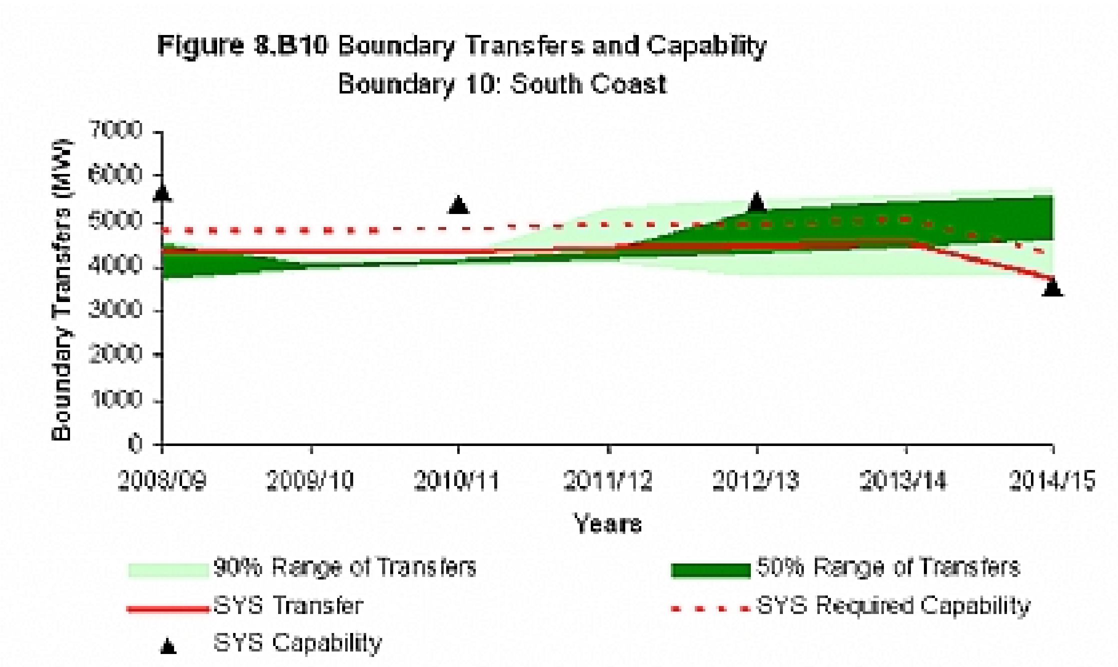

Figure 8.T10

Click to load a larger version of Figure8.T10 image

Figure 8-T10 - Boundary B10 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B10E	SOUTH COAST (EXPORT)							
	Effective Generation	2734	2867	2922	2892	2942	2913	3748
	Demand	7077	7194	7265	7336	7389	7451	7499
	Planned Transfer	-4343	-4327	-4343	-4444	-4447	-4538	-3751
B10I	SOUTH COAST (IMPORT)							
	Effective Generation	59276	59975	60792	62452	63163	63869	63870
	Demand	54935	55647	56447	58006	58719	59329	60123
	Planned Transfer	4341	4328	4345	4446	4444	4540	3747

The South Coast area is an importing area. The SYS transfer remains fairly constant from 2008/09 to 2012/13, with a marginal increase as the system progresses towards 2012/13 and this is due mainly to steady demand growth in the area.

The system transfer begins to reduce from 2012/13 due to new generation openings in the south coast area.

The boundary capability is below the required transfer from 2013/14 onwards. The requirement for reinforcement is more likely towards the end of the SYS period, due to the increase in demand

Boundary 11: NGET North East and Yorkshire

Figure 8.B11

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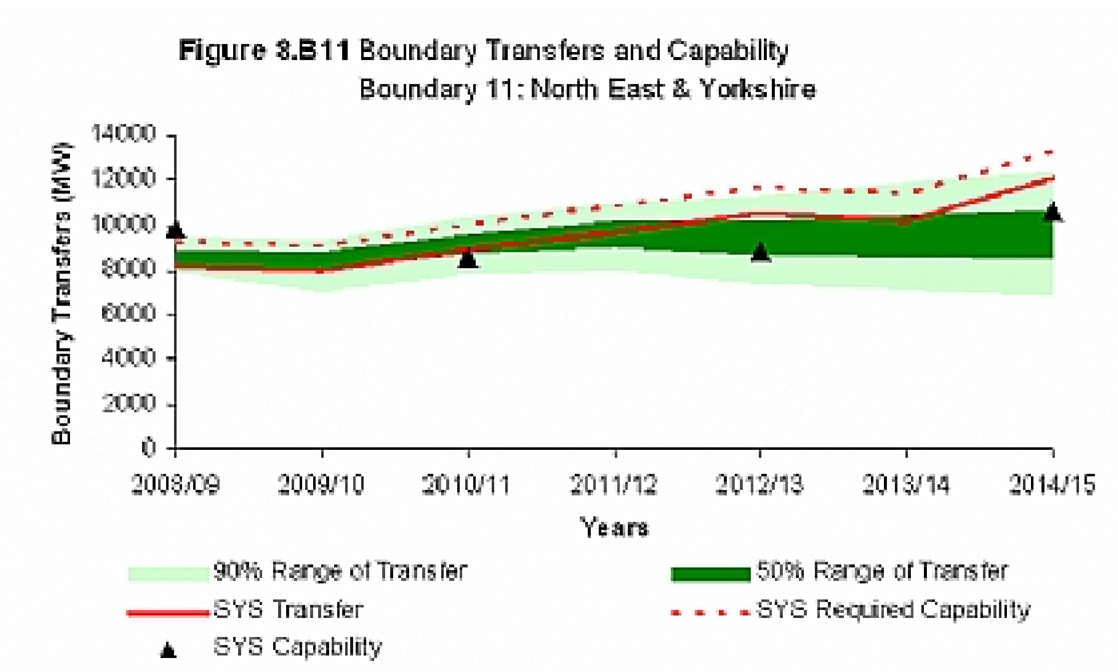

Figure 8.T11

Click to load a larger version of Figure8.T11 image

Figure 8-T11 - Boundary B11 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B11E	NORTH EAST & YORKSHIRE (EXPORT)							
	Effective Generation	23259	23189	24315	25450	26484	26311	28571
	Demand	15083	15209	15379	15730	15936	16082	16482
	Planned Transfer	8176	7980	8936	9720	10549	10229	12089
B11I	NORTH EAST & YORKSHIRE (IMPORT)							
	Effective Generation	38751	39653	39399	39894	39621	40471	39047
	Demand	46929	47632	48333	49612	50172	50698	51140
	Planned Transfer	-8178	-7979	-8934	-9718	-10551	-10227	-12093

SYS transfer across the boundary increases year on year for the entire SYS period and SYS capability is below SYS required transfer beyond 2009/2010.. Additional reinforcements beyond what is currently planned will be needed to meet SYS required capability.

Boundary 12: NGET South & South West

Figure 8.B12

Click to load a larger version of Figure8.B12 image

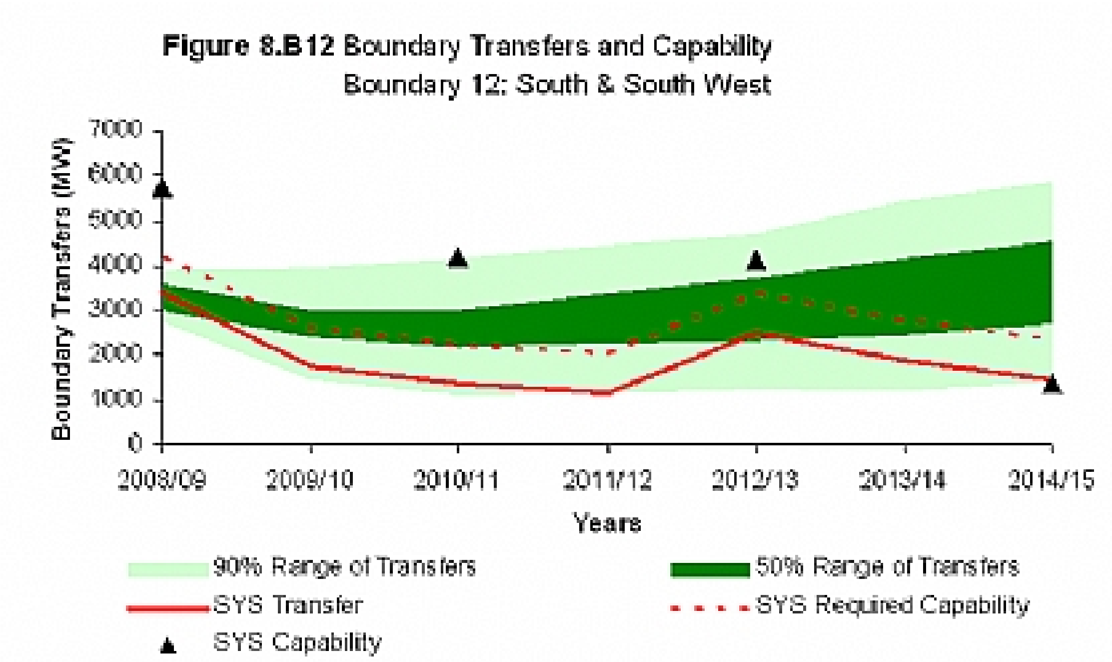

Figure 8.T12

Click to load a larger version of Figure8.T12 image

Figure 8-T12 - Boundary B12 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B12E	SOUTH & SOUTH WEST (EXPORT)							
	Effective Generation	9036	10828	11375	11707	10489	11248	11828
	Demand	12450	12605	12741	12877	12990	13152	13278
	Planned Transfer	-3414	-1777	-1366	-1170	-2501	-1904	-1450
B12I	SOUTH & SOUTH WEST (IMPORT)							
	Effective Generation	52974	52014	52339	53637	55616	55534	55790
	Demand	49562	50236	50971	52465	53118	53628	54344
	Planned Transfer	3412	1778	1368	1172	2498	1906	1446

New generation within the boundary results in a reduction in boundary transfer. SYS transfer lies within the likely range of probabilistic transfer. SYS capability falls below the SYS required transfer in later years due to limitations in the London importing circuits.

Within the boundary no additional reinforcement are required for compliance.

Boundary 13: NGET South West

Figure 8.B13

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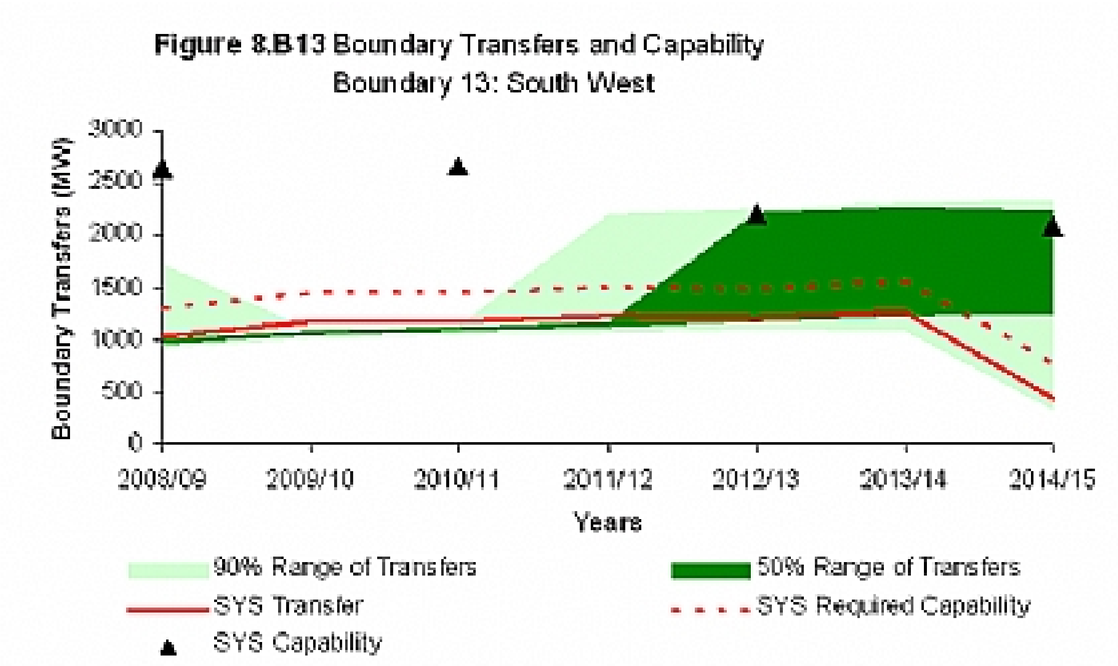

Figure 8.T13

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Figure 8-T13 - Boundary B13 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B13E	**SOUTH WEST (EXPORT)**							
	Effective Generation	1774	1704	1737	1719	1749	1731	2570
	Demand	2802	2882	2912	2944	2966	2994	3017
	Planned Transfer	-1028	-1178	-1175	-1225	-1217	-1263	-447
B13I	**SOUTH WEST (IMPORT)**							
	Effective Generation	60236	61138	61977	63625	64356	65051	65048
	Demand	59210	59959	60800	62398	63142	63786	64605
	Planned Transfer	1026	1179	1177	1227	1214	1265	443

SYS transfer remains relatively unchanged until 2012/13 when it decreases for the remainder of the SYS period due to significant new generation. The spread of likely transfers between 08/09 and 10/11 is narrow, which is representative of the lack of proposed generation in the boundary. The probabilistic transfer then widens out reflecting uncertainties associated with possible new generation and station closures within the boundary.

SYS capability exceeds the SYS transfer and SYS required capability until 2014/2015 when voltage restrictions outside the boundary cause non compliance., suggesting that further reinforcements will not be needed within this boundary.

