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.

Ranking Plant in Order of Likelihood of Operation at Peak

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.

External Interconnections:

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 (Tuesday, 23/01/07), typical winter (Wednesday, 31/01/07), typical summer (Thursday, 22/06/06) and summer minimum (Sunday, 06/07/06) respectively.

Figure 7.1(a)

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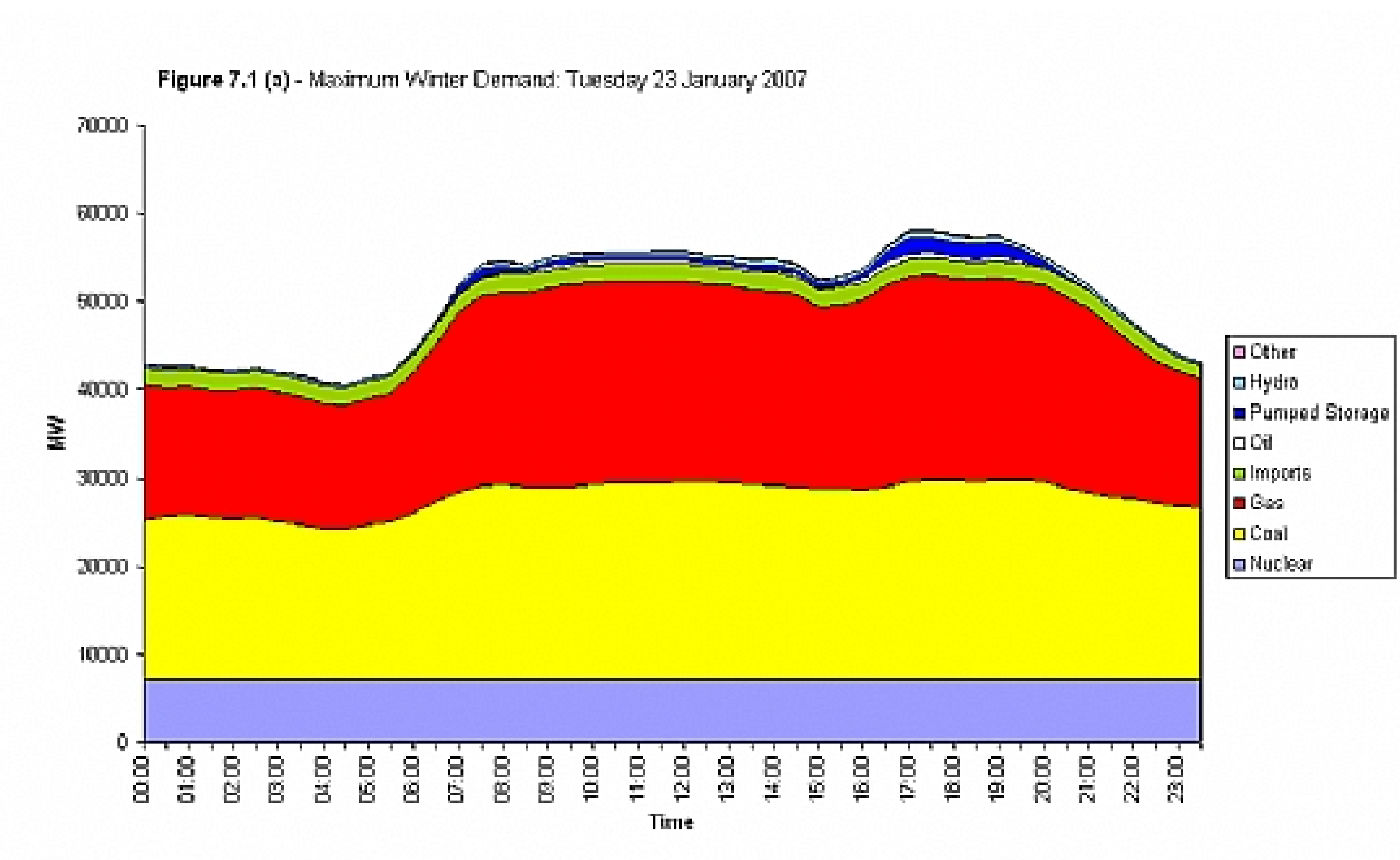

Figure 7.1(b)

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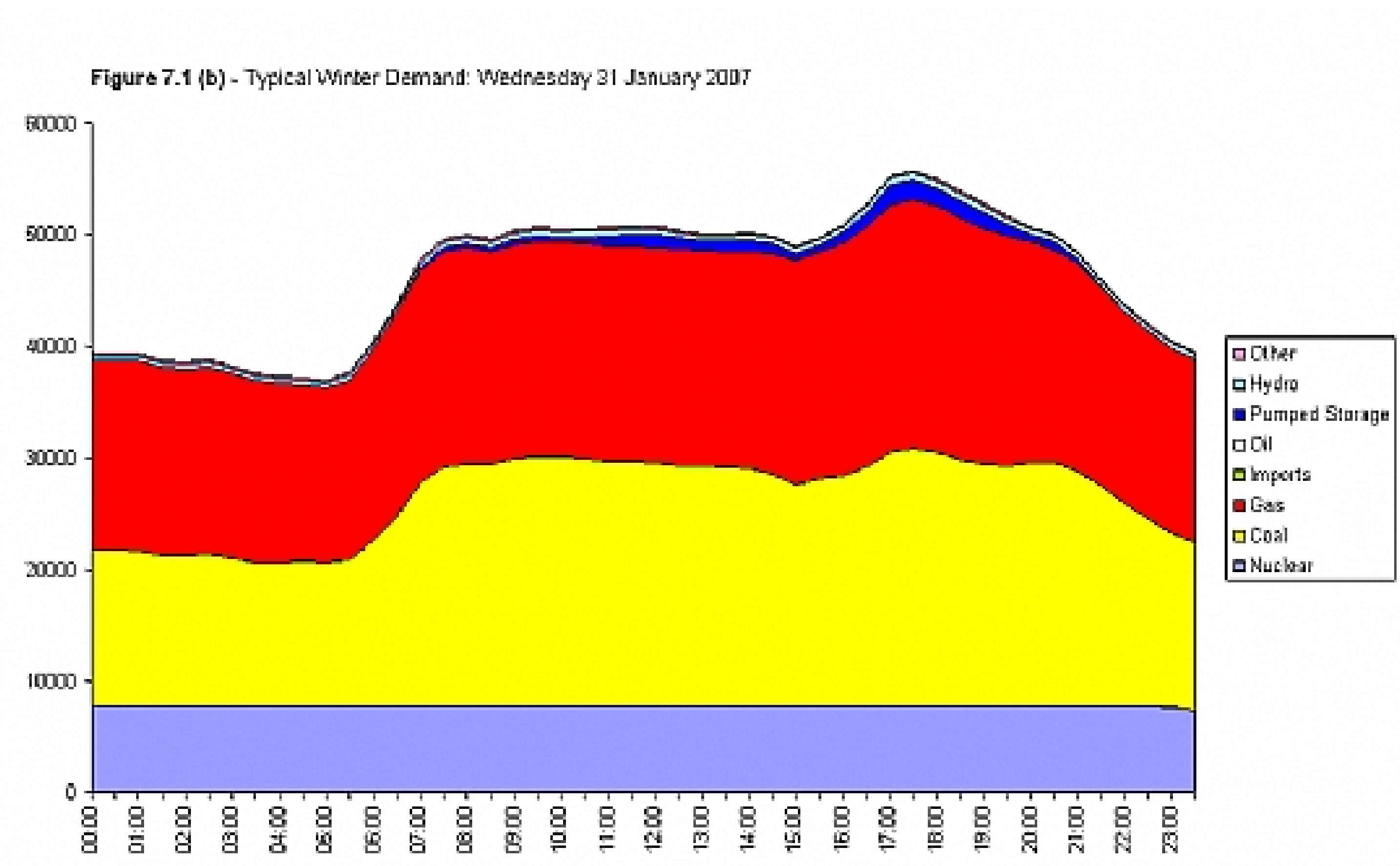

Figure 7.1(c)