Boundary 14: NGET London

Figure 8.B14

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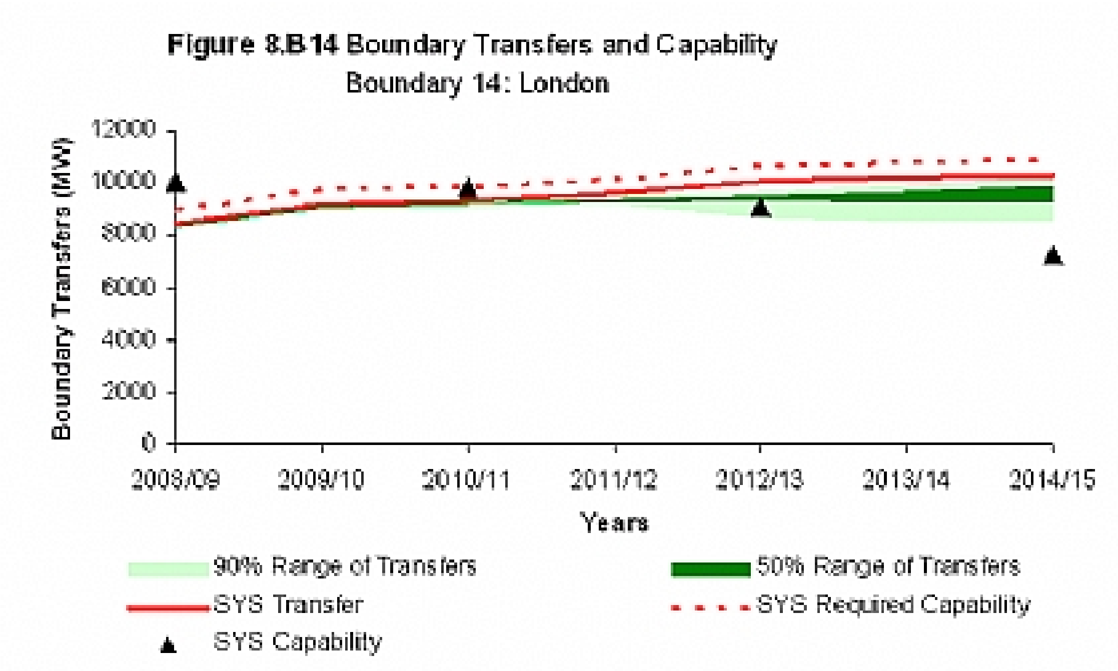

Figure 8.T14

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Figure 8-T14 - Boundary B14 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B14E	LONDON (EXPORT)							
	Effective Generation	1726	1181	1204	1192	896	888	885
	Demand	10175	10409	10546	10816	11014	11118	11217
	Planned Transfer	-8449	-9228	-9342	-9624	-10118	-10230	-10332
B14I	LONDON (IMPORT)							
	Effective Generation	60284	61661	62510	64152	65209	65894	66733
	Demand	51837	52432	53166	54526	55094	55662	56405
	Planned Transfer	8447	9229	9344	9626	10115	10232	10328

London imports a significant proportion of its demand. The spread of likely transfers for B14 is narrow due to the high level of demand and the relatively low volatility and volume of generation in the boundary, increasing slightly year on year for the entire SYS period as a result of demand growth in the London region. From 2010/11, the SYS capability is below the required capability indicating a requirement for reinforcements.

Boundary 15: NGET Thames Estuary

Figure 8.B15

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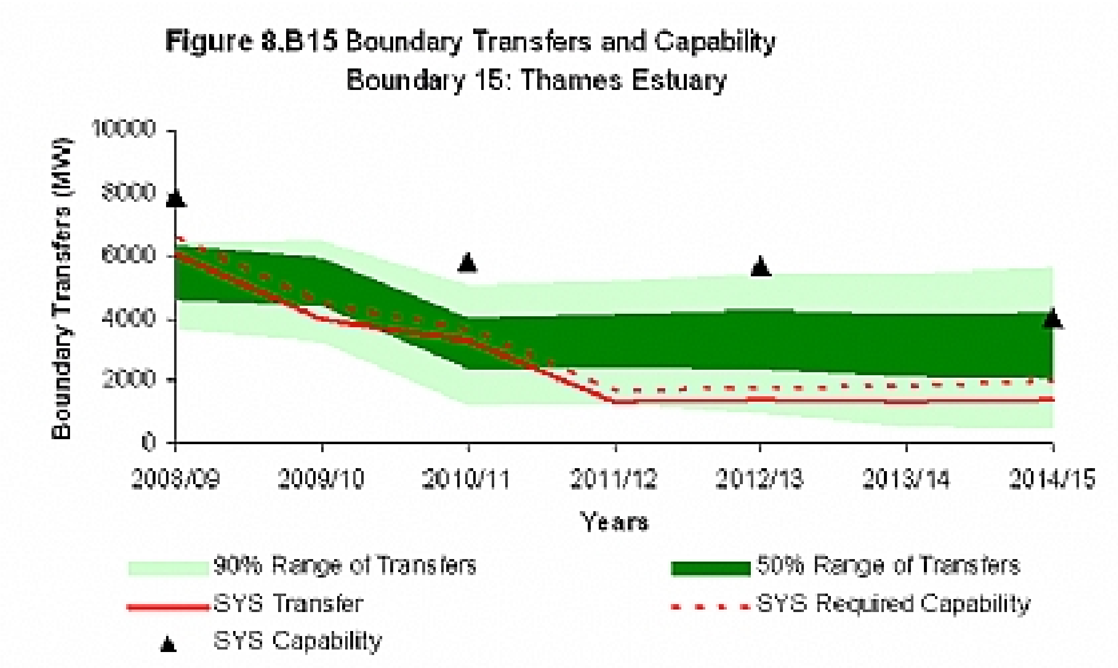

Figure 8.T15

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Figure 8-T15 - Boundary B15 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B15E	THAMES ESTUARY (EXPORT)							
	Effective Generation	8276	6751	5562	4209	4279	4241	3768
	Demand	2180	2758	2273	2976	2880	2906	2357
	Planned Transfer	6096	3993	3289	1333	1399	1335	1411
B15I	THAMES ESTUARY (IMPORT)							
	Effective Generation	53734	56091	58152	61135	61826	62541	63850
	Demand	59832	60083	61439	62466	63228	63874	65265
	Planned Transfer	-6098	-3992	-3287	-1331	-1402	-1333	-1415

The SYS transfer decreases steadily until 2012/13 when it stabilises. This is due to changes in interconnector flows ranging from importing to exporting. If the interconnectors were to import from the continent the SYS transfer would be greatly increased possibly exceeding the boundary capability, suggesting that further reinforcements would be required.

Boundary 16: NGET North East, Trent & Yorkshire

Figure 8.B16

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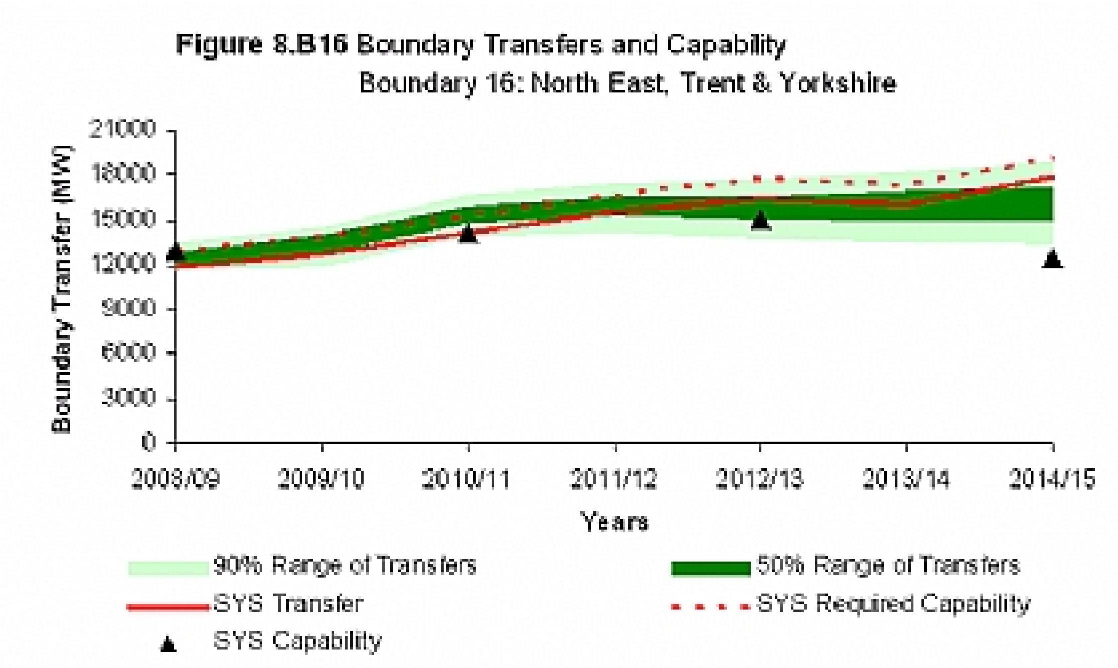

Figure 8.T16

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Figure 8-T16 - Boundary B16 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B16E	NORTH EAST, TRENT & YORKSHIRE (EXPORT)							
	Effective Generation	27559	28655	30234	31999	33149	32909	35152
	Demand	15706	15847	16033	16401	16630	16771	17206
	Planned Transfer	11853	12808	14201	15598	16519	16138	17946
B16I	NORTH EAST, TRENT & YORKSHIRE (IMPORT)							
	Effective Generation	34451	34187	33480	33345	32957	33873	32466
	Demand	46306	46994	47679	48941	49478	50009	50416
	Planned Transfer	-11855	-12807	-14199	-15596	-16521	-16136	-17950

New generation openings and a steady demand growth typify this boundary. The boundary shows insufficient transmission capability and remains below the planned system transfer from 2010/11 throughout the SYS period to 2014/15. The probabilistic range and SYS transfer for this boundary increases progressively over the SYS period.

In order to satisfy boundary compliance significant reinforcements in this area will be required in order facilitate higher flows.

Boundary 17: NGET West Midlands

Figure 8.B17

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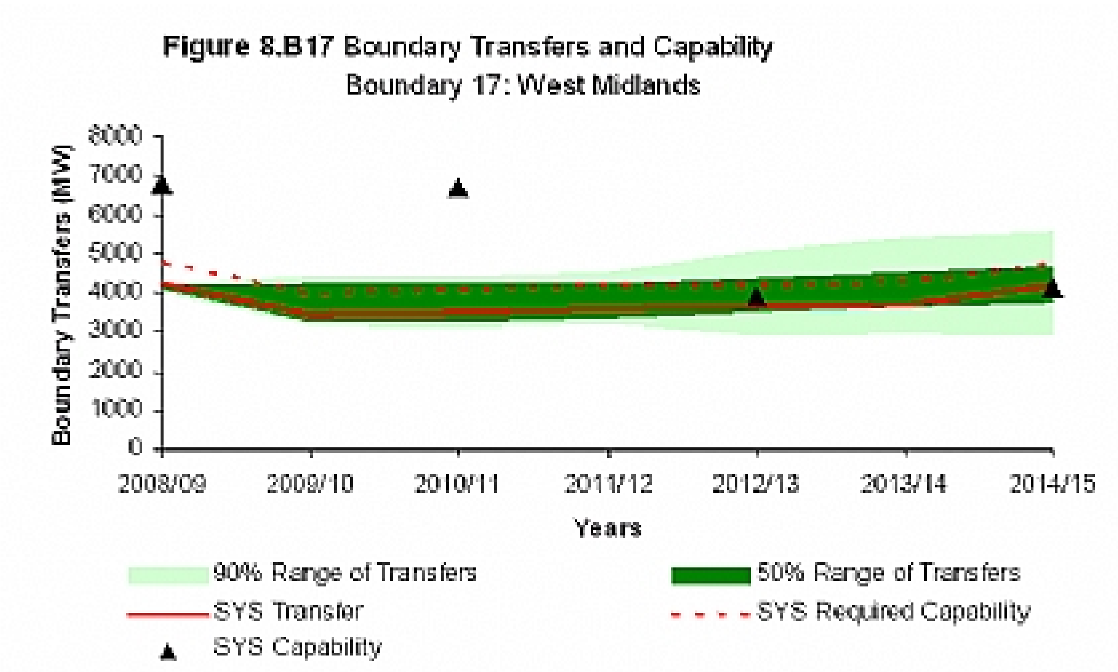

Figure 8.T17

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Figure 8-T17 - Boundary B17 Demand and Generation (MW)

	BOUNDARY	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
B17E	WEST MIDLANDS (EXPORT)							
	Effective Generation	3431	4262	4344	4299	4374	4331	3936
	Demand	7687	7728	7867	7928	8010	8058	8124
	Planned Transfer	-4256	-3466	-3523	-3629	-3636	-3727	-4188
B17I	WEST MIDLANDS (IMPORT)							
	Effective Generation	58579	58580	59370	61045	61731	62451	63682
	Demand	54325	55113	55845	57414	58098	58722	59498
	Planned Transfer	4254	3467	3525	3631	3633	3729	4184

The West Midlands imports a significant share of its demand during this SYS period as well as supporting the bulk North to South power flows on the transmission system. The transfer drops in 2008/09 mainly due to new generation connections in this importing area. The transfer then increases gradually until 2013/14, largely because of the increasing North to South power flows.

The boundary capability is higher than the requirement determined by the SYS background throughout the whole period. However, the fan diagram shown in Figure 8.B17 suggests that there is a significant probability of the SYS transfer being exceeded, in which case system reinforcements might be required for year 2013/14.

Indicative Reinforcements for licence compliance

The list of reinforcement schemes presented in Table 8.2 provides an indication of those reinforcements that may be required to ensure continued compliance with the Licence Standard across the 17 major SYS boundaries at the time of peak for the given SYS background, i.e. to remedy capability deficits.

These indicative schemes would be additional to the currently planned transmission reinforcements listed in Table 6.2, and which already form part of the SYS background.
The additional schemes would be required, not only for compliance across the 17 SYS boundaries ('inter-zonal' reinforcements), but also for compliance across a number of boundaries internal to the zones delineated by the 17 SYS boundaries ('intra-zonal' reinforcements). The developments listed are those required for the specific SYS background. The additional indicative schemes would be varied to meet the changing needs of the system as it evolves.

Once the need for a particular reinforcement is established the detailed specification will be considered. By way of example, for reactive compensation plant, the optimal location, size and desired performance will be the subject of detailed analyses nearer the time when there is a need to commit to the work.

Some of the works listed in Table 8.2 will have been made a condition of particular 'GB Agreements' for connection to and use of the GB system. That is, a condition will have been included in certain agreements stipulating that the works would have to be completed before connection to or use of the GB Transmission System is permitted. This is in order to ensure continued compliance of the system with the Licence Standard and to safeguard the interests of all Users of the GB Transmission System in respect of security of supply.

In any event, the three Transmission Licensees will continue to manage the timing of reinforcements to ensure that an efficient, co-ordinated and economic system, compliant with the License Standard is provided at all times, except where derogations have been granted or have been applied for.