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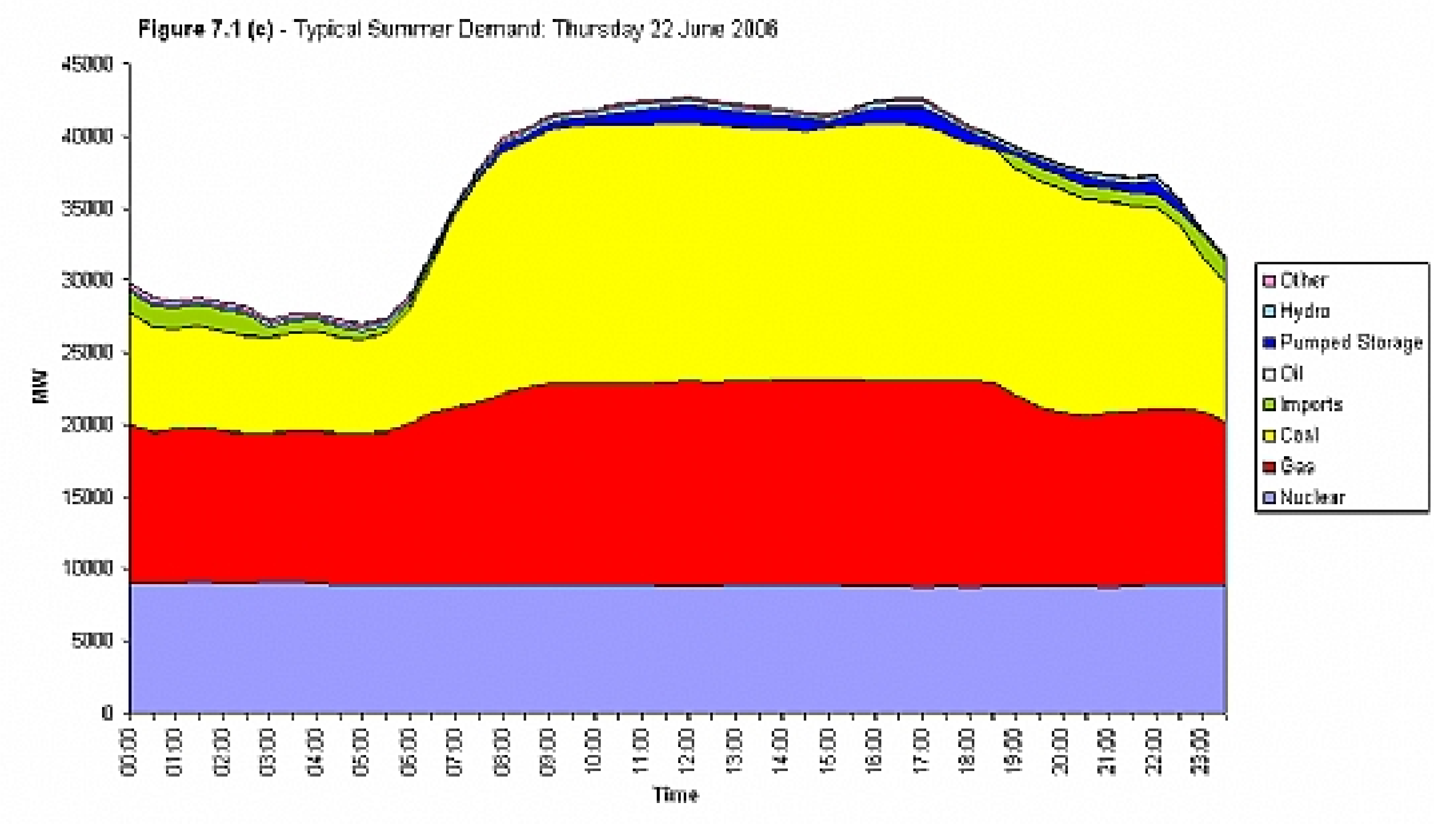

Figure 7.1(d)

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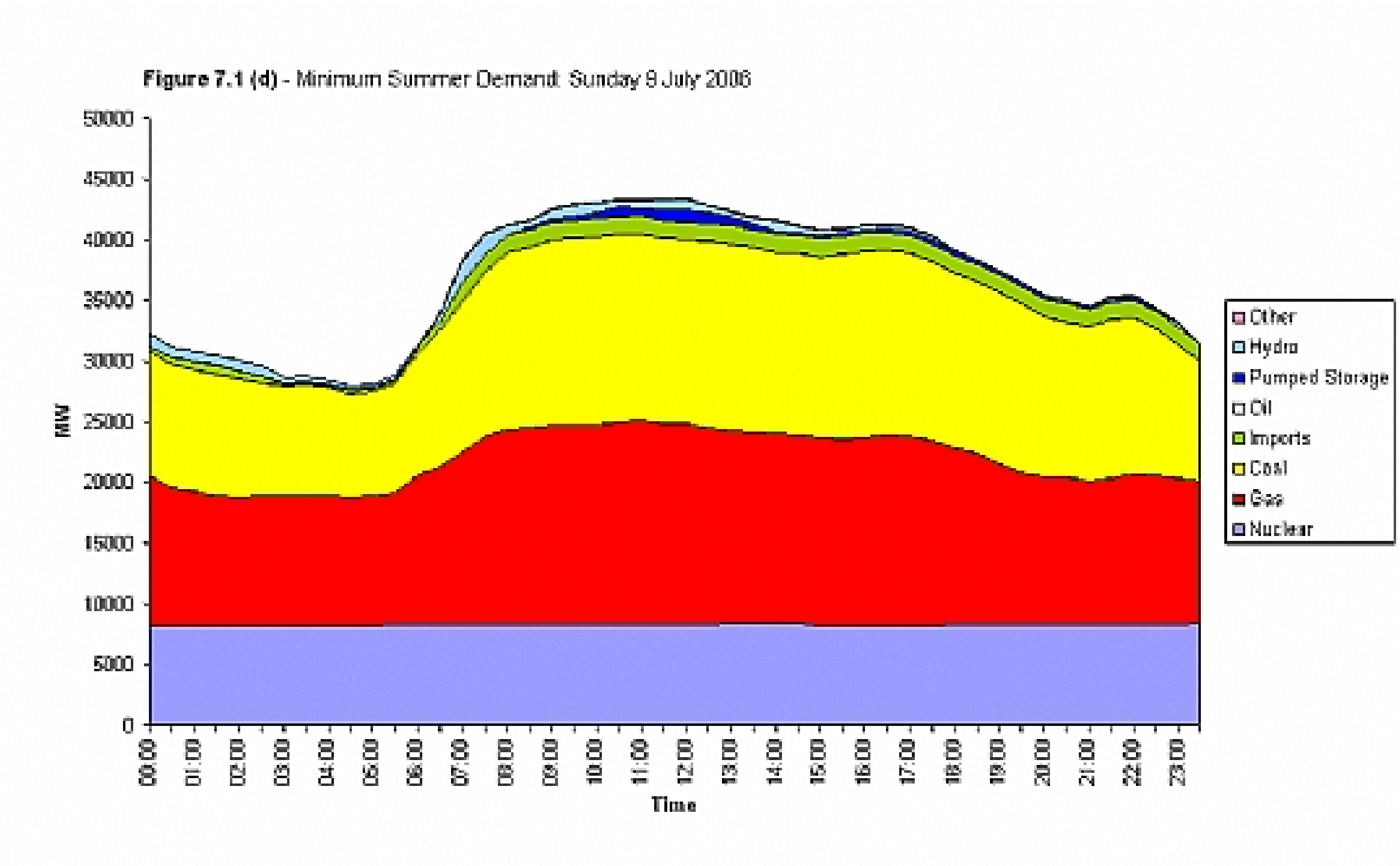

The same information is given in pie chart form in Figure 7.2(a), Figure 7.2(b), Figure 7.2(c) and Figure 7.2(d).

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: Tuesday 23 January 2007

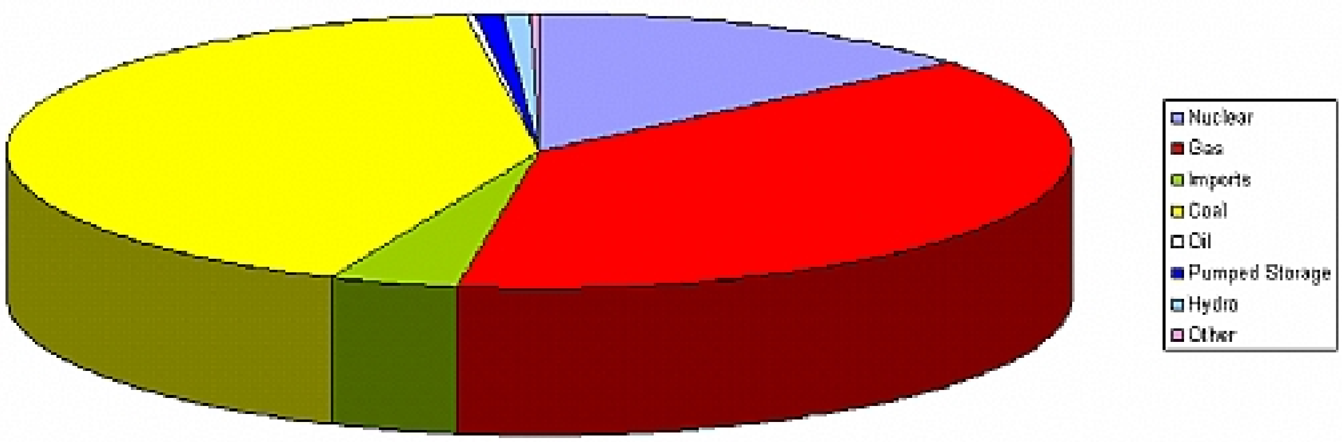

Figure 7.2(b)