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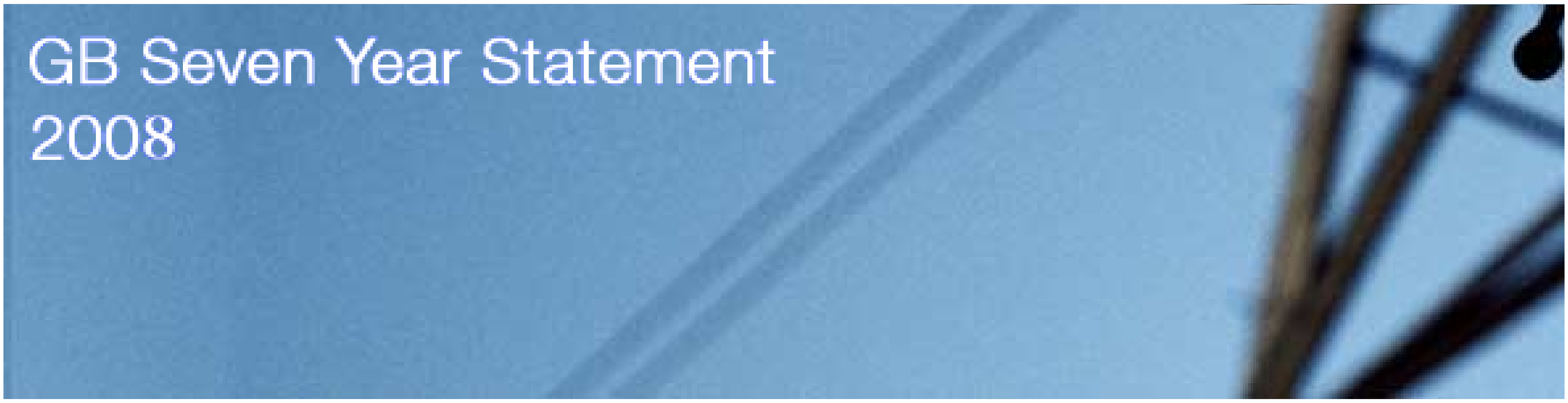

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Table 8.1 - GUM Boundaries Defined by SYS Study Zone

Boundary Number	Boundary Name	SYS Study Zone/s (one side of boundary)
B1	North West Export	Z1
B2	North-South	Z1, Z2
B3	Sloy Export	Z3
B4	SHETL-SPT Boundary	Z1, Z2, Z3, Z4
B5	North-South	Z1, Z2, Z3, Z4, Z5
B6	SPT-NGET Boundary	Z1, Z2, Z3, Z4, Z5, Z6
B7	Upper North-North	Z1, Z2, Z3, Z4, Z5, Z6, Z7
B8	North to Midlands	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9
B9	Midlands to South	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z9, Z10, Z11
B10	South Coast	Z16, Z17
B11	North East & Yorkshire	Z1, Z2, Z3, Z4, Z5, Z6, Z7,Z8
B12	South & South West	Z13, Z16, Z17
B13	South West	Z17
B14	London	Z14
B15	Thames Estuary	Z15
B16	North East, Trent & Yorkshire	Z1, Z2, Z3, Z4, Z5, Z6, Z7, Z8, Z10

B17	West Midlands	Z11

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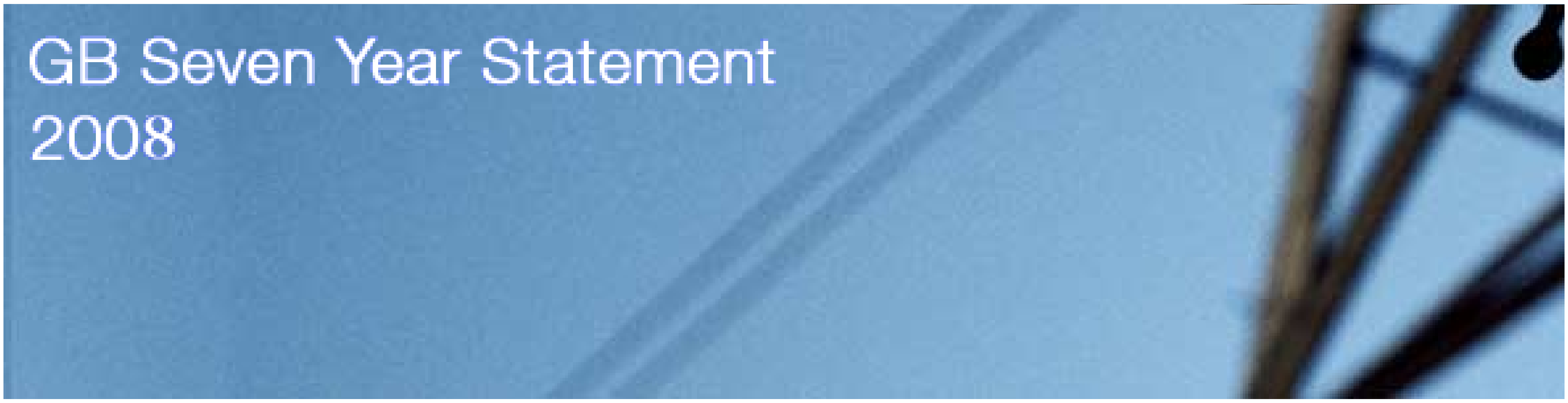

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Table 8.2 - Indicative Developments for Licence Compliance

Location/Circuit	Works	Affected Boundaries/Licensee
Strathaven - Torness - Eccles	Reconfigure 400kV network to remove post-fault overloads and reduce impedance between Strathaven and Eccles.	SPT – NGET
Galloway 132kV	Reconfigure 132kV network to remove post-fault overloads.	SPT – NGET
Strathaven-Harker / Eccles-Stella West	Install reactive series compensation.	SPT – NGET
Strathaven-Harker	Replace overhead line conductor.	SPT – NGET
Kilmarnock South- Harker	Establish a new transmission route from Kilmarnock South to Harker. Install reactive compensation equipment.	SPT – NGET
Eccles - Stella West	Establish a new transmission route from Eccles to Stella West. Install reactive compensation equipment.	SPT – NGET
Blyth - Stella West	Increase the rating of the Blyth to Stella West circuits	NGET
Bramley - Didcot	Replace the cables between Bramley and Dicot with ones of higher rating	NGET
Kirkby to Frodsham	Change the existing circuits to 400kV operation and estlish 400kV substations at Rainhill, Fiddlers Ferry and Frodsham	NGET

Iver	Replace the two interbus transformers at Ivers with higher rates units	NGET
Elstree - Sundon	Increase the rating of the Elstree to Sundon circuits	NGET
Elstree – St Johns Wood	Install second cable	NGET
Cottam - Staythorpe	Increase the rating of the Cottam to Staythorpe circuits	NGET
Drakelow	Install a series reactor at Drakelow	NGET
Wymondley	Turn the Sundon to Pelham circuit into Wymondley	NGET
Higm Marnham - Ratcliffe	Increase the rating on the High Marnham to Ratcliffe circuits	NGET
Ratcliffe - Staythorpe	Increase the rating of the Ratcliffe to Staythorpe circuit	NGET
Grendon – West Burton	Increase the rating of the Grendon to West Burton circuit	NGET
Hutton	Install reactive compensation (1 MSC)	NGET
Stella West	Install reactive compensation (2 MSCs)	NGET
Harker	Install reactive compensation (3 MSCs)	NGET
Cottam	Install reactive compensation (1 MSC)	NGET
Staythorpe	Install reactive compensation (3 MSCs)	NGET
Ratcliffe on Soar	Install reactive compensation (2 MSCs)	NGET
Cowley	Install reactive compensation (1 MSC)	NGET
Eaton Socon	Install reactive compensation (1 MSC)	NGET
High Marnhan	Install reactive compensation (2 MSCs)	NGET
Padiham	Install reactive compensation (1 MSC)	NGET
Stoke Bardolph	Install reactive compensation (1 MSC)	NGET
Bramley	Install reactive compensation (2 MSCs)	NGET
Rye House	Install reactive compensation (2 MSCs)	NGET
Burwell	Install reactive compensation (2 MSCs)	NGET
Daines	Install reactive compensation (1 MSC)	NGET
North Fleet	Install reactive compensation (1 MSC)	NGET

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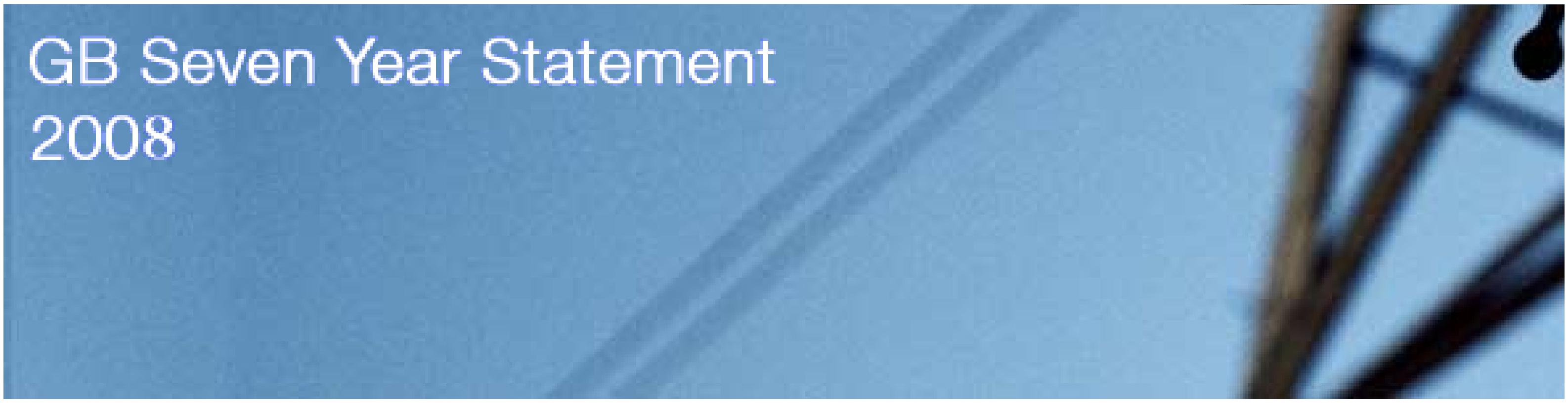

Introduction to Chapter 9

This chapter provides a commentary on those parts of the GB transmission system most suited to new connections and to the transport of further quantities of electricity. The information presented draws on that contained in the previous chapters. In particular GB Transmission System Capability.

Readers are reminded that anyone considering a development at a specific site requiring additional technical information relating to that site may contact us for assistance as explained in Further Information.

Notwithstanding the opportunities set out in this chapter, the three Transmission Licensees will continue to comply with Transmission Licence obligations and make offers to any User or potential new User wishing to use the GB transmission system in respect of new generation and/or demand. The timescales, required by each Transmission Licensee to complete any necessary transmission work, associated with a new development, is, amongst other things, a function of the size and location of the development. In some instances no infrastructure reinforcement work at all will be required and no delay will be incurred. That is, if the required transmission reinforcement is localised and environmentally uncontentious, the necessary work can normally be completed in similar timescales to that of the customer's project. However, where the development requires extensive and/or contentious transmission work (with the associated need for Planning Consent and possible Public Inquiries), it may not always be possible for the relevant Transmission Licensee to fully meet the customer's wishes with respect to timescales. Nevertheless, all three Transmission Licensees will always endeavour to meet their customer's requirements.

Finally, the provision of voltage support services is discussed towards the end of this chapter. Amongst other things this section presents information on possible future opportunities for Users to provide voltage support services under contract to ourselves and outline information on performance requirements for such services to help Users decide whether to approach us with an offer of service.

Use of External Interconnections

Introduction

Interconnections With External Systems explained that our transmission system is directly interconnected with those of France, Northern Ireland and the Netherlands. Parties that have acquired rights to use these External Interconnections are, subject to the relevant market arrangements and agreements, able to trade between the electricity market in Great Britain and those of the External Systems.

France Link

Under NETA, new arrangements for obtaining access to the link were introduced and these continue under BETTA. The arrangements allow for capacity to be allocated in either direction via a system of auctions. These are jointly administered by National Grid and the French Transmission System Operator (RTE). Details of the access arrangements including the auction process can be found on the RTE and National Grid Website, namely: http://www.nationalgrid.com/uk

Northern Ireland Link

This link is owned by Moyle Interconnector Limited and operated by System Operator Northern Ireland (SONI), who also administer the sale of capacity on the interconnector on behalf of Moyle. The relevant Website address is: http://www.soni.ltd.uk

Netherlands Link

National Grid and NLink, a subsidiary of TenneT, the transmission system operator in the Netherlands, are developing a project for an interconnector between Britain and the Netherlands. Arrangements for providing access to this link are currently awaiting regulatory approval.

New Demand

The majority of single new demands are less than 50MW in size (e.g. a large new car production plant). However, the demand from a new steelworks could be in the region of 150MW. In any event, a step-change of say 150MW of demand is usually too small a value to affect any single zone significantly. In general terms, there is likely to be sufficient spare capability over a whole zone of the supergrid to be able to accommodate any single new demand of this size without requiring major reinforcement into the whole zone. Reinforcements at and into a particular Grid Supply Point may be required for a new demand, and in some cases additional reactive compensation may also be required, and a prospective new entrant should contact us for a detailed discussion of an individual site.

An exception might be the introduction of such a step-change of load at certain points within or around some southern areas. For example, the London area has a large demand; approaching one tenth of the GB system peak demand. The London boundary is close to its thermal limit although planned work, some in Table 6.2 and some in Table 8.2, will ensure continued compliance. A large step-change in demand might, dependent on exact location, require major reinforcement.

In should also be remembered that, whilst a 150MW demand increase may not have an appreciable effect upon the particular zone in which it is located, it could have a more global effect on the overall system. For instance additional demand in the south could, under certain circumstances, advance the need for major inter zonal transmission reinforcement between the north and the south. Each case needs to be considered on its own merits.

New Generation

Overview

In general terms, the disposition of demand and generation across the GB transmission system is such that much of the generation capacity is located in or towards the northern parts while much of the demand is located in the southern parts of the system. In consequence, the resultant power broadly flows from the northern parts to the southern parts of the system, particularly at times of the GB system peak demand.

The aggregate power station capacity is projected to rise from 79.9GW in 2008/09 to 110.1GW by 2014/15. The largest change is due to a 13.9GW increase in CCGT plant capacity, which constitutes a 17.4% increase in overall capacity over the period. On this basis, the capacity of CCGT plant will overtake that of coal by 2009/10. By 2014/15, CCGT capacity will exceed coal capacity by 8.2GW and account for 36.0% of the total transmission contracted installed generation capacity.

The second largest increase is due to the growth in Wind generation, with onshore wind accounting for an 7.8% increase and offshore wind accounting for a 7.4% increase in overall capacity. Wind generation capacity (both onshore and offshore) is set to rise to 12.1GW by 2014/15.

The above capacities do not include the embedded Medium and Small generation and embedded External Interconnections with External Systems. The capacity of such embedded generation sources is the subject of Embedded and Renewable Generation.

It should be remembered that the above figures reflect the current contracted position and take no account of future uncertainty. As mentioned previously, it is reasonable to suppose that further new applications for power station connections will be received and, at the same time, some existing contracts may be modified or terminated and some existing power stations will close.

The disposition of the 30.2GW of projected increase in generating capacity is described in Generation Disposition. In particular, Table 3.13 details the capacity changes on a zonal basis. A key message arising from the analyses of boundary power transfers is that, with this 30.2GW increase in new generation planned over the next seven years, the resultant power flows through the Scottish and English grid systems to the Midlands would require significant reinforcement. The future is uncertain and it may be that not all projects may proceed to completion. In addition some existing fossil fuel stations may close for either technical or commercial reasons e.g. following the introduction of the Large Combustion Plant Directive in 2008.

Generation Opportunities

In the generation context, opportunities are interpreted as the ability to connect new generation without an associated need for major transmission reinforcement which could, in turn, lead to delays including those which may be incurred by the need for Planning Consent and possible Public Inquiry.

GB generation agreements are conditional on the completion of any necessary reinforcements to maintain compliance with the Licence Standard. A particular case in point is the SPTL - NGET boundary (Boundary B6), where there is insufficient transmission capacity to accommodate the level of contracted generation in Scotland.

The SYS background power flows across major boundaries within Scotland have increased over the period of the SYS. This has resulted in a number of transmission reinforcements being required to achieve the necessary boundary capacities. 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 reinforcement schemes which include the planned Beauly/Denny transmission reinforcement. The Beauly/Denny reinforcement is included as part of the SYS background for commissioning by 2012/13. 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 and on opportunities.

A further consequence of the connection of 'contracted' generation in Scotland is that there is insufficient capacity on some boundaries within England, in particular the Upper North - North (Boundary B7), North East and Yorkshire (Boundary 11) and North East, Trent and Yorkshire (Boundary B16) boundaries. These boundaries are currently non-compliant for the SYS background. Furthermore, the probabilistic assessment in the previous chapter indicates a rather high likelihood of insufficient capacity for the North – Midlands (Boundary 8).