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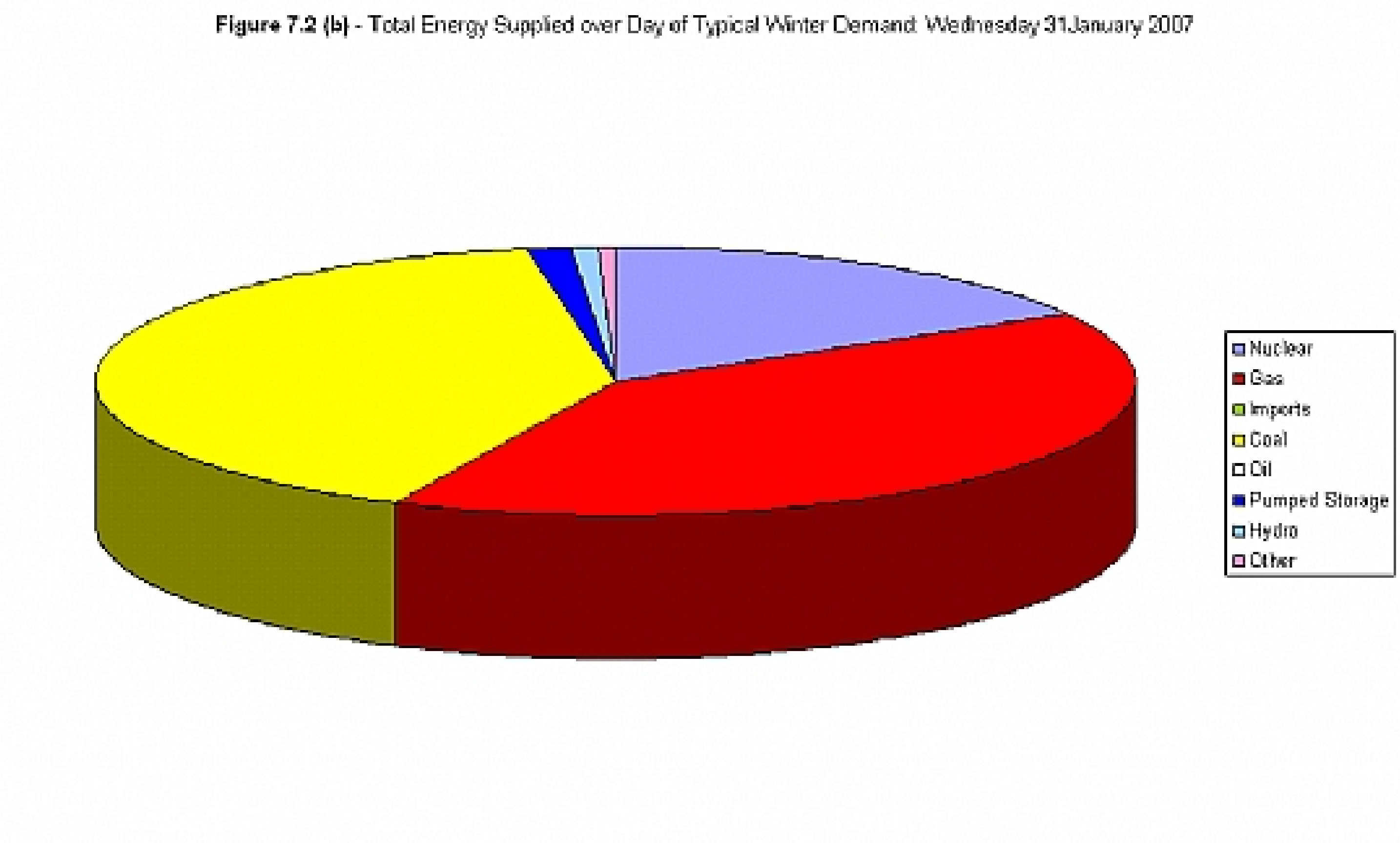

Figure 7.2(c)

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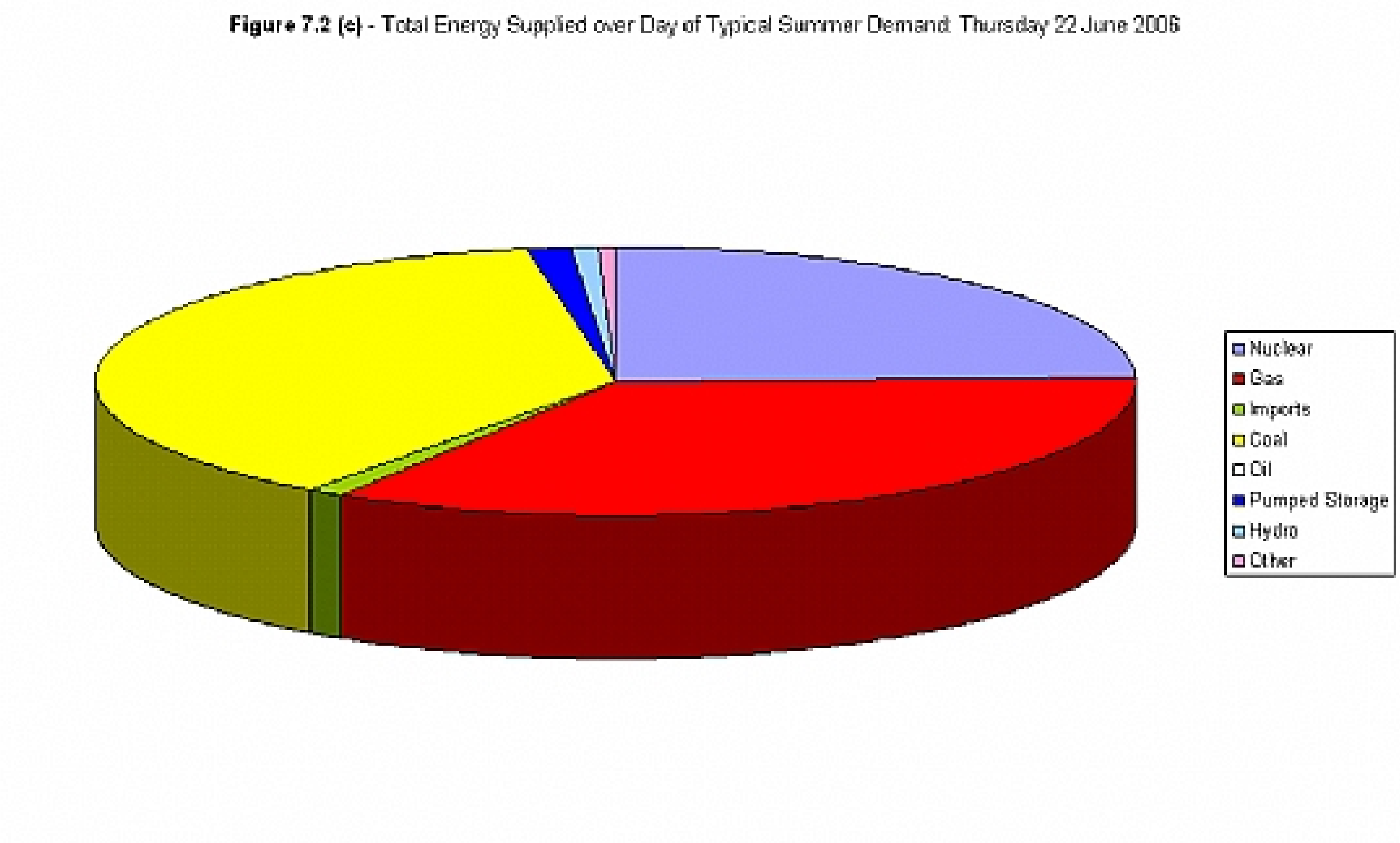
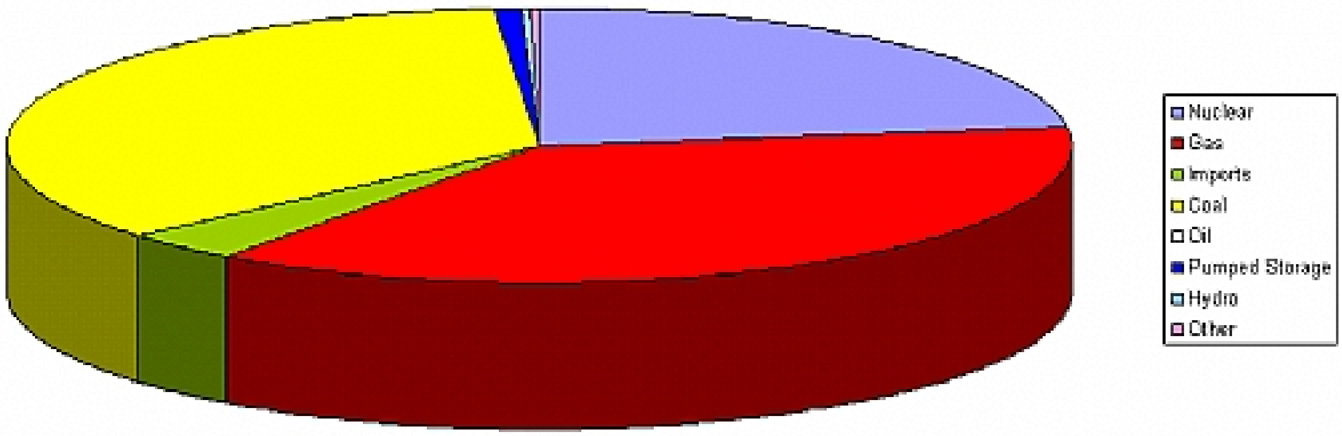