These circumstances could lead to significant operational constraints and, depending on location, connection dates may be subject to delays until major system reinforcements are completed. The system reinforcements concerned are mainly within Scotland, around the SPTL-NGET boundary and in the North East of England. A significant proportion of these reinforcement works are unlikely to be completed much before 2010/11. On this basis it would be unlikely that there would be any opportunity for new applicants to connect generation at any point to the north of the North - Midlands boundary (Boundary B8) within the seven year period covered by this Statement. However, the proposed new transmission access rules (see below) are expected to change the emphasis by providing an opportunity for earlier transmission access for new generation projects.

It is worth stressing that the deterministic SYS background has been used as the basis of the studies for determining the transmission capacity required to accommodate the current generation 'contracted' position and for determining when further generation can be accommodated onto the GB transmission system. However, in view of the level of uncertainty associated with the future outturn, it would be misleading and inappropriate to attempt to provide precise numerical guidance with regard to opportunities. More usefully, we are able to provide an overview based on the information presented in other chapters of this Statement; in particular the boundary transfers, Figure 8.B1 , Figure 8.B2 , Figure 8.B3 , Figure 8.B4 , Figure 8.B5 , Figure 8.B6 , Figure 8.B7 , Figure 8.B8 , Figure 8.B9 , Figure 8.B10 , Figure 8.B11 , Figure 8.B12 , Figure 8.B13 , Figure 8.B14 , Figure 8.B15 , Figure 8.B16 and Figure 8.B17, see GB Transmission System Capability . Additional information on zonal generation opportunities is given in Zonal Commentary later in this chapter.

Figure 9.1 provides a summary of the opportunities available in the 17 SYS Study Zones. The 17 zones have been grouped into five opportunity groups, namely: VERY LOW, LOW, MEDIUM, HIGH and VERY HIGH. These categorisations are intended to provide a broad indication of the relative level of possible opportunities for connection within individual zones, or groups of zones, without the need for further major inter-zonal transmission reinforcement, which would be likely to incur significant delays in the proposed project.

Figure 9.1

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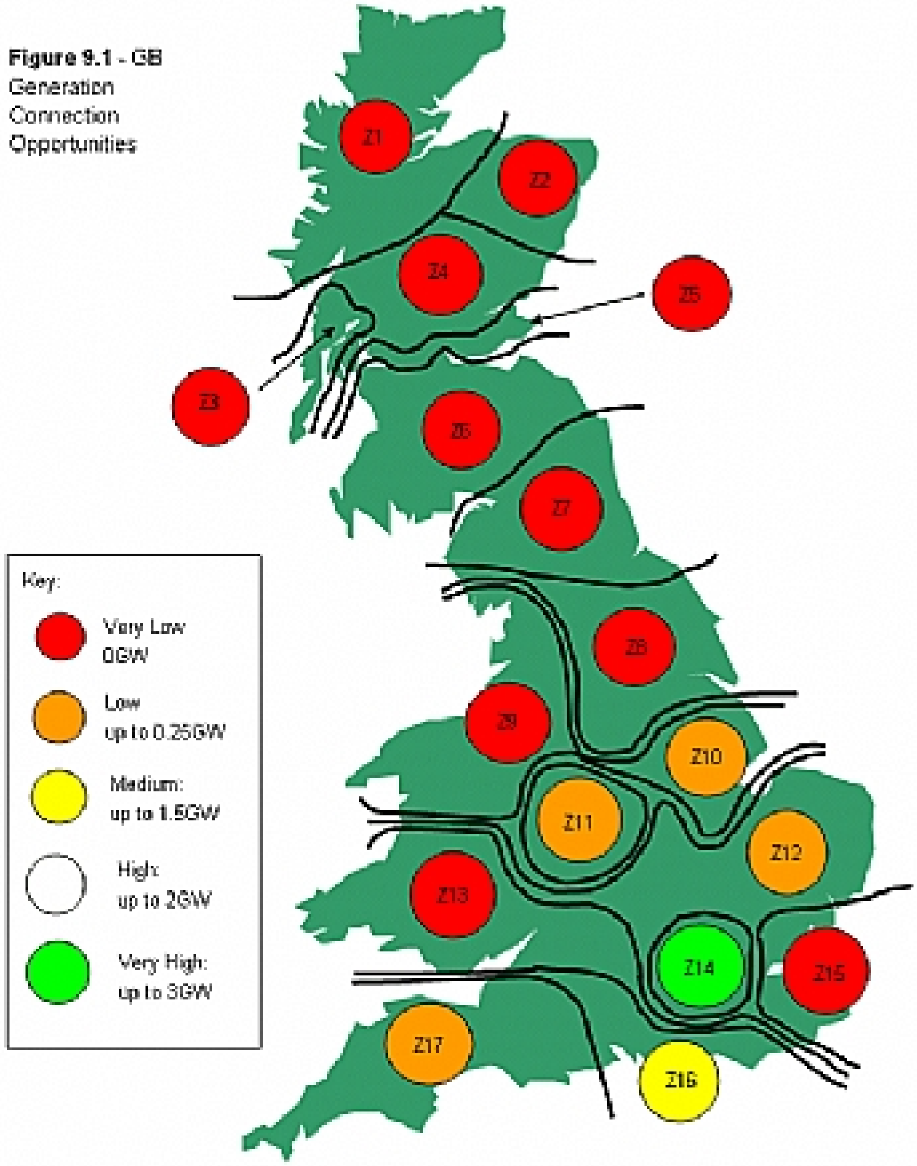

It does not follow that all the generation capacity within an opportunity group could be located at one site within a zone. In some zones, for example the London (zone 14), a considerable spread would be necessary. Nor does it follow that the capacities indicated for each zone within an opportunity group could be accepted together.

The above guidance is necessarily general and emphasises the need to consider individual prospective generation developments on their merits at the time of application. The zonal commentary section presented later in this chapter considers opportunities under both the 'SYS background' and the probabilistic backgrounds.

As mentioned in the introduction to this chapter, notwithstanding the above opportunity messages, we will continue to comply with our licence obligations to make offers and we will endeavour to meet our customers' requirements including those relating to timescales.

Transmission Access Review

The current transmission access review is also relevant in the context of future opportunities for generation access to the GB transmission system.

This review was announced in the Government's Energy White Paper 2007 and is being led by Ofgem and the Department for Business, Enterprise and Regulatory Reform (BERR). The review covers the present technical, commercial and regulatory framework for the delivery of new transmission infrastructure and the management of the existing grid capacity to ensure that they remain fit for purpose as the proportion of renewable generation on the system grows.

Access to the GB transmission system is provided through arrangements with National Grid, acting as GBSO, under the Connection and Use of System Code (CUSC). The CUSC sets out the contractual framework for connection to, and use of, the GB transmission system. The CUSC has applied across the whole of Great Britain since BETTA was introduced on 1 April 2005.

The review includes the consideration of different models of transmission access, and to support this part of the review, National Grid has raised a suite of CUSC amendments and charging methodology modifications which could be used as building blocks to implement a number of different access models. Each of these models could be expected to provide an opportunity for earlier transmission access to new generation projects.

Zonal Power Losses

It was explained in Zonal Power Losses that the effectiveness, in system terms of any new generating station is related, in part, to the effect it has on system losses. Clearly, if a new power station were to be located in the north, and this were to displace the operation of southern generation, then the north to south power flows would increase, transmission losses would increase and some of the output of the new station would, in effect, be 'lost' to the system. However, if the new power station were to be located in the south and this displaced northern generation, the converse would be true. That is, north to south power flows would decrease, system losses would decrease and the relative net effect would be as if a larger station had been installed.

Table 7.5 illustrates the effectiveness, in terms of optimising (i.e. minimising) overall transmission system losses, of locating additional generation in each of the 17 SYS Study Zones in turn. That table presents the 17 zones in order of effectiveness and thereby provides a useful and reasonably robust indicator of relative merits. The resultant order is consistent with the relative order of generation opportunities, discussed in the previous section, and the relative order of generation TNUoS charges across the system.

For comparison, Schedule 1 of our 2008/09'Statement of Use of System Charges', is reproduced in Table 9.1 - Generation and Table 9.2 - Demand. However, please note that, whilst similar, the 17 SYS Study Zones used for the purpose of displaying zonal power losses differ from the 20 generation and 14 demand TNUoS tariff zones.

Zonal Commentary

This section complements the previous sections of this chapter by providing additional information on opportunities for new generation capacity presented on the basis of individual zones or groups of zones. The following zonal commentary considers the opportunities for new generation on the probabilistic background as well as the SYS background.

The Boundary Commentary describes the wide range of probabilistic transfers across the 17 SYS boundaries over the next seven-year period. The reader is guided to the description of the probabilistic transfers for each boundary shown in Figure 8.B1 , Figure 8.B2 , Figure 8.B3 , Figure 8.B4 , Figure 8.B5 , Figure 8.B6 , Figure 8.B7 , Figure 8.B8 , Figure 8.B9 , Figure 8.B10 , Figure 8.B11 , Figure 8.B12 , Figure 8.B13 , Figure 8.B14 , Figure 8.B15 , Figure 8.B16 and Figure 8.B17 within this section. The adoption of a probabilistic view of future boundary transfer levels recognises the fact that there is uncertainty in the future generation and demand background. Clearly, this has an impact on the likely opportunities for the connection of new generation onto the transmission network. The commentary below seeks to address the opportunities for new generation given this level of uncertainty.

Clearly, generation and demand backgrounds, which increase North to South transfers, tend to precipitate the need for major inter-zonal transmission reinforcement and thereby reduce northern opportunities. Such backgrounds would include further northern planting and/or the export of power to France at times of peak. Conversely backgrounds which reduce north to south transfers tend to increase northern opportunities and/or relax the need for major inter-zonal transmission reinforcement. Such backgrounds would include new generation in the South.

In considering the following zonal commentary it is useful to cross reference Table 7.2 , which presents the studied generation, demand and transfer for each zone and the boundary commentary in Boundary Commentary. Please note, however, that Table 7.2 is on the basis of the 'SYS background' and that the generation capacities given are the 'studied' or contributory capacities (based on Table 7.1) rather than installed capacities.

For ease of reference, each zonal commentary includes the relevant extract of Table 7.2 together with a summary of generation capacity changes in the period 2006/07 to 2012/13 based on Table 3.7 . Please refer to Table 7.1 for the effect of generation capacity changes in terms of other plant displaced from being contributory under the SYS background. Finally, the changes in generation capacity from 2008/09 to 2014/15 are described for each zone in various tables in Chapter 3; Table 3.7 and Table 3.13 in particular.

Zone 1: North West (SHETL)

Figure 9.Z1

Click to load a larger version of Figure9.Z1 image

Figure 9.Z1 - SYS Study Zone Z1, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z1	NORTH WEST (SHETL)							
	Effective Generation	914	1045	1035	912	1264	1366	1625
	Demand	531	569	570	545	511	525	534
	Planned Transfer	383	477	465	367	753	842	1091

The SHETL North West zone encompasses the area to the north and west of Fort Augustus, Beauly (near Inverness) and Keith. This area includes a significant amount of existing hydro generation, new renewable generation and the Foyers pumped storage scheme. Demand in this zone is significantly lower than the installed generation; consequently this zone is normally an exporting zone.

Generation in this zone is increasing at a significant rate due to the high volume of new renewable generation seeking connection in the area. Consequently, opportunities for connection of new generation are very low in this zone.

Zone 2: North (SHETL)

Figure 9.Z2

Click to load a larger version of Figure9.Z2 image

Figure 9.Z2 - SYS Study Zone Z2, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z2	NORTH (SHETL)							
	Effective Generation	1301	1382	1269	1266	1320	1353	1501
	Demand	583	591	598	600	607	615	628
	Planned Transfer	718	691	671	666	713	738	872

The SHETL North zone comprises the area to the north of Errochty and Tealing, and to the east of a line drawn between Keith and Errochty. This area includes the thermal power station at Peterhead and some new renewable generation. Demand in this zone is significantly lower than the installed generation; consequently this zone is normally an exporting zone.

Generation in this zone is increasing gradually due to the connection of new renewable generation in the area. Consequently, opportunities for connection of new generation are very low in this zone.

Zone 3: Sloy (SHETL)

Figure 9.Z3

Click to load a larger version of Figure9.Z3 image

Figure 9.Z3 - SYS Study Zone Z3, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z3	SLOY							
	Effective Generation	276	316	313	254	365	330	331
	Demand	66	69	70	70	73	75	75
	Planned Transfer	209	247	243	184	292	255	256

The Sloy zone in the south west of the SHETL system encompasses the flows to the north and south of the Sloy busbar. In comparison to the 132kV infrastructure in the area, this boundary includes a significant amount of existing hydro generation and new renewable generation in Kintyre and Argyll. Demand in the area is centred around Oban and Mull, Lochgilphead and Islay and Campbeltown and Arran. The power flows are normally into this zone from Killin in the north and out of the zone to the south towards Windyhill (near Glasgow).

New renewable generation in Kintyre and Argyll is increasing over time and reinforcement is needed to accommodate the required capability. Consequently, opportunities for connection of new generation are very low in this zone.

Zone 4: South (SHETL)

Figure 9.Z4

Click to load a larger version of Figure9.Z4 image

Figure 9.Z4 - SYS Study Zone Z4, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z4	SOUTH (SHETL)							
	Effective Generation	332	328	458	456	463	518	498
	Demand	512	517	528	531	531	540	554
	Planned Transfer	-180	-190	-70	-74	-68	-22	-56

Zone 4 comprises the southern part of the SHETL system excluding the Sloy zone. In view of the system limitations to the south of this zone, opportunities for connection of new generation are very low in this zone.

Zone 5: North (SPT)

Figure 9.Z5

Click to load a larger version of Figure9.Z5 image

Figure 9.Z5 - SYS Study Zone Z5, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z5	NORTH (SPT)							
	Effective Generation	2368	2380	2396	2296	2217	2125	2024
	Demand	1238	1248	1254	1263	1271	1277	1293
	Planned Transfer	1131	1132	1142	1033	946	849	731

Zone 5 includes thermal generation at Longannet and the Cruachan pumped storage scheme. The zone has a surplus of generation over demand and provides a path for exports from the north of Scotland towards southern Scotland and England.

Opportunities for connection of new generation are low in this zone.

Zone 6: South (SPT)

Figure 9.Z6

Click to load a larger version of Figure9.Z6 image

Figure 9.Z6 - SYS Study Zone Z6, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z6	SOUTH (SPT)							
	Effective Generation	3514	4193	4471	4888	5198	5254	5256
	Demand	3173	3200	3223	3236	3277	3300	3337
	Planned Transfer	341	993	1248	1652	1921	1954	1919

In view of the system limitations within and to the south of this zone, opportunities for connection of new generation are very low.

Zone 7: North & North-East England

Figure 9.Z7

Click to load a larger version of Figure9.Z7 image

Figure 9.Z7 - SYS Study Zone Z7, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z7	NORTH & NE ENGLAND							
	Effective Generation	2848	2735	2787	3579	3634	3602	5562
	Demand	3059	3103	3152	3223	3270	3305	3522
	Planned Transfer	-211	-368	-365	356	364	297	2040

Zone 7 is located between the SPTL to NGET and Upper North to North boundaries where exports to the South are carried on three 400kV double circuits, one in the west from Harker to Hutton and two in the east from Norton to Osbaldwick and Lackenby to Thornton.