Figure 7.2(d)

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

Figure 7.2 (d) - Total Energy Supplied over Day of Minimum Summer Demand: Sunday 9 July 2006



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 2007/ 08 to 2013/14 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 2007/ 08 to 2013/14 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 2007/ 08 to 2013/14 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 23.6GW over the period 2007/08 to 2013/14 (Table 3.5 refers). Amongst other things, Generation Disposition described the disposition of this future plant. In broad terms 6.7GW will be located in Scotland, 5GW in the north of England and the midlands with the remaining 11.8GW 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 2007/08 and 2013/14 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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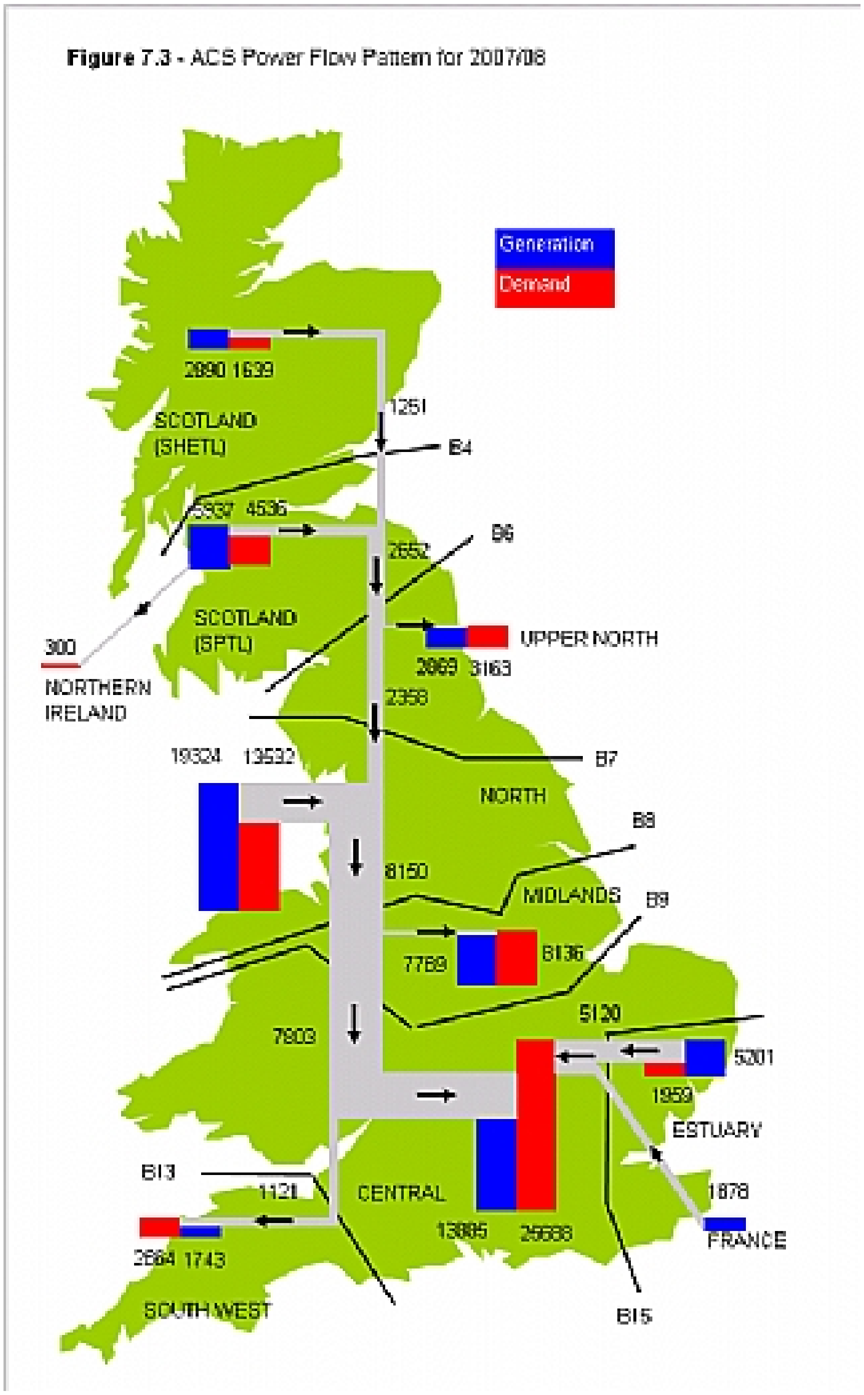

Figure 7. 4

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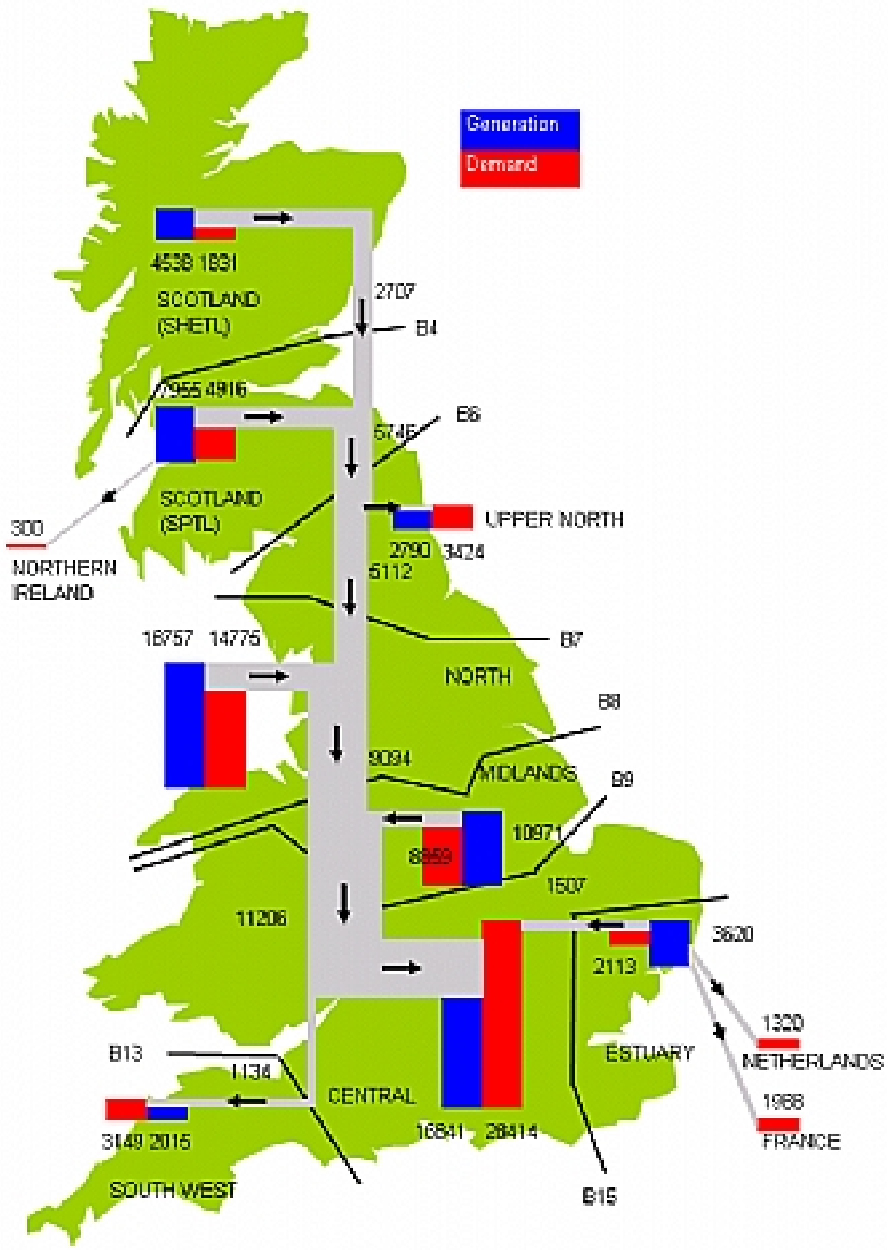
Figure 7.4 - ACS Power Flow Pattern for 2013/14



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

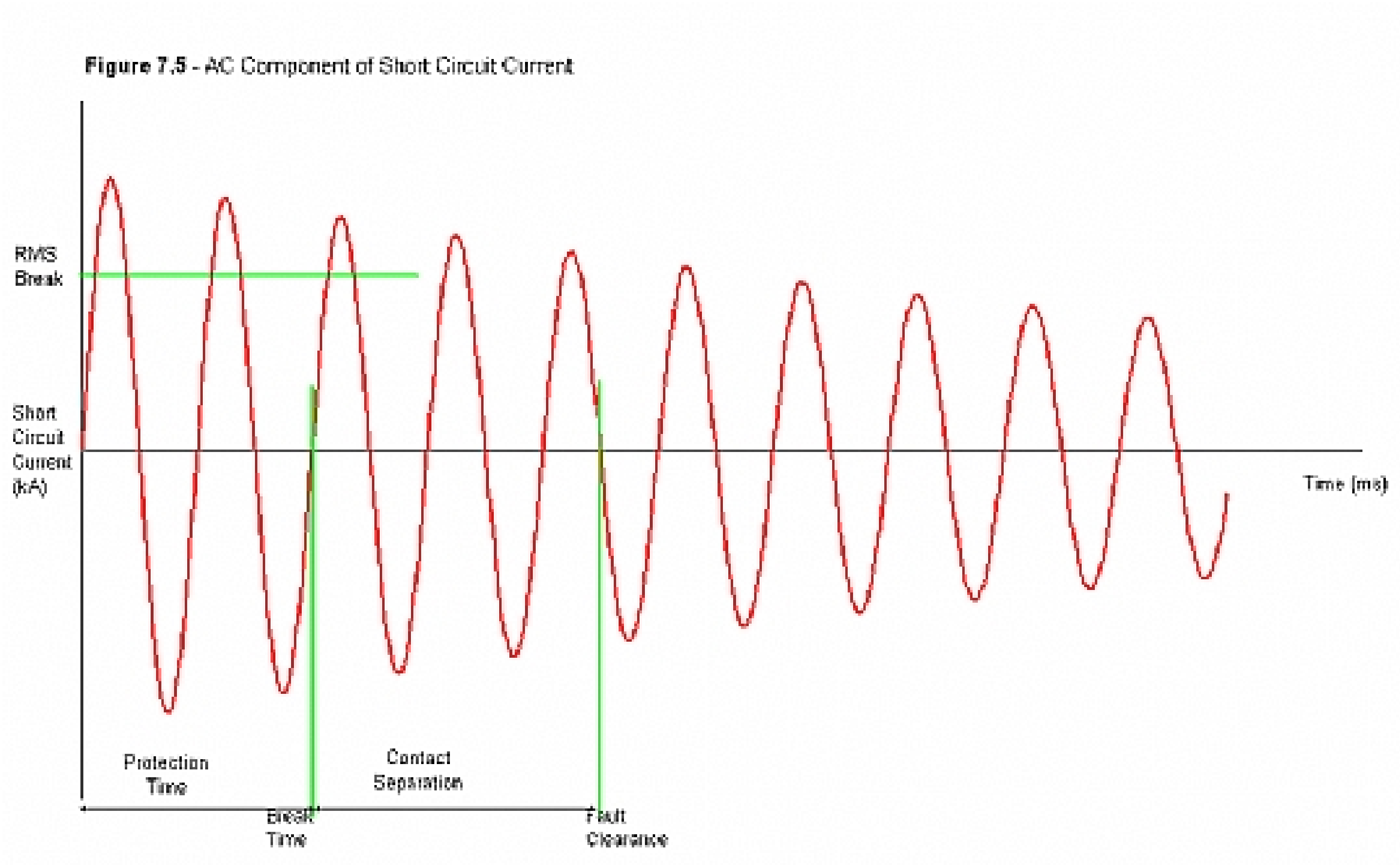
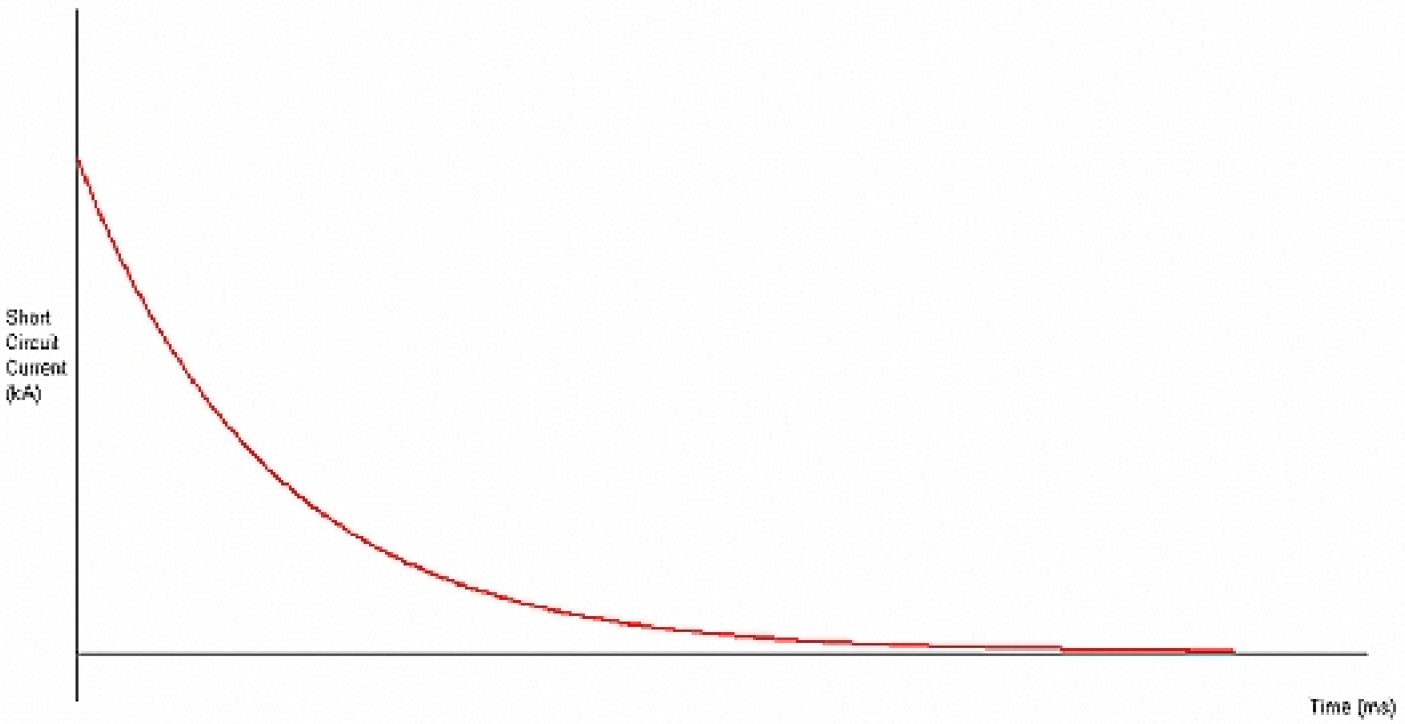


Figure 7.6

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.