Both the deterministic and probabilistic boundary analyses in the previous chapter indicated that there is little opportunity for further generation to connect in this zone.

Zone 8: Yorkshire

Figure 9.Z8

Click to load a larger version of Figure9.Z8 image

Figure 9.Z8 - SYS Study Zone Z8, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z8	YORKSHIRE							
	Effective Generation	11528	11069	11281	11641	11843	11513	11482
	Demand	5920	5953	6010	6312	6368	6407	6492
	Planned Transfer	5608	5116	5271	5329	5475	5106	4990

The zone includes the large concentration of CCGT generation on Humberside and also a significant share of coal fuelled generation. Zone 8 has a large surplus of generation over demand and provides a path for northern exports towards southern regions.

The heavy concentration of existing and transmission contracted generating on Humberside means that there is a very limited opportunity for additional generation in this part of Zone 8. In the remainder of the zone, opportunity is limited by the ability of the North East & Yorkshire boundary to carry additional power transfers. The opportunity for new generation connection projects within this zone is considered very low.

Zone 9: North West England & North Wales

Figure 9.Z9

Click to load a larger version of Figure9.Z9 image

Figure 9.Z9 - SYS Study Zone Z9, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z9	NW ENGLAND & N WALES							
	Effective Generation	8368	7679	7261	6920	7430	7442	6984
	Demand	8043	8117	8293	8874	8914	9050	9116
	Planned Transfer	325	-438	-1032	-1954	-1484	-1608	-2132

This zone is enclosed by the North East & Yorkshire boundary among others towards the East and the North to Midlands boundary in the South. Currently The generation and demand within the zone is close to equal; nonetheless, the main interconnecting circuits out of the zone support a general North to South transport of power through the zone.

A consequence of new generation connections in Zone 8 to East of Zone 9 would be a ‘spill’ of power westwards and then south through Zone 9 under certain fault outage conditions thus limiting opportunities in Zone 9. In any case, major circuits within Zone 9 would become overloaded were any new generation to connect to the North or West of them without reinforcements. Thus, the opportunity for new generation projects within this zone is considered very low.

Zone 10: Trent

Figure 9.Z10

Click to load a larger version of Figure9.Z10 image

Figure 9.Z10 - SYS Study Zone Z10, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z10	TRENT							
	Effective Generation	4300	5466	5919	6549	6664	6598	6581
	Demand	623	638	654	671	694	689	724
	Planned Transfer	3677	4828	5265	5878	5970	5909	5857

This zone is enclosed by the North to Midlands boundary towards the North and the North East, Trent & Yorkshire boundary towards the South and has a large surplus of generation. The boundary capability assessment indicated no future spare capacity for the North East, Trent & Yorkshire boundary for latter years and new generation projects in the zone are therefore likely to require additional reinforcements. Opportunities for new generation within Zone 10 generally are Low.

Zone 11: Midlands

Figure 9.Z11

Click to load a larger version of Figure9.Z11 image

Figure 9.Z11 - SYS Study Zone Z11, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z11	MIDLANDS							
	Effective Generation	3431	4262	4344	4299	4374	4331	3936
	Demand	7687	7728	7867	7928	8010	8058	8124
	Planned Transfer	-4256	-3466	-3523	-3629	-3636	-3727	-4188

Zone 11 covers much of the West Midlands. This zone lies between the critical 'North to Midlands' and 'Midlands to South' boundaries and carries a high level of north to south power transfer. The local transmission system comprises of a 400kV outer ring to which a number of large coal fired generating stations are connected and a local 275kV system which serves the West Midlands conurbation.

There are two underlying system characteristics, which dominate development within the West Midlands. First there is a large power transfer through the zone from north to south. Secondly, most of the demand within Zone 11 is supplied from the local 275kV system, which has little generation support. The 275kV system has historically been supported by medium and small coal fired generating plant connected at 275kV and also at 132kV. All of this has now closed and the loss of generation support has resulted in increased power transfers from 400kV into the 275kV system.

Given the high cross boundary flows and limited local 275KV transmission capacity, further operunities within the zone are considered as ‘low’.

Zone 12: Anglia & Bucks

Figure 9.Z12

Click to load a larger version of Figure9.Z12 image

Figure 9.Z12 - SYS Study Zone Z12, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z12	**ANGLIA & BUCKS**							
	Effective Generation	3614	3486	3734	5018	5489	5723	5065
	Demand	5771	5377	5959	5570	5670	5725	6324
	Planned Transfer	-2157	-1891	-2225	-552	-181	-2	-1259

This zone is enclosed by the Midlands to South, South and South West, London and Thames Estuary boundaries. Traditionally the zone has had a significant deficit of generation and strongly contributes to transport of power from North towards the South. New generation is now contracted to connect along the east coast which will help balance the demand and generation within the zone. New generation within this zone would serve to reduce the power flow from the North but could lead to a requirement to reinforce the transmission network across the north of London. The opportunity for new projects within the zone is considered as 'low'.

Zone 13: South Wales & Central England

Figure 9.Z13

Click to load a larger version of Figure9.Z13 image

Figure 9.Z13 - SYS Study Zone Z13, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z13	**S WALES & CENTRAL ENGLAND**							
	Effective Generation	6302	7961	8453	8816	7547	8335	8080
	Demand	5373	5411	5476	5541	5601	5701	5779
	Planned Transfer	929	2550	2977	3274	1946	2634	2301

This zone contains the main interconnected transmission network in South Wales and a large part of the transmission network in Central England. The zone is exporting and has generation sited at Oldbury, Seabank, Aberthaw, Barry, Baglan Bay, Fifoots and Didcot with a substantial amount of generation scheduled to connect in the SYS background. Generally the internal transmission is strong but considering planned generation, local restrictions are likely to apply. Hence, the opportunity for new generation projects within the zone is considered to be Very Low.

Zone 14: London

Figure 9.Z14

Click to load a larger version of Figure9.Z14 image

Figure 9.Z14 - SYS Study Zone Z14, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z14	**LONDON**							
	Effective Generation	1726	1181	1204	1192	896	888	885
	Demand	10175	10409	10546	10816	11014	11118	11217
	Planned Transfer	-8449	-9228	-9342	-9624	-10118	-10230	-10332

This zone covers the Central London area, a heavily importing area with limited generation. The boundary capability proved insufficient beyond 2010/11. At the same time, the probabilistic transfers indicated that some generation is likely to be present during winter peak.

While there is a significant opportunity for generation in this area, the transmission infrastructure within the zone is such that new generation would necessarily need to be sufficiently well spread, and at precise locations, if major transmission reinforcements were to be avoided. If suitable sites could be found opportunities for new generation in these zones would be 'very high'. It is appreciated that siting difficulties and access to existing transmission infrastructure could be problematic, but there would be a great benefit to the system of base load plant in the London zone.

Zone 15: Thames Estuary

Figure 9.Z15

Click to load a larger version of Figure9.Z15 image

Figure 9.Z15 - SYS Study Zone Z15, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z15	**THAMES ESTUARY**							
	Effective Generation	8276	6751	5562	4209	4279	4241	3768
	Demand	2180	2758	2273	2876	2880	2906	2357
	Planned Transfer	6096	3993	3289	1333	1399	1335	1411

This zone is encircled by the Thames Estuary boundary and contains the generation on the Thames Estuary and also generation on the Essex and Kent coasts and is an exporting zone. The cross-channel link to RTE feeds into Sellindge and the Britned interconnector is scheduled to connect during the SYS period together with replanting of the existing Grain generation. Renewable generation is also planned to connect during the period.

Future opportunities for new generation are 'very low' given the above generation already contracted to connect within this zone.

Zone 16: Central South Coast

Figure 9.Z16

Click to load a larger version of Figure9.Z16 image

Figure 9.Z16 - SYS Study Zone Z16, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z16	CENTRAL S COAST							
	Effective Generation	960	1163	1185	1173	1193	1182	1178
	Demand	4275	4312	4353	4392	4423	4457	4482
	Planned Transfer	-3315	-3149	-3168	-3219	-3230	-3275	-3304

This is an importing zone covering the area from Hastings to Southampton on the South Coast and connected to the adjacent zones by five double circuit 400kV lines. According to the SYS background, generation is expected to connect during the period. The opportunity for new generation development can be regarded as medium, however, the transmission infrastructure could require local reinforcement within this zone for new generation to be accepted.

Zone 17: South West England

Figure 9.Z17

Click to load a larger version of Figure9.Z17 image

Figure 9.Z17 - SYS Study Zone Z17, Studied Zonal Demand and Generation (MW)

	ZONE	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Z17	SOUTH WEST ENGLAND							
	Effective Generation	1774	1704	1737	1719	1749	1731	2570
	Demand	2802	2882	2912	2944	2966	2994	3017
	Planned Transfer	-1028	-1178	-1175	-1225	-1217	-1263	-447

This zone is enclosed by the South West boundary and is an importing zone with the only large generation presently being the nuclear plant at Hinkley Point B. Significant new generation is contracted to connect within the zone. As the new generation connects the local generation approaches equality with the local demand. The opportunity for generation development can be regarded as 'low', given the fact that Z17 is connected to the adjacent zones by only two double circuit 400kV lines. Careful consideration would need to be given if a large development should take place at the far western end of the Peninsula.

Voltage Support Services

Introduction

This section provides information on possible future opportunities for the provision of voltage support services to the GB transmission system.

Generating units providing a Mandatory Reactive Power Service (i.e. under and in accordance with the requirements of the Grid Code) receive system Ancillary Service Payments according to arrangements set out in Schedule 3 of the Connection and Use of System Code, CUSC. This provides for a Default Payment Mechanism (DPM) and for alternative, bilateral, Market Agreements.

The Schedule also provides for Market Agreements for Enhanced Reactive Power Services from pre-qualified providers (for example, generating units able to provide reactive power capability in excess of the Grid Code requirements).

The terms ‘Reactive Power Default Mechanism’, ‘Obligatory Reactive Power Service’, ‘Enhanced Reactive Power Service’ and ‘Market Agreement’ are defined in Schedule 3 of the CUSC. The CUSC Schedule 3 also sets out payment rules and qualifications and evaluation criteria. The payment rate under the Reactive Power Default Mechanism is now indexed against RPI and Power Prices, and has varied between £1.61/Mvarh and £3.28/Mvarh during 2007/08.

Table 8.2 lists indicative network reinforcements that may be required in future to ensure that the system meets Licence Standards for the given SYS background. Amongst these reinforcements are schemes for the support and control of voltages in different parts of the network. As an alternative to purchasing the relevant assets, we would be willing to contract with service providers for voltage support services when this would be economic. As discussed in Indicative Reinforcements for Licence Compliance the voltage support schemes detailed in Table 8.2 are those required for the specific 'SYS background'. However, as a general guidance it is broadly true that voltage support requirements increase at high levels of power transfer across the system. Thus further reactive compensation schemes over and above those detailed in Table 8.2 could be expected with backgrounds which result in higher transfer levels.

The voltage support schemes included in Table 8.2 are identified in terms of specific types of plant, i.e. mechanically switched capacitors (MSCs) and static var compensators (SVCs), and in terms of defined ratings at identified supergrid substations. However, these schemes must be regarded as indicative only, and the opportunities will, as previously explained, depend on the outturn generation and demand background. We would consider offers of service in the region of the identified sites, different ratings or different performance characteristics. The offered services would be evaluated on a case by case basis, and contracts awarded where they would be economic and enable system needs to be met by the required dates. The types of voltage support service that might be offered and the types of performance that we would seek are discussed later in this section.

One means by which we address the uncertainty in future transmission requirements, is to delay commitment to asset construction to the latest possible date, while at the same time, ensuring that we can provide an efficient, co-ordinated and economic system compliant with the security standards, as required by the Electricity Act 1989 and the Transmission Licence. Similar considerations apply when placing contracts for voltage support services. A contract would be let when we are sufficiently confident that the offer represents an economic, practical and robust means of meeting the system requirements in the context of overall transmission system cost and performance and the surrounding uncertainties. A contract may be valid for one or more years.

The types of services that we believe might be offered include:

(i) generating plant able to offer a greater reactive power range than that specified in the Grid Code and paid for under System Ancillary Service Contracts; and

(ii) synchronous compensation plant, de-clutchable gas turbines or static compensation plant.

However, the above list is illustrative only and any offered service would be considered on its merits.

Contracts would be assessed by comparing the total costs and the performance of alternative options that match the system requirement. Performance factors considered would include rating, speed of response, availability of the service relative to the system requirement and control issues. In the case of additional capability from generating units, the predicted merit order position and running regime of the units would be a critical factor.

Where a contract would involve a new connection to our transmission system (e.g. a service offered under item (ii) above) the cost of the connection would have to be factored into the offered contract price. Before contract terms could be finalised, therefore, a formal application for a connection would need to be submitted in order that we could offer connection terms.

We currently buy equipment of the mechanically switched capacitor (MSC) or static Var compensator (SVC) type specifically for voltage support and these are discussed in the following paragraphs.

Mechanically Switched Capacitors (MSCs)

These provide switchable blocks of susceptance and are used where it is necessary to offset the reactive requirements of the intact system (which change slowly through the day) or to provide a response (after some 30 seconds) following a system contingency such as an outage of transmission equipment or generating unit. MSCs have high year-round availability and reliable performance. They may be operated either by remote control or by automatic control with remote setting of switching criteria.

MSCs would provide the initial basis for contract comparison where the system requirement is to offset slowly varying reactive demands or to provide a slow, infrequent response to system contingencies.

Static Var Compensators (SVCs)

Whilst continuously rated for reactive current within their operating range, these devices are able to adjust their reactive current very quickly (within 100ms) in response to system voltage changes. They are thus used when it is necessary to cope with minute-to-minute changes in reactive requirement, and also rapid changes due, for example, to faults on the system. SVCs have high year-round availability and perform reliably. They operate under automatic control with remote adjustment of control parameters by ourselves.

SVCs would provide the initial basis for contract comparison where the system requirement is to cope with minute-to-minute changes in reactive requirement or to respond rapidly to system contingencies.

All reactive compensation equipment bought by ourselves is specified to be re-locatable to permit redeployment if system needs change in future. Any contract for a reactive service would need to reflect this flexibility through contract duration or re-locatability.

We would welcome offers of voltage support services, subject to provisos that any new equipment connected to the transmission system, including the connection between the equipment and the transmission system, would need to meet (and any existing equipment would need to continue to meet) the relevant commercial and technical standards.

Interested parties considering offering a service are invited to contact the Contracts & Trading Manager, Network Operations, who will provide details of the reactive power market mechanisms and will be happy to discuss possible tenders and contract arrangements, service requirements, locations and performance factors in further detail.

Reactive Energy

Table 9.3 shows the reactive energy generated by Large Power Stations. This has formed the basis upon which ‘reactive energy’ payments are made. Data is provided for the period from April 1995 to September 2007 and is the latest information available at the time of writing. Data for Scotland has only been available since 1 April 2005. Accordingly prior to that time information is restricted to the three geographical areas in England and Wales, namely: North; Midlands; and South.

Modified versions of the main system boundaries in England and Wales have been used to define the above three geographical areas (see Figure A.4.3). 'North' is defined as the area north of a boundary, which follows boundary 8 in the west but reverts to boundary 9 east of Ratcliffe on Soar. 'South' is defined as the area south of a boundary which follows boundary 9 in the west but reverts to the section of boundary 14 just south of East Claydon, Sundon and Wymondley and then boundary 15 south of Braintree and north of Rayleigh Main. 'Midlands' is the area bounded by the above two modified boundaries.

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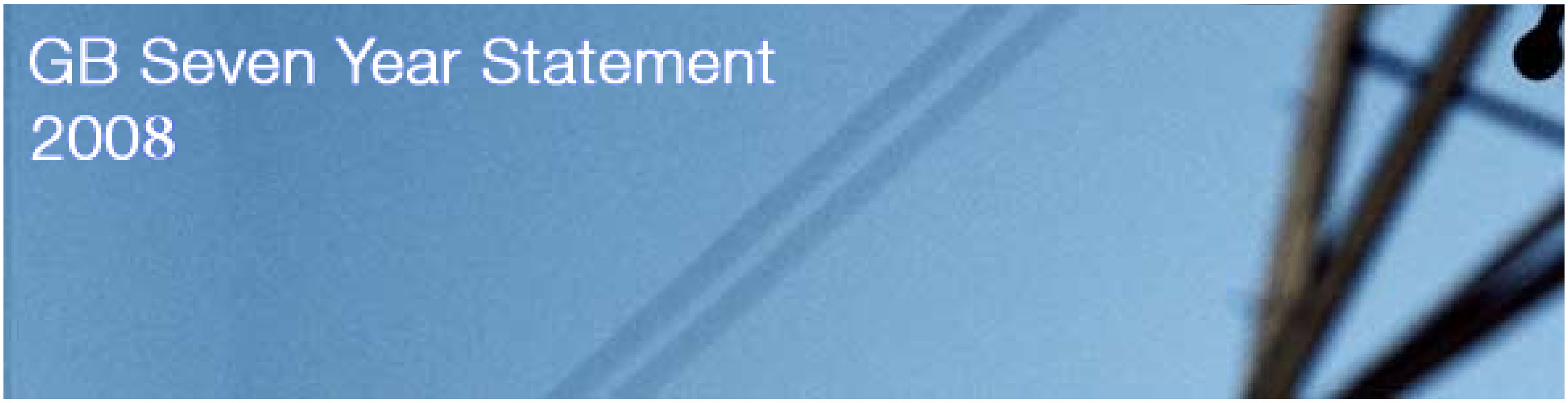

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Table 9.1 - Transmision Network Generation Use of System Charges - 2008/09

Generation Zone	Zone Name	GB Zonal Tariff (£/kW)
1	North Scotland	22.259739
2	Peterhead	19.755277
3	Western Highland & Skye	20.532857
4	Central Highlands	16.740461
5	Argyll	15.061477
6	Stirlingshire	14.355815
7	South Scotland	13.521131
8	Auchencrosh	10.381288
9	Humber, Lancashire & SW Scotland	6.316499
10	North East England	9.94884
11	Anglesey	6.8287
12	Dinorwig	9.819972
13	South Yorks & North Wales	4.417103
14	Midlands	2.316992
15	South Wales & Gloucester	-2.472781
16	Central London	-5.657229

17	South East	1.219845
18	Oxon & South Coast	-0.014772
19	Wessex	-2.570938
20	Peninsula	-8.525957
	Small Generators Discount	4.877944

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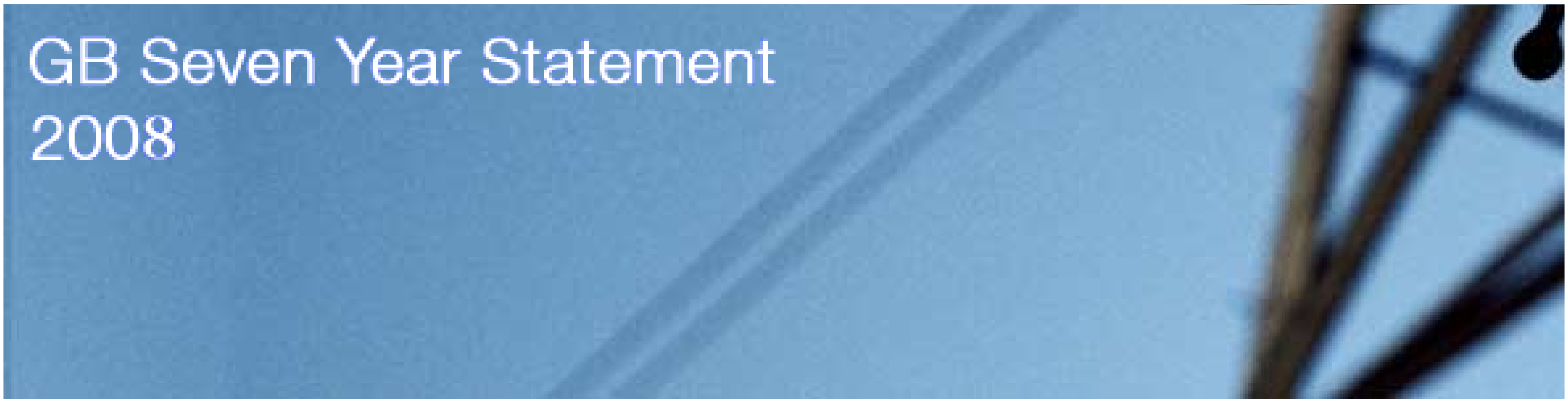

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Table 9.2 - Transmission Network Demand Use of System Charges - 2008/09

Demand Zone	Zone Name	HH Zonal Tariff (£/kW)	NHH Zonal Tariff (p/kWh)
1	Northern Scotland	2.869716	0.372036
2	Southern Scotland	7.950377	1.049619
3	Northern	10.899023	1.424364
4	North West	14.911638	1.95678
5	Yorkshire	14.829178	1.935788
6	N Wales & Mersey	15.460156	2.036959
7	East Midlands	17.620712	2.343048
8	Midlands	19.147817	2.543378
9	Eastern	18.364952	2.474431
10	South Wales	23.230707	2.940514
11	South East	21.50087	2.849708
12	London	23.548992	3.013718
13	Southern	22.19481	2.933872
14	South Western	25.212997	3.217128
	Small Generators Adjustment	0.061298	0.008062

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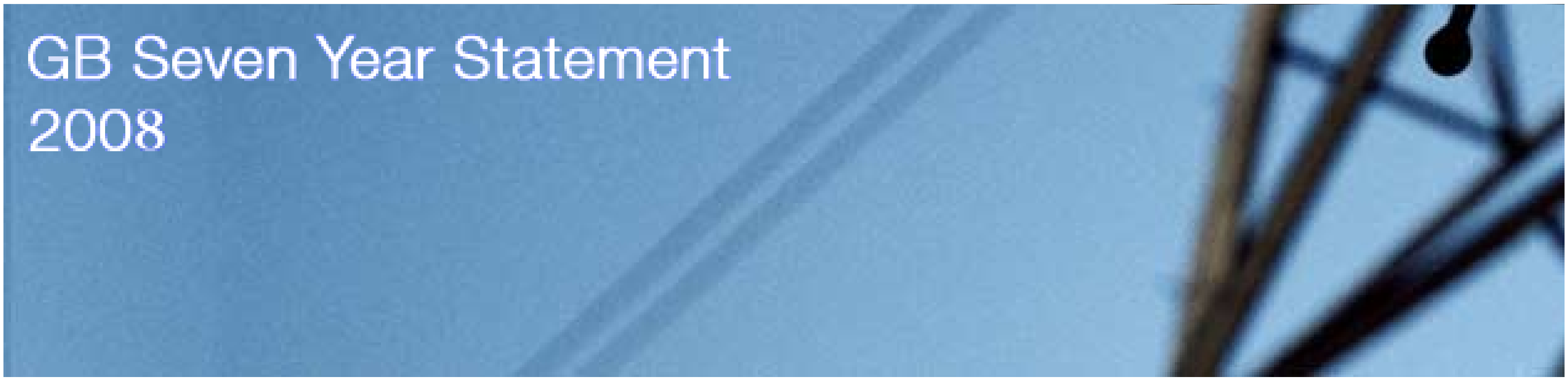
Table 9.3 - Reactive Utilisation (metered output) April 1995 to September 2007 (TVArh)

StartDate	EndDate	Scotland Lead	Scotland Lag	NORTH LEAD	NORTH LAG	MIDLANDS LEAD	MIDLANDS LAG	SOUTH LEAD	SOUTH LAG	TOTAL LEAD	TOTAL LAG
01/04/1995	31/03/1996			5.26	22.23	0.71	6.19	2.69	5.33	8.67	33.75
01/04/1996	31/03/1997			5.58	22.5	0.73	5.01	3.23	5.01	9.54	32.52
01/04/1997	31/03/1998			5.67	19.32	0.72	4.67	3.41	3.78	9.8	27.77
01/04/1998	31/03/1999			4.06	17.55	0.8	4.12	3.28	3.05	8.15	24.72
01/04/1999	31/03/2000			3.75	17.7	0.64	3.65	2.62	3.59	7	24.97
01/04/2000	31/03/2001			2.96	13.71	0.88	4.41	3.07	3.05	6.91	21.17
01/04/2001	31/03/2002			3.5	10.38	1.08	4.83	3.44	2.96	8.03	18.18
01/04/2002	31/03/2003			3.3	10.43	0.99	3.46	3.29	2.98	7.58	16.87
01/04/2003	31/03/2004			3.68	9.44	0.9	3.48	3.61	3.65	8.19	16.57
01/04/2004	31/03/2005			4.15	9.23	1.15	2.92	4.01	3.28	9.67	15.43
01/04/2005	31/03/2006	2.38	1.19	4.17	7.84	1.59	2.95	3.95	2.51	12.09	14.49
01/04/2006	31/03/2007	1.83	1.52	4.78	7.27	1.31	1.84	3.58	2.05	11.5	12.68
01/04/2007	30/09/2007	1.04	0.31	2.3	2.63	0.64	0.69	1.63	0.74	5.61	4.37



Introduction to Chapter 10

The Energy Act (2004) received Royal Ascent in July 2004. Under powers granted by this legislation the Secretary of State directed changes to licences and designated changes to codes that together provided for the introduction of the British Electricity Trading and Transmission Arrangements (BETTA), which were subsequently introduced on 1 April 2005 They replaced the previous New Electricity Trading Arrangements (NETA) in England and Wales, and the separate arrangements that existed in Scotland and the British Grid System Agreement (BGSA). This chapter provides an overview of BETTA and reports on related issues such as governance, institutional and contractual arrangements. The chapter concludes with a generalised summary of some of the main requirements placed upon users in relation to their obligations to become party to the various codes and charges under BETTA.

Offshore Electricity Transmission

The arrangements described in this chapter are subject to continual change and review either via legislative processes or through normal electricity industry governance. In addition to this, Ofgem and BERR are currently working together to implement a new regulatory regime for electricity transmission networks offshore. This is intended to enable significant volumes of offshore renewable generation to connect from UK offshore waters and will play an important role in increasing the amount of electricity generated from renewable sources in the UK and hence in meeting Government renewable targets.

The Government's aim is that there will be a transition to this new regime commencing as close as possible to December 2008 with full implementation 12 months later. The new regime will be based on the existing arrangements which apply onshore but with new provisions to manage the transmission networks expected to be constructed in the offshore environment where they are required,

A new feature of the regime is a proposal to select 'Offshore Transmission Owners' (OFTOs), parties who will design, construct and own offshore transmission networks, via a competitive selection process. Therefore, the SO-TO Code, the features of which are summarised below, will be extended to the offshore environment and will be used by National Grid (in its role as GBSO designate for offshore transmission) to manage a significant part of the delivery of offshore transmission services to users.

British Electricity Trading and Transmission Arrangements

The Market Structure

The arrangements under BETTA are based on bilateral trading between generators, suppliers, traders and customers across a series of markets operating on a rolling half-hourly basis. Under these arrangements generators self despatch their plant rather than being centrally despatched by the System Operator. There are three stages to the new wholesale market, plus a new settlement process. These are illustrated in Figure 10.1.

Figure 10.1

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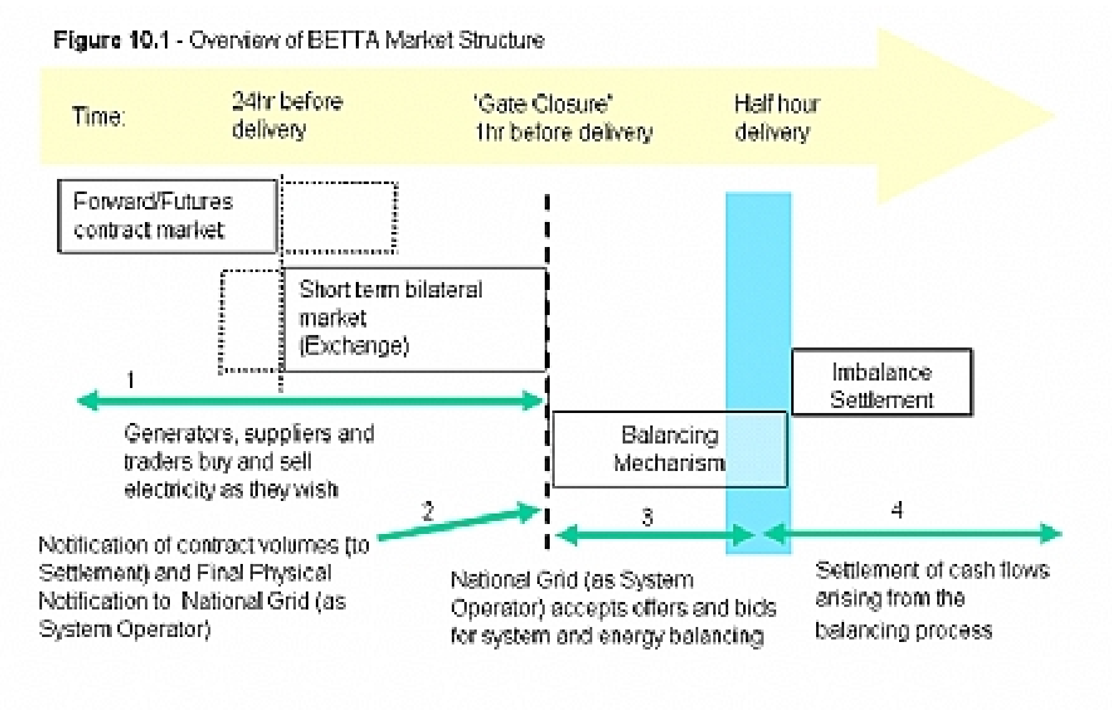

Participation in the bilateral markets (i.e. the Forward/Futures contract market and the Short-term bilateral markets) and the Balancing Mechanism (i.e. offer/bid submission) is optional. Participation in Settlements is mandatory. In addition, certain categories of generator are required to provide Physical Notifications. The Balancing and Settlement Code (BSC) provides the framework within which participants comply with the Balancing Mechanism and Settlement Process. The BSC is administered by a non-profit making entity called Elexon. Information on Elexon is available from its website: www.elexon.co.uk.