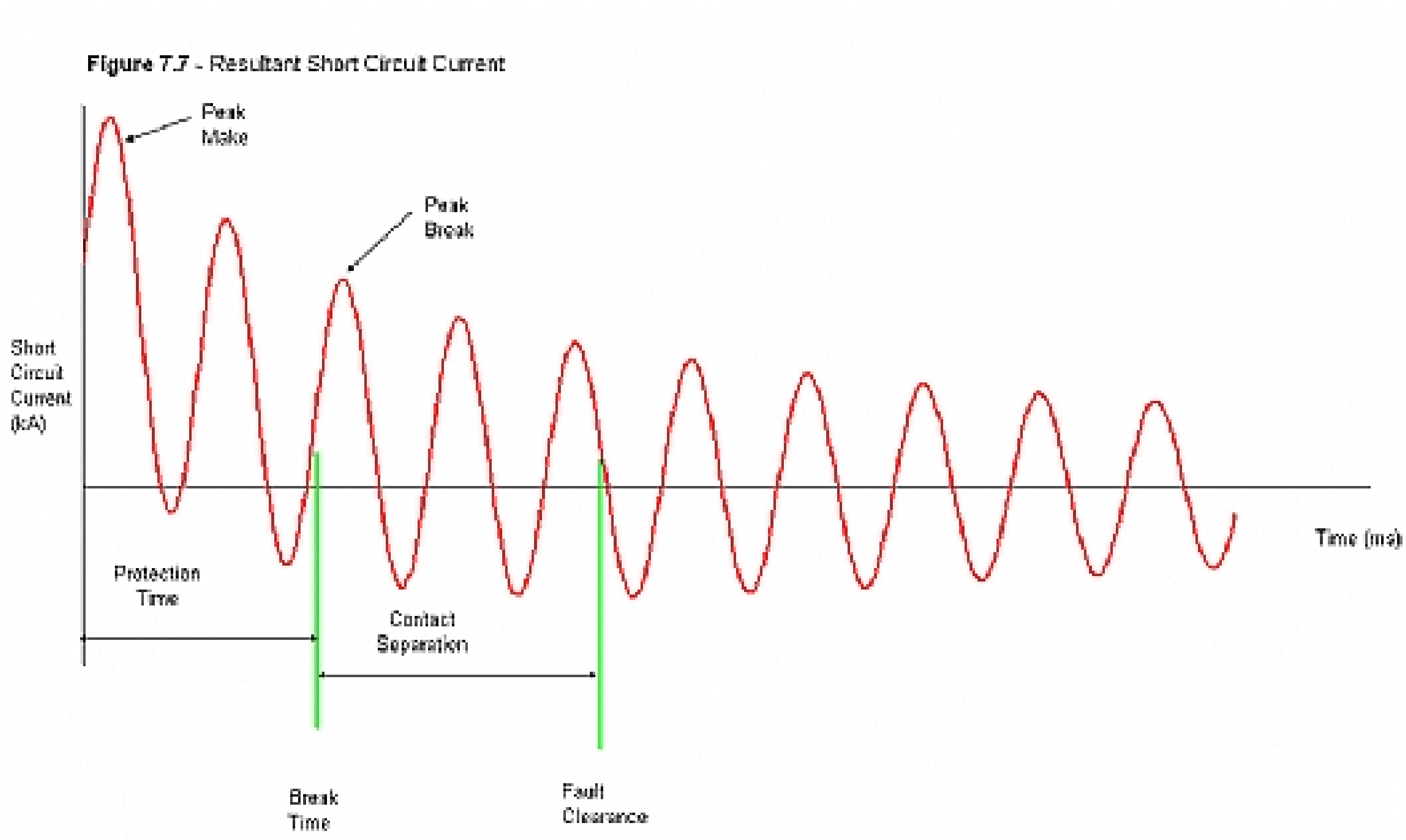
Circuit breakers associated with faulted circuits are required to interrupt fault current in order to safeguard system stability, prevent damage to plant and maintain security and quality of supply.

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 2007/08 to 2013/14 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) of Table 7.4 are a function of the power flow pattern around the system and display a steady increase over the period in line with demand growth and increasing utilisation of the transmission system.

Fixed losses (line 2) are fairly constant over the period. Please note that these fixed losses are estimated rather than measured values and reflect reasonable growth in the values presented in last year's Statement. 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) also 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 2006 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 2007/08 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 lists the resultant generation effectiveness in percent for each SYS Study Zone. For example, an effectiveness of 92% means that for a small increase in generation, 92% will meet demand, whilst 8% will be accounted for by increased 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 106% in meeting demand by virtue of reducing transmission power losses. Whilst these results are very broad brush and absolute percentages should not be relied upon, the relative order is considered reasonably robust. 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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Table 7.1 - GB Generation Ranking Order

Rank	BM Unit ID	Station	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
1		Interconnector Import	1878	138	-283	-3066	-3308	-3308	-3308
2		Moyle	-300	-300	-300	-300	-300	-300	-300
3	BARKB2	Barking	1000	1000	1000	1000	1000	1000	1000
4	DRAXX-3	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
5	DRAXX-6	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
6	FAWN-1	Fawley CHP	158	158	158	158	158	158	158
7	HEYM12	Heysham 1	596	596	596	596	596	596	596
8	RUGPS-6	Rugeley B	498	498	498	498	498	498	498
9	SCCL-2	Saltend	366.7	366.7	366.7	366.7	366.7	366.7	366.7
10	SIZB-1	Sizewell B	595	595	595	595	595	595	595
11	SIZB-2	Sizewell B	595	595	595	595	595	595	595
12	TESI-1	Teesside	937.5	937.5	937.5	937.5	937.5	937.5	937.5
13	TESI-2	Teesside	937.5	937.5	937.5	937.5	937.5	937.5	937.5
14	TORN-1	Torness	600	600	600	600	600	600	600
15	TORN-2	Torness	600	600	600	600	600	600	600

16	WBUPS-3	West Burton A	503	503	503	503	503	503	503
17	DERW-1	Willington (Derwent)	228	228	228	228	228	228	228
18	FELL-1	Hutton (Sellafield)	155	155	155	155	155	155	155
19	KINO-4	Kingsnorth	485	485	485	485	485	485	485
20		Amlwch	0	0	0	0	0	270	270
21		Drakelow	0	1230	1230	1230	1230	1230	1230
22		Grain Stage 1	0	0	0	860	860	860	860
23		Grain Stage 2	0	0	0	0	430	430	430
24		Immingham Stage 2	0	601	601	601	601	601	601
25		Langage Stage 1	850	850	850	850	850	850	850
26		Langage Stage 2	0	0	0	400	400	400	400
27		Little Barford B	0	0	0	0	0	475	475
28		Marchwood	0	900	900	900	900	900	900
29		Pembroke 1 Stage 1	800	800	800	800	800	800	800
30		Pembroke 1 Stage 2	0	1200	1200	1200	1200	1200	1200
31		Pembroke 2 Stage 1	0	0	0	400	400	400	400
32		Pembroke 2 Stage 2	0	0	0	0	1600	1600	1600
33		Severn Power Stage 1	0	0	425	425	425	425	425
34		Severn Power Stage 2	0	0	0	425	425	425	425
35		Staythorpe Stage 1	0	425	425	425	425	425	425
36		Staythorpe Stage 2	0	0	0	425	425	425	425
37		Staythorpe Stage 3	0	0	0	0	0	850	850
38		Sutton Bridge B	0	0	0	1305	1305	1305	1305
39		West Burton B Stage 1	0	0	0	435	435	435	435
40		West Burton B Stage 2	0	0	0	0	870	870	870
41		Wilton	50	50	50	50	50	50	50
42	DRAXX-4	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5

43	HUMR-1	Immingham Stage 1	719	719	719	719	719	719	719
44	RATS-4	Ratcliffe-on-Soar	500	500	500	500	500	500	500
45	COCK-4	Cockenzie 4	288	288	288	288	288	288	288
46	COTPS-4	Cottam	495	495	495	495	495	495	495
47	FERR-3	Ferrybridge C	490	490	490	490	490	490	490
48	KINO-3	Kingsnorth	485	485	485	485	485	485	485
49	WBUPS-2	West Burton A	503	503	503	503	503	503	503
50		Lochay	47	47	47	47	47	47	47
51		Mossford	18.7	18.7	18.7	18.7	18.7	18.7	18.7
52		Orrin	18	18	18	18	18	18	18
53		Pitlochry	15	15	15	15	15	15	15
54		Quoich	18	18	18	18	18	18	18
55		Rannoch	44	44	44	44	44	44	44
56		Shin	18.6	18.6	18.6	18.6	18.6	18.6	18.6
57		Tongland	33	33	33	33	33	33	33
58	GRMO-1	BP Grangemouth	120	120	120	120	120	120	120
59		Exxon MossMorran	16	16	16	16	16	16	16
60		Flotta Terminal	10	10	10	10	10	10	10
61	E_HYTHE	Lynes Common	49.9	49.9	49.9	49.9	49.9	49.9	49.9
62		Stoneywood Mills (Wiggins Teape Stoneywood)	12	12	12	12	12	12	12
63	FIDL-1	Fiddlers Ferry	485	485	485	485	485	485	485
64	FIDL-4	Fiddlers Ferry	506	506	506	506	506	506	506
65	WBUPS-1	West Burton A	483	483	483	483	483	483	483
66	SHOT-1	Shotton	210	210	210	210	210	210	210
67	RATS-2	Ratcliffe-on-Soar	500	500	500	500	500	500	500
68	EGGPS-1	Eggborough	482.5	482.5	482.5	482.5	482.5	482.5	482.5
69	KEAD-1	Keadby	735	735	735	735	735	735	735
70	RUGPS-7	Rugeley B	498	498	498	498	498	498	498
71	GYAR-1	Great Yarmouth	420	420	420	420	420	420	420
72	FIDL-2	Fiddlers Ferry	485	485	485	485	485	485	485
73	EGGPS-4	Eggborough	487.5	487.5	487.5	487.5	487.5	487.5	487.5
74	CNQPS-3	Connah's Quay	345	345	345	345	345	345	345

75	ABTH8	Aberthaw B	547	547	547	547	547	547	547
76	FERR-2	Ferrybridge C	490	490	490	490	490	490	490
77	EGGPS-2	Eggborough	482.5	482.5	482.5	482.5	482.5	482.5	482.5
78	RATS-1	Ratcliffe-on-Soar	500	500	500	500	500	500	500
79	COCK-3	Cockenzie 3	288	288	288	288	288	288	288
80	EGGPS-3	Eggborough	487.5	487.5	487.5	487.5	487.5	487.5	487.5
81	LBAR-1	Little Barford A	665	665	665	665	665	665	665
82	FIDL-3	Fiddlers Ferry	485	485	485	485	485	485	485
83	SUTB-1	Sutton Bridge A	800	800	800	800	800	800	800
84	WYLF-2	Wylfa	245	245	245	0	0	0	0
85	BAGE-2	Baglan Bay	32	32	32	32	32	32	32
86	DRAXX-1	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
87	TILB-8	Tilbury B	350	350	350	350	350	350	350
88	ABTH9	Aberthaw B	547	547	547	547	547	547	547
89	SPLN-1	Spalding	880	880	880	880	880	880	880
90	DRAXX-5	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
91	COSO-1	Coryton	743	743	743	743	743	743	743
92		Afton	0	0	0	77	77	77	77
93		Aikengall	0	0	48	48	48	48	48
94		Akron Wind (Caithness)	0	20	20	20	20	20	20
95		Andershaw	0	0	0	45	45	45	45
96		Ardkinglas, Clachan (SRO)	19.3	19.3	19.3	19.3	19.3	19.3	19.3
97		Arecleoch	0	0	150	150	150	150	150
98		Ark Hill Wind Farm, Glamis (SRO)	12	12	12	12	12	12	12
99		Auchencorth	0	0	0	45	45	45	45
100		Aultmore Windfarm	0	0	0	0	60	60	60
101		Baillie & Bardnaheigh Wind	0	0	0	0	0	0	57
102		Ballindalloch Muir Wind Farm, Balfron	0	20.8	20.8	20.8	20.8	20.8	20.8
103		Balunton	0	0	0	150	150	150	150
104		Barmoor	0	30	30	30	30	30	30

105		Beatrice Pilot	0	0	0	0	0	10	10
106		Beinn an Tuirc Wind (SRO)	30.4	30.4	30.4	30.4	30.4	30.4	30.4
107		Ben Aketil Wind, Dunvegan	28	28	28	28	28	28	28
108		Ben Tharsuinn Wind, E Ross	29	29	29	29	29	29	29
109		Berry Burn	0	0	0	0	82.5	82.5	82.5
110		Black Craig	0	0	0	0	0	0	71.3
111		Black Craig 40MW Windfarm, Dunoon	0	0	0	0	0	40	40
112		Black Law	134	134	134	134	134	134	134
113		Boyndie Wind, Banff	14.3	14.3	14.3	14.3	14.3	14.3	14.3
114		Boyndie Wind, Banff (Add. Cap.)	7	7	7	7	7	7	7
115		Braes of Doune Wind, Braco	74	74	74	74	74	74	74
116		Broadmeadows	0	0	36	36	36	36	36
117		Cairn Uish Wind, Rothes	50.6	50.6	50.6	50.6	50.6	50.6	50.6
118		Calliachar Wind	0	0	0	0	0	62.2	62.2
119		Camster Windfarm, Caithness	0	0	0	0	0	62.5	62.5
120		Carraig Gheal	0	75	75	75	75	75	75
121		Carscreugh	0	0	0	0	0	0	21
122		Causeymire	48.3	48.3	48.3	48.3	48.3	48.3	48.3
123		Causeymire (Phase 2), Mybster	0	0	0	0	6.9	6.9	6.9
124		Clashindarroch Wind, Huntly	0	0	0	0	112.7	112.7	112.7
125		Clyde	0	0	519	519	519	519	519
126		Cruach Mhor Farm	29.8	29.8	29.8	29.8	29.8	29.8	29.8
127		Cruach Mor	0	0	0	0	0	90	90
128		Crystal Rig 1	62.5	62.5	62.5	62.5	62.5	62.5	62.5
129		Crystal Rig 2	0	0	200	200	200	200	200
130		Dalswinton	30	30	30	30	30	30	30

131		Dersalloch	0	0	0	75	75	75	75
132		Deucherin Hill Wind	15	15	15	15	15	15	15
133		Drone Hill	0	37.8	37.8	37.8	37.8	37.8	37.8
134		Drumderg Wind Farm, Dalrulzion	32	32	32	32	32	32	32
135		Dun Law Extension	0	32.3	32.3	32.3	32.3	32.3	32.3
136		Dunbeath Wind Farm	0	0	0	0	55	55	55
137		Dungavel	0	44	44	44	44	44	44
138		Earlsburn	35	35	35	35	35	35	35
139		Earlshaugh	0	0	0	108	108	108	108
140		Edinbane Wind, Skye	0	56	56	56	56	56	56
141		Eishken Estate, Isle of Lewis	0	0	0	0	0	0	300
142		Eredine Forest Wind, Argyll (SRO)	30	30	30	30	30	30	30
143		Ewe Hill	0	0	92	92	92	92	92
144		Fairburn Wind (Orrin)	0	42	42	42	42	42	42
145		Fairwind (Orkney) Ltd	0	0	0	0	0	126	126
146		Fallago	0	0	180	180	180	180	180
147		Farr Wind Farm, Tomatin	92	92	92	92	92	92	92
148		Glens of Foudland Wind (SRO)	26	26	26	26	26	26	26
149		Gordonbush Wind, Caithness	0	0	87.5	87.5	87.5	87.5	87.5
150		Greenknowes	31.5	31.5	31.5	31.5	31.5	31.5	31.5
151		Greenock	0	0	55	55	55	55	55
152		Griffin Windfarm, near Aberfeldy	0	0	0	216	216	216	216
153		Hadyard Hill	130	130	130	130	130	130	130
154		Harestanes	0	213	213	213	213	213	213
155		Harrows Law	0	0	140	140	140	140	140
156		Hearthstanes B	0	0	0	81	81	81	81

157		Houstary Wind, Dunbeath	14	14	14	14	14	14	14
158		Insch Windfarm, Insch	10.4	10.4	10.4	10.4	10.4	10.4	10.4
159		Kingsburn Wind Farm, Fintry, Stirling	0	20	20	20	20	20	20
160		Kyle	0	0	0	300	300	300	300
161		Lairg - Achany Wind Farm	0	62	62	62	62	62	62
162		Largie Wind, South Kintyre	0	40	40	40	40	40	40
163		Limmer Hill	0	0	0	80	80	80	80
164		Longpark	0	47.5	47.5	47.5	47.5	47.5	47.5
165		Margree	0	0	0	0	0	0	180
166		Mark's Hill	0	99	99	99	99	99	99
167		Mid Hill Wind, Stonehaven	0	0	0	0	0	75	75
168		Millennium Wind, Ceannacroc	65	65	65	65	65	65	65
169		Minsca	37.5	37.5	37.5	37.5	37.5	37.5	37.5
170		Montreathmont Moor Wind	0	0	0	0	0	40	40
171		Neilston	0	0	0	100	100	100	100
172		Newfield	0	0	60	60	60	60	60
173		North Nesting Wind, Shetland	0	0	0	0	0	0	250
174		Novar (SRO), Alness	18.5	18.5	18.5	18.5	18.5	18.5	18.5
175		Novar 2 Windfarm, Alness	0	0	0	0	0	0	32
176		Parc (South Lochs) Wind, Lewis	0	0	0	0	0	250	250
177		Paul's Hill Wind	56	56	56	56	56	56	56
178		Paul's Hill Wind (Add.Cap)	14	14	14	14	14	14	14
179		Pencloe	0	0	63	63	63	63	63
180		Shira	0	0	0	0	0	75	75
181		Snowgoat Glen	0	0	0	0	0	28	28