The BSC also specifies the process for modifying the BSC itself. All modifications to the BSC are approved by the Authority (Ofgem) and must, in order to be approved, better facilitate achieving the applicable BSC objectives.

Gate Closure is the point in time when market participants notify the System Operator of their intended final physical position and is set at one hour ahead of real time. In addition, no further contract notification can be made to the central settlement systems.

Forwards and Futures Contract Market

The bilateral contracts markets for firm delivery of electricity operate from a year or more ahead of real time (i.e. the actual point in time at which electricity is generated and consumed) and typically up to 24 hours ahead of real time. The markets provide the opportunity for a seller (generator) and buyer (supplier) to enter into contracts to deliver/take delivery, on a specified date, of a given quantity of electricity at an agreed price.

The markets are optional with participants having complete freedom to agree contracts of any form. Formal disclosure of price is not required.

The Forwards and Futures Contract Market is intended to reflect electricity trading over extended periods and represents the majority of trading volumes. Although the market operates typically up to a year ahead of real time, trading is possible up to Gate Closure.

Short-term Bilateral Markets (Power Exchanges)

Power Exchanges operate over similar timescales, although trading tends to be concentrated in the last 24 hours.

The markets are in the form of screen-based exchanges where participants trade a series of standardised blocks of electricity (e.g. the delivery of xMWh over a specified period of the next day). Power Exchanges enable sellers (generators) and buyers (suppliers) to fine-tune their rolling half hour trade contract positions as their own demand and supply forecasts become more accurate as real time is approached. The markets are firm bilateral markets and participation is optional. One or more published reference prices are available to reflect trading in the Power Exchanges.

Balancing Mechanism

The Balancing Mechanism operates from Gate Closure through to real time and is managed by National Grid in its role as Great Britain System Operator (GBSO). It exists to ensure that supply and demand can be continuously matched or balanced in real time. The mechanism is operated with the System Operator acting as the sole counter party to all transactions.

Participation in the Balancing Mechanism, which is optional, involves submitting 'offers' (proposed trades to increase generation or decrease demand) and/or 'bids' (proposed trades to decrease generation or increase demand). The mechanism operates on a 'pay as bid' basis.

We purchase offers, bids and other Balancing Services see Balancing Services to match supply and demand, resolve transmission constraints and thereby balance the system. As part of this process we are also required to ensure that the system is run within operational standards and limits (see entry on Licence Standard in References).

Generators and suppliers registered within the Balancing and Settlement Code are bound by the relevant requirements of the Grid Code which includes the arrangements for System Operator to accept Balancing Mechanism bids and offers, for calling off Balancing Services and for dealing with emergencies.

Our previous duty to purchase ancillary services economically and to despatch plant in accordance with a merit order has been replaced by a general duty to operate the transmission system in an efficient, economic and co-ordinated manner through the procurement and utilisation of Balancing Services including Balancing Mechanism bids and offers. Our GBSO Incentive Scheme normally covers this duty.

As the market moves towards the Balancing stage, we need to be able to assess the physical position of market participants to ensure security of supply is maintained effectively and efficiently. To this end, all market participants are required to inform us of their planned net physical flows onto and/or from the system. Initial Physical Notifications (IPNs) are submitted at 11.00a.m. at the day ahead stage. These are continually updated until Gate Closure when they become the Final Physical Notifications (FPNs).

Imbalances and Settlements

Power flows are metered in real time to determine the actual quantities of electricity produced and consumed at each location. The magnitude of any imbalance between participants' contractual positions (as notified at Gate Closure) including accepted offers and bids, and the actual physical flow is then determined. Imbalance volumes are settled at one of the dual imbalance prices; System Buy Price (SBP) and System Sell Price (SSP). Following the Authority approval of BSC Modification Proposal P205, the methodology that is used to set the imbalance prices changed on 2nd November 2006. To explain this change, the following paragraphs describe the previous arrangements and then the new arrangements that were introduced on 2nd November 2006.

Previous Imbalance Pricing Arrangements

SBP was the price at which deficits were charged and, when the system was short, reflected the average price at which the system had to buy in order to make good the deficit on behalf of the party (i.e. the average of accepted offers). SSP was the price at which surpluses were charged and, when the system wais long, reflected the average price at which the system had to sell in order to dispense with the surplus spill energy (i.e. the average of accepted bids). However, some bids and offers were excluded from the averaging calculations on the basis that they were related to system balancing (e.g. resolving transmission constraints) as opposed to energy balancing trades. In addition, an adjustment to the imbalance prices was made based on any pre-gate closure Balancing Services that we had used for energy balancing. This was known as the Balancing Services Adjustment Data (BSAD). Since the introduction of BSC Modification P78 in March 2003, SBP when the system was long and SSP when the system was short were based upon a forward market price derived from Power Exchange trades.

Imbalance Pricing Arrangements from 2nd November 2006

Imbalance prices are now derived by taking the average cost of the marginal 500MWh of actions that National Grid has taken to resolve the energy imbalance – excluding those “tagged” actions taken for system balancing reasons. This is shown diagrammatically in Figure 10.2.

Figure 10.2

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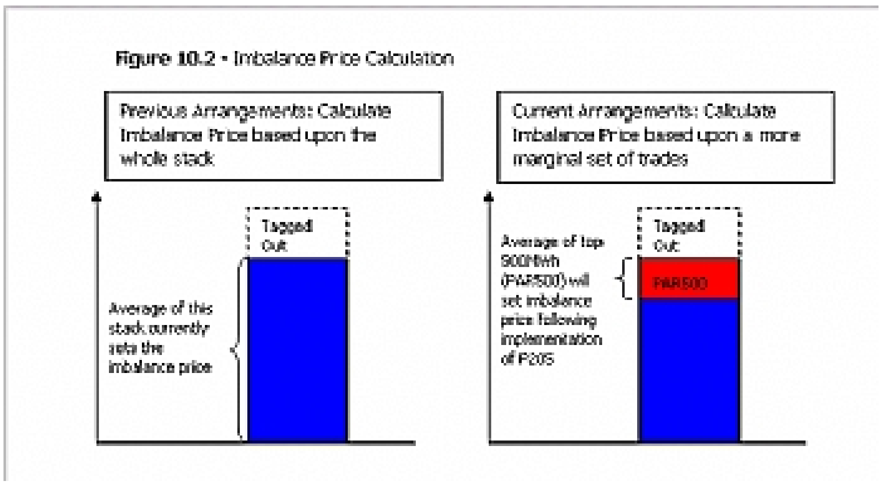


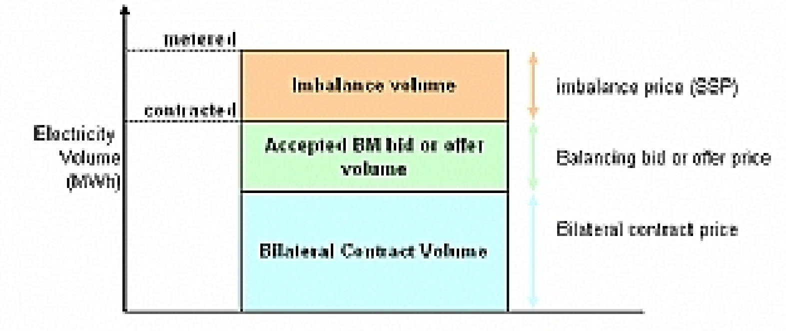
Under these revised arrangements the “reverse price” i.e. SBP when the system is long and SSP when the system is short, will continue to be based upon a forward market price derived from Power Exchange trades.

Imbalance prices are intended to serve as an appropriate incentive for market participants to efficiently manage their contractual energy position ahead of gate closure. There is therefore a link between imbalance prices and plant margin in that the incentive on a participant to balance determines the level and value of contracting in the forward markets. This price signals drives plant availability, and in the longer term should sustain investment in new capacity. It is therefore essential that imbalance prices are set to provide the appropriate incentives in this respect. Figure 10.3 provides a simplified example where the metered energy output of a generator exceeds the contracted position.

Figure 10.3

Click to load a larger version of Figure 10.3 image

Figure 10.3 - Energy Imbalance



There is a positive imbalance volume for which the generator would only be paid at SSP. Under normal circumstances SBP exceeds SSP. Had there been a negative imbalance volume, the system would have bought at SBP to compensate and so the generator would be charged at SBP. The use of dual imbalance prices is intended to provide an incentive for participants to balance their own position as accurately as possible.

Finally, in addition to energy imbalance charges there is also provision in the market rules for an information imbalance charge. Information imbalance corresponds to the difference between the expected delivery (as indicated by FPNs plus accepted BM bids and offers), on the one hand and metered output/consumption on the other. This charge is currently set at zero.

Balancing Mechanism Reporting Service (BMRS)

As part of the BETTA arrangements, market participants have access to information to enable them to trade to balance their positions and self despatch their plant. The Balancing Mechanism Reporting Service (BMRS) is the service for reporting the necessary information that includes:

- Demand forecasts from National Grid;
- Generation availabilities and margins;
- Imbalance forecasts based on participants' Physical Notifications;
- Submitted BM offer and bid volumes and prices; and
- Accepted BM trades and imbalance prices
- A variety of other information related to market operation

Forecast information is primarily made available for the day ahead and on the day. Submitted BM data is made available shortly after Gate Closure. Accepted bids and offers and initial imbalance prices are published shortly after real time. LogicaCMG operates the systems for this process under contract to Elexon, and administer a dedicated web-site providing near real-time information available at http://www.bmreports.com/.

Market Governance

The Balancing and Settlement Code (BSC)

The BSC sets out the rules governing the operation of the Balancing Mechanism (BM) and the Imbalance Settlement process and also sets out the relationships and responsibilities of all market participants.

All Licence holders (i.e. transmission, generation, supply and distribution) are required to be registered within the BSC. Parties registered within the BSC may or may not choose to participate in the Balancing Mechanism (BM). Participation is defined as submitting an “offer” or a “bid” and is not dependent on its acceptance.

Parties exempt from holding a Licence may nevertheless choose to sign the framework agreement by which the BSC is made contractually binding. They may then also choose to participate in the BM. However, those parties who sign the BSC, whether licensed or license exempt, are also likely to be required to sign on to the Connection and Use of System Code (CUSC).

A copy of the code may be obtained from www.elexon.co.uk, which also has links to all BSC change process documentation including modifications to the code itself.

The Grid Code (GC)

National Grid has a Licence Obligation in consultation with the other participants, to prepare and at all times to have in force and to implement, comply with, and review regularly, a Grid Code which would set down the operating procedures and principles governing our relationship with all users of the transmission system, be they generating companies, suppliers or suppliers' customers, Externally Interconnected Parties or users with systems directly connected to the transmission system.

The Grid Code is designed to permit the development, maintenance and operation of an efficient, co-ordinated and economical system for the transmission of electricity, to facilitate competition in the generation and supply of electricity and to promote the security and efficiency of the power system as a whole. National Grid and users of the GB Transmission System are required to comply with the Grid Code.

The Grid Code covers all material and technical aspects relating to connections and to the operation and use of the transmission system or, in as far as relevant to the operation and use of the transmission system, the operation of the electric lines and electrical plant connected to it or to a distribution system. It also specifies data which system users are obliged to provide to us for use in the planning and operation of the transmission system, including demand forecasts, availability of generating sets and intended dates of overhaul of large generating sets.

All parties connected to, or involved in the use of, the transmission system, including National Grid, are subject to the Grid Code. Please note that amongst other things, the Grid Code requires that participants embedded within another party's system (e.g. distribution system) must ensure that their physical notifications (see Balancing Mechanism Reporting Service (BMRS)), bids and offers are feasible with respect to their host network. Users' Licences and the Connection and Use of System Code (CUSC) give legal force to the Grid Code. Any changes to the Grid Code are subject to the approval of the Authority (Ofgem).

The Grid Code, along with associated information on its structure is available at http://www.nationalgrid.com/uk/Electricity/Codes/

The Connection and Use of System Code (CUSC)

National Grid is required under the Transmission Licence to be a party to the CUSC Framework Agreement and comply with the CUSC. It is also a requirement for holders of a generation, distribution or supply licence to be a party to the CUSC Framework Agreement and comply with the CUSC. In addition to licensees, the following parties need to be a party to the CUSC Framework Agreement and comply with the CUSC. Users who are:

- Required to sign an agreement pursuant to the Balancing and Settlement Code; or
- Not licensed nor subject to the Balancing and Settlement Code but who are directly connected to the National Grid Transmission System; or
- Who are Embedded and required pursuant to Paragraph 6.5 of the CUSC to have an agreement with National Grid.

The CUSC is a licence-based code setting out within it the principal rights and obligations in relation to connection to and/or use of the GB transmission system and also relating to the provision of certain Balancing Services. The CUSC was developed as a replacement to the previous Master Connection and Use of System Agreement (MCUSA), which had been used since Vesting. All persons who were party to the MCUSA as at the CUSC Implementation Date continued as Original Parties to the CUSC Framework Agreement. Other Parties who have since acceded to the CUSC are additional parties.

The CUSC contains obligations for CUSC signatories to comply with the relevant provisions of the Grid Code, and obligations to pay charges in accordance with the Charging Statements.

The SO-TO Code (STC)

The STC is the legal document, which forms the contractual framework for the interactions between the three Transmission Licensees and makes provision for certain interactions between these three parties. These interactions include:

- The Transmission Owners providing Transmission Services to the GB System Operator;
- Directions from the GB System Operator to configure the GB Transmission System;
- Transmission Outage Planning;
- Joint Transmission Investment Planning;
- Governance of the STC and amendments to it; and
- Dispute resolution.

National Grid's Role and Obligations

Licence Obligations

Section C of the Transmission Licence places a number of obligations upon National Grid in relation to, amongst other things, the Balancing and Settlement Code (BSC) and these include:

- National Grid shall at all times have in force and comply with, a Balancing and Settlement Code
- National Grid shall operate the transmission system in an efficient, economic and co-ordinated manner; and
- Having taken into account the relevant price and technical differences, National Grid shall not discriminate between any persons or classes of persons in its procurement of Balancing Services.

Under the arrangements of BETTA, NGET, SPT and SHETL each have Transmission Licenses that stipulate certain obligations. However, in its role as the GB System Operator (GBSO), National Grid has extra responsibilities as indicated above. The SO-TO code (STC) sets out the arrangements for the interface between the GBSO and the Scottish Transmission Operators.
http://www.nationalgrid.com/uk/indinfo/stc/mn_stc.html

Balancing Services

The services that we procure, as GBSO, in order to operate the transmission system constitute Balancing Services.

Balancing Services include:

- Ancillary Services;
- Offers and bids made in the Balancing Mechanism; and
- Other services available to National Grid which serve to assist us in operating the transmission system in accordance with the Electricity Act 1989 or the Conditions in an efficient and economic manner.

Ancillary Services, under the Grid Code, can be Part 1 System Ancillary Services, Part 2 System Ancillary Services or Commercial Ancillary Services. Part 1 System Ancillary Services are those which Users are required to have available in accordance with the Grid Code. Part 2 System Ancillary Services are those optional services (e.g. black start capability) set out in the Grid Code, which the User has agreed to have available. Commercial Ancillary Services are other optional services (e.g. hot standby) described in the Grid Code, which the User has agreed to have available.

Balancing Mechanism offers and bids are commercial services offered by generators and suppliers and procured through arrangements set out in the BSC. They represent the willingness to increase or decrease the energy output from BM Participants in exchange for payment.

Other Services refers to commercial services that can be entered into with any party, which are classified neither as Ancillary Services nor BM offers or bids. These services can be provided by parties who are not authorised electricity operators. This category would include any service provided by parties that are not signatories to the BSC and may also include the procurement of energy ahead of BM timescales.

For further information on Balancing Services, please see the following website:-http://www.nationalgrid.com/uk/indinfo/balancing

Information Provision

There are four documents which we produce pursuant to Special Condition C16 of the Transmission Licence which have particular relevance in this area, namely the:

- Procurement Guidelines;
- Balancing Principles Statement;
- Balancing Services Adjustment Data (BSAD) Methodology Statement; and
- Applicable Balancing Services Volume Data (ABSVD) Methodology Statement.

The Procurement Guidelines set out the kinds of Balancing Services which we may be interested in purchasing, together with the mechanisms by which we envisage purchasing such services. The Procurement Guidelines are not prescriptive of every possible situation that we are likely to encounter, but rather represent a generic statement of the procurement principles we expect to follow.

The Balancing Principles Statement defines the broad principles and criteria (the Balancing Principles) by which we determine, at different times and in different circumstances, which Balancing Services we will use to assist in the operation of the transmission system (and/or to assist in doing so efficiently and economically), and when we would resort to measures not involving the use of Balancing Services. The Balancing Principles Statement is designed to indicate the broad framework in which we will make balancing action decisions.

The Balancing Services Adjustment Data (BSAD) Methodology Statement sets out information on relevant Balancing Services that will be taken into account under the BSC for the purpose of determining Imbalance Price(s).

Further information and electronic versions of the above documents are available from:- http://www.nationalgrid.com/uk/indinfo/balancing

Transmission Pricing

Charging Statements

We produce three Charging Statements in accordance with the requirements of the Transmission Licence. Whereas the contractual obligation to pay charges resides within the Connection and Use of System Code (CUSC), the principles that underpin these charges are contained in the Charging Statements.

The three Charging Statements are; the Statement of Use of System Charges; the Statement of Use of System Charging Methodology; and the Statement of the Connection Charging Methodology.

It is a requirement of our Transmission Licence that we charge in accordance with the above Statements. The Statements contain sufficient detail to enable our customers to make a reasonable estimate of their charges. The documents are kept under continual revue and any amendments are approved by Ofgem.

For a comprehensive description, please refer to the Charging Statements which are available at the following web site: www.nationalgridinfo.co.uk/charging/index.html.

The follow paragraphs provide a brief summary of National Grid's charges.

Connection Charges

All customers who are directly connected to the GB transmission system are subject to Connection charges.

These charges enable National Grid to recover, with a reasonable rate of return, the costs involved in providing the assets that afford connection to the GB transmission system. The Connection charges relate to the costs of assets installed solely for and only capable of use by an individual User and take into account the asset value and age. Connection charges additionally include a maintenance component and an overhead component based on the asset value.

Transmission Network Use of System (TNUoS) Charges

Transmission Network Use of System charges reflect the cost of installing, operating and maintaining the transmission system for the Transmission Owner (TO) Activity function of the Transmission Businesses of each Transmission Licensee. These activities are undertaken to the standards prescribed by the Transmission Licences, to provide the capability to allow the flow of bulk transfers of power between connection sites and to provide transmission system security.

The basis of charging to recover the allowed revenue is the Investment Cost Related Pricing (ICRP) methodology, which was approved for use for GB in March 2005. Charges are based on the customer's location and on their import and export requirements as calculated by a DC Load flow (DCLF) ICRP transport model. The GB charging methodology was implemented in April 2005.

The TNUoS charge is split in the ratio 27:73 respectively between users that export onto the system (Generators) and users that import from it (Suppliers), and is calculated annually.

Generation TNUoS Charges

There are currently 21 generation TNUoS tariff zones (see Figure A.1.3 and Chapter ("6_11","Use of System Tariff Zones"). The charges for these zones display a north to south differential and vary from positive tariffs in the north to negative tariffs in some southern zones. This locational message reflects whether the generation contributes to or alleviates the need for additional transmission reinforcement/investment. The basis of the generation charge is the highest Transmission Entry Capacity (TEC) applicable over the year for positive tariff zones, or the average of the three highest metered volumes over the winter period for negative tariff zones.

The Transmission Entry Capacity (TEC) of a power station is defined as the access capacity that the generator requires to export power onto the main transmission system. We use this as input into its planning studies to determine the wider system infrastructure requirements and as the basis for TNUoS charges. TEC is the permitted sum of outputs from the Balancing Mechanism units comprising the power station less station demand, expressed in MW averaged over a Settlement Period.

Demand TNUoS Charges

There are currently 14 demand TNUoS tariff zones (see Figure A.1.4 and Chapter ("6_11","Tariff Zones and Main System Boundaries"). The supplier TNUoS charges display a reverse north to south differential relative to the generation tariff zones and have a set minimum level of zero. Suppliers' charges for half-hourly, metered demand are based on the average of the actual demand supplied during the Triad. The Triad is defined as the three half hour settlement periods of highest transmission system demand during November to February of a Financial Year, separated by 10 clear days. Non half-hourly metered demand charges are on the basis of energy demand over the half hours 16.00 - 19.00 inclusive from 1 April to 31 March.

Balancing Services Use of System (BSUoS) Charges

The Transmission Licence allows us to derive revenue in respect of Balancing Services through the Balancing Services Use of System (BSUoS) charges. We in our role as GB System Operator, have a responsibility to keep the electricity system in balance (energy balancing) and to maintain quality and security of supply (system balancing). Under the Balancing Services Incentive Scheme we are incentivised on the procurement of services for energy and system balancing and other costs associated with operating the system.

Customers pay for the cost of Balancing Services and any incentivised payments/receipts through BSUoS charges. All users registered within the Balancing and Settlement Code (BSC) are liable to pay BSUoS charges based on their energy taken from or supplied to our transmission system and is calculated every settlement period.

Participants' Requirements

Licence Requirements

Under the provision of the Utilities Act 2000, the Secretary of State's power to grant (and, in the case of supply, extend) electricity licences has been removed. These provisions bring the Electricity Act, 1989 into line with the Gas Act, 1995, where licences may be granted only by the Authority (Ofgem). Accordingly, having determined and published standard conditions to be included in each type of electricity licence, the Secretary of State has no role in the subsequent modification of the standard conditions save only a power to veto modifications proposed by the Authority (Ofgem).

Under the provisions of the Utilities Act 2000, supply and distribution have become separate licensable activities. The previous distinction in legislation between public electricity supplier (PES) and second-tier supply licences have been removed and the supply and distribution businesses of the PES have been put into separate legal entities. There is a bar on the same person holding both an electricity supply and an electricity distribution licence. As a result of this and other changes, the concept of a PES has ceased to exist. However, there is no provision requiring separate supply and distribution companies to be owned separately.

Transmission Licence

Transmission licences are granted under Section 6 (1) (b) of the Electricity Act, 1989. National Grid, SPT and SHETL are currently the holders of the three transmission licences. However, it is possible for further transmission licences to be granted.

Generation Licences

Generation licences are granted pursuant to Section 6 (1) (a) of the Electricity Act, 1989. In essence, any power station capable of providing 100MW or more to the total system in Great Britain is required to have a Generation Licence. In this context the total system means the GB transmission system and all distribution systems. Furthermore, a distribution system means a system, which consists (wholly or mainly) of low voltage lines and electrical plant and is used for conveying electricity to any premises or to any other distribution system.

At the time of writing, power stations capable of exporting between 50MW and 100MW to the total system that connected after 30 September 2000 may apply to the Department of Trade and Industry to seek a Licence Exemption (see Technical and Data Requirements). Power Stations that are not capable of exporting 50MW or more to the total system are automatically exempt from the requirement to hold a generation licence.

Supply Licences

Supply Licences are granted pursuant to the Electricity Act, 1989. The concept of geographically mutually exclusive authorised areas, which applied to the previous PES licences does not apply to supply licences. Supply licences may be granted in respect of all customers throughout Great Britain, or may relate to specific geographical areas or customer groups.

As with distribution, some functions necessary to ensure that everyone has reasonable access to electricity, previously carried by the PES in relation to supply, continues and this obligation is imposed through the licences.

Distribution Licences

Distribution licences are granted under the Electricity Act, 1989. The concept of geographically mutually exclusive authorised areas for distribution is retained.

Consents Under the Electricity Act 1989

Section 36 Consent (S36)

This refers to Section 36 of the Electricity Act 1989 which specifies that a generating station of over 50MW capacity shall not be constructed, extended or operated except in accordance with a consent granted by the Secretary of State within England and Wales and the Scottish Executive in Scotland. The relevant office takes into account views on particular applications, including views of the local planning authority and, in certain circumstances, may call a public inquiry into a proposal. When granted, consent lasts for five years within which time a project must show signs of construction.

Many of the tables giving information on power stations introduced in Chapter 3 include an indication of whether that plant has obtained S36 and S14 consent or not. For completeness Table 3.2 and Table 3.3 list power stations, not yet under construction, for which Section 36 and Section 14 consent has been given Table 3.2) and power stations for which an application for consent has been made Table 3.3) but not yet given. Please note that the output capacities (MW) given in the tables do not necessarily reflect the 'transmission contracted' capacities shown elsewhere in this Statement. The information presented in the tables represents our current view obtained through market intelligence and should not be relied upon; better information may be available through other sources.

Section 14 Consent (S14)

This refers to Section 14 of the Energy Act 1976.

Section 14(1) prohibits the establishment or conversion of an electricity generating station fuelled by oil or natural gas unless notice has been given to the Secretary of State. The Secretary of State may direct, having regard to current energy policies, that the proposal be not carried out or be carried out in accordance with specified conditions.

Section 14(2) makes similar provisions in respect of the making or extension of contracts for obtaining of natural gas to such a station. Stations less than 10MW, and contracts of up to a year's duration, are excepted by Orders under the Act.

Section 14(3) allows the Secretary of State to halt any proposals notified to him, if he considers it expedient, having due regard to current energy policy. This clause may be exercised, for instance, to prevent a project being built which has had Section 36 consent for five years but which, in the opinion of the Secretary of State, has shown no evidence of construction.

Finally, as mentioned in the previous sub-section of this chapter on S36 Consent, Table 3.2 lists, inter alia, power stations not yet under construction for which Section 36 and/or Section 14 consent has been given.

Section 37 Consent (S37)

This refers to Section 37 of the Electricity Act 1989, which specifies that, subject to certain exemptions, an electric line shall not be installed or kept installed above ground except in accordance with a consent granted by the Secretary of State. Exceptions include:

- Electric lines with a nominal voltage of 20kV or less used to supply a single consumer;
- Electric lines within premises in the occupation or control of the person responsible for its installation; or
- Such other cases as may be prescribed.

Compliance with Industry Codes

Figure 10.4 provides a generalised summary of some of the main requirements placed on generators, suppliers and distributors in relation to their obligations to become party to the various codes and charges discussed earlier in this chapter.

The table is intended only as an initial quick reference guide for readers unfamiliar with the arrangements under BETTA. There may well be variations to the requirements depending on circumstances. The table has been constructed on the basis of the following generalised rules:

- All **directly connected power stations** and directly connected Distribution Systems are required to accede to the **CUSC**.
- All **power stations** (regardless of whether they are directly connected or embedded) capable of exporting 100MW or more to the total system normally require a **Licence**.
- All holders of a **Licence** (regardless of whether they are directly connected or embedded) are required to accede to the **CUSC** and sign the **BSC**
- If **Licence-Exempt**, a User may choose to sign the **BSC** and accede to the **CUSC**;
- If registered within **BSC**, a User may choose to participate in the **BM**;
- **Licence-exempt** embedded generation may nevertheless be required to become party to the **CUSC** or sign an appropriate Bilateral Agreement under the requirements of CUSC Condition 6.5.
- If party to the **CUSC**, a User is bound by and must comply with relevant parts of the **Grid Code**; and
- If party to the **CUSC**, a User has an obligation to pay any relevant charges in accordance with the **Charging Statements**.

Figure 10.4

Click to load a larger version of Figure 10.4 image

Figure 10.4 - Generalised Summary of Main Requirements Placed on Generators, Suppliers and Distributors

Market Participants	BSC	BM	CUSC	GC	Charges		
					Connection	TNUoS	BSUoS
Licence Holders							
Power Stations	yes	optional	yes	yes	if direct	yes	yes
Suppliers	yes	optional	yes	yes	no	yes	yes
Distributors	yes	no	yes	yes	yes	no	no
Licence Exempt							
Large Embedded Power Stations	Yes (subject to CUSC 6.29)	optional if BSC	yes	yes	no	if BSC (subject to CUSC 6.29)	if BSC (subject to CUSC 6.29)
Medium & Small Embedded Power Stations	optional	optional if BSC	if BSC or if required by CUSC Condition 6.5	if CUSC	no	if BSC	if BSC
Transmission Connected Power Stations	Yes (subject to CUSC 6.29)	optional if BSC	yes	yes	yes	if BSC (subject to CUSC 6.29)	if BSC (subject to CUSC 6.29)

Notes:
BSC=Balancing and Settlement Code
BM=Balancing Mechanism
CUSC=Connection and Use of System Code
GC=Grid Code
Connection=Connection Charge
TNUoS=Transmission Network Use of System Charge
BSUoS=Balancing Services Use of System Charge

Bilateral Agreements

Finally, Bilateral Agreements described the three types of Bilateral Agreement, namely: the Bilateral Connection Agreement (BCA); the Bilateral Embedded Generation Agreement (BEGA); and the Bilateral Embedded Licence Exemptable Large Power Station Agreement (BELLA). For completeness, Bilateral Agreements a fourth type of Bilateral Agreement, namely the Licence Exempt Generation agreement (LEGA), which has now been phased out.

The descriptions contained in Bilateral Agreements, outline the relationships between the types of agreement, the class of power station, the type of connection to the system, the appropriate terminology for power station output and the appropriate charges. For ease of reference that information has been condensed, tabulated and re-presented here as Figure 10.5.

Figure 10.5

Click to load a larger version of Figure 10.5 image

Figure 10.5 - Relationships between Types of: Bilateral Agreement, Power Station, Connection, Output Terminology and Charges

Type of Bilateral Agreement	Type of Power Station	Generation Licence	Connection		Power Station Output Terminology			Charges Applicable		
			Embedded	Direct	TEC	CEC	Size*	Connection	TNUoS	BSUoS
BCA	All	yes		yes	yes	yes		yes	yes	yes
BEGA	All	yes	yes		yes				yes	yes
BELLA	Large	no	yes				yes		if BSC	if BSC

Notes:

BCA=Bilateral Connection Agreement
BEGA=Bilateral Embedded Generation Agreement
BELLA=Bilateral Embedded Licence Exemptable Large Power Station Agreement
A BCA is also for Directly Connected Distribution Systems, Non-Embedded Customer Sites and Interconnector Owners
A BEGA is also for Use of System for a Small Power Station Trading Party and a Distribution Interconnector Owner
In the case of a BELLA, the relevant Large Power Station must be SMRS registered or CMRS by an appropriate User