182		Stacain Wind Farm, Sron Mor, Inverary	0	0	0	0	0	42	42
183		Strath Brora Wind, Brora	67	67	67	67	67	67	67
184		Strathy North & South Wind	0	0	0	0	226	226	226
185		Stroupster Windfarm, near Wick, Caithness	0	0	0	0	0	0	31.5
186		Tangy (1) Wind, Argyll	12.8	12.8	12.8	12.8	12.8	12.8	12.8
187		Tangy (Add Capacity)	6	6	6	6	6	6	6
188		Toddleburn	0	36	36	36	36	36	36
189		Tomatin Windfarm	0	0	0	0	30	30	30
190		Tormywheel	0	0	32.4	32.4	32.4	32.4	32.4
191		Tullo Wind Farm, Laurencekirk	13.5	13.5	13.5	13.5	13.5	13.5	13.5
192		Ulzieside	0	0	0	69	69	69	69
193		Waterhead Moor	0	0	120	120	120	120	120
194		Whitelee	322	322	322	322	322	322	322
195		Whiteside Hill	0	0	0	27	27	27	27
196		Windy Standard 2	0	0	0	60	60	60	60
197	COTPS-2	Cottam	505	505	505	505	505	505	505
198		Aigas	20	20	20	20	20	20	20
199		Cashlie	11.1	11.1	11.1	11.1	11.1	11.1	11.1
200		Ceannacroc	20	20	20	20	20	20	20
201	CAS-CLU01	Clunie	61.2	61.2	61.2	61.2	61.2	61.2	61.2
202		Deanie	38	38	38	38	38	38	38
203		Fasnakyle G1 & G3	46	46	46	46	46	46	46
204		Fasnakyle unit 4	0	0	0	0	0	0	7.5
205	CAS-MOR01	Glenmoriston	37	37	37	37	37	37	37
206		Grudie Bridge	21.7	21.7	21.7	21.7	21.7	21.7	21.7
207	CAS-GAR01	Invergarry	20	20	20	20	20	20	20
208		Kilmorack	20	20	20	20	20	20	20
209		Luichart	34	34	34	34	34	34	34

210	NANT-1	Nant	15	15	15	15	15	15	15
211		St Fillans	16.8	16.8	16.8	16.8	16.8	16.8	16.8
212	CAS-BEU01	Torr Achilty	15	15	15	15	15	15	15
213		Rothes Bioplant	0	52	52	52	52	52	52
214		Steven's Croft	45	45	45	45	45	45	45
215	FERR-4	Ferrybridge C	490	490	490	490	490	490	490
216	CNQPS-2	Connah's Quay	345	345	345	345	345	345	345
217	TILB-9	Tilbury B	350	350	350	350	350	350	350
218	SCCL-3	Saltend	366.7	366.7	366.7	366.7	366.7	366.7	366.7
219	CNQPS-4	Connah's Quay	345	345	345	345	345	345	345
220	COTPS-3	Cottam	505	505	505	505	505	505	505
221	DRAXX-2	Drax	648.5	648.5	648.5	648.5	648.5	648.5	648.5
222	KINO-1	Kingsnorth	485	485	485	485	485	485	485
223	SHBA-1	South Humber Bank 1	769	769	769	769	769	769	769
224	DIDC3	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
225		Docking Shoal Windfarm	0	0	0	0	0	0	0
226		Greater Gabbard Offshore Windfarm	0	500	500	500	500	500	500
227		Heysham Offshore Wind	140	140	140	140	140	140	140
228		Lincs Offshore Windfarm	0	0	0	0	0	0	0
229		London Array Stage 1	0	0	0	200	200	200	200
230		London Array Stage 2	0	0	0	800	800	800	800
231		Race Bank Windfarm	0	0	0	0	0	0	0
232		Rhigos	0	0	299	299	299	299	299
233		Walney Offshore Windfarm	0	0	0	450	450	450	450
234		West of Duddon Sands	0	0	0	0	0	500	500
235	DIDC1	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
236	KINO-2	Kingsnorth	485	485	485	485	485	485	485

237		Prenergy Woodchip Power Station, Port Talbot	0	0	0	0	0	0	295
238	MEDP-1	Medway	680	680	680	680	680	680	680
239	DINO-5	Dinorwig	200	274	274	274	274	274	274
240	ERRO-1	Errochty	75	75	75	75	75	75	75
241		Glendoe Hydro, Fort Augustus	0	0	0	0	100	100	100
242	SLOY-2	Sloy G2 & G3	80	80	80	80	80	80	80
243		Tummel	34	34	34	34	34	34	34
244	DAMC-1	Damhead Creek	805	805	805	805	805	805	805
245	COTPS-1	Cottam	495	495	495	495	495	495	495
246	HEYM11	Heysham 1	607	607	607	607	607	607	607
247	WYLF-3	Wylfa	245	245	245	0	0	0	0
248	LOAN-2	Longannet 2	576	576	576	576	576	576	576
249	HEYM28	Heysham 2	602.5	602.5	602.5	602.5	602.5	602.5	602.5
250	ROCK-1	Rocksavage	748	748	748	748	748	748	748
251	CRUA-1	Cruachan	110	110	110	110	110	110	110
252	DIDC2	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
253	TILB10	Tilbury B	350	350	350	350	350	350	350
254	SHOS-1	Shoreham	420	420	420	420	420	420	420
255	WBUPS-4	West Burton A	483	483	483	483	483	483	483
256	FERR-1	Ferrybridge C	490	490	490	490	490	490	490
257	BAGE-1	Baglan Bay	520	520	520	520	520	520	520
258	IRNPS-1	Ironbridge B	482	482	482	482	482	482	482
259	BRYP-1	Barry	245	245	245	245	245	245	245
260	HRTL-2	Hartlepool	603.5	603.5	603.5	603.5	603.5	603.5	603.5
261	SCCL-1	Saltend	366.7	366.7	366.7	366.7	366.7	366.7	366.7
262	COCK-2	Cockenzie 2	288	288	288	288	288	288	288
263	HEYM27	Heysham 2	600.5	600.5	600.5	600.5	600.5	600.5	600.5
264	DNGB21	Dungeness B	540.5	540.5	540.5	540.5	540.5	540.5	540.5
265	DNGB22	Dungeness B	540.5	540.5	540.5	540.5	540.5	540.5	540.5
266	HRTL-1	Hartlepool	603.5	603.5	603.5	603.5	603.5	603.5	603.5
267	HINB-7	Hinkley Point B	644	644	644	644	644	644	644
268	HINB-8	Hinkley Point B	617	617	617	617	617	617	617

269	HUNB-7	Hunterston	605	605	605	605	605	605	605
270	HUNB-8	Hunterston	605	605	605	605	605	605	605
271	ABTH7	Aberthaw B	547	547	547	547	547	547	547
272	USKM-13	Uskmouth	121	121	121	121	121	121	121
273	PEHE-1	Peterhead CCGT1	1524	1524	1524	1524	1524	1524	1524
274	ROOS-1	Roosecote	229	229	229	229	229	229	229
275	RATS-3	Ratcliffe-on-Soar	500	500	500	500	500	500	500
276	WYLF-4	Wylfa	245	245	245	0	0	0	0
277	PETEM1	Peterborough	405	405	405	405	405	405	405
278	USKM-15	Uskmouth	121	121	121	121	121	121	121
279	DINO-4	Dinorwig	200	274	274	274	274	274	274
280	RYHPS-1	Rye House	715	715	715	715	715	715	715
281	ALCN-1	Alcan Lynemouth	420	420	420	420	420	420	420
282	IRNPS-2	Ironbridge B	482	482	482	482	482	482	482
283	CRUA-2	Cruachan	110	110	110	110	110	110	110
284	USKM-14	Uskmouth	121	121	121	121	121	121	121
285	CDCL-1	CDCL	395	395	395	395	395	395	395
286	DIDC4	Didcot A	527.3	527.3	527.3	527.3	527.3	527.3	527.3
287	CRUA-4	Cruachan	110	110	110	110	110	110	110
288	LOAN-1	Longannet 1	576	576	576	576	576	576	576
289	LOAN-4	Longannet 4	576	576	576	576	576	576	576
290	FIFE-1	Fife Energy	123	123	123	123	123	123	123
291	CNQPS-1	Connah's Quay	345	345	345	345	345	345	345
292	COCK-1	Cockenzie 1	288	288	288	288	288	288	288
293	LOAN-3	Longannet 3	576	576	576	576	576	576	576
294		Cassley	10	10	10	10	10	10	10
295		Clachan	40	40	40	40	40	40	40
296		Culligran	19.1	19.1	19.1	19.1	19.1	19.1	19.1
297		Fasnakyle G2	23	23	23	23	23	23	23
298	FINL-1	Finlarig	16.5	16.5	16.5	16.5	16.5	16.5	16.5
299		Inverawe	25	25	25	25	25	25	25
300		Kinlochleven	30	30	30	30	30	30	30
301		Livishie	15	15	15	15	15	15	15
302	SLOY-1	Sloy G1 & G4	72.5	72.5	72.5	72.5	72.5	72.5	72.5
303	DINO-2	Dinorwig	200	274	274	274	274	274	274

304	WYLF-1	Wylfa	245	245	245	0	0	0	0
305	DINO-1	Dinorwig	200	274	274	274	274	274	274
306	FOYE-1	Foyers	150	150	150	150	150	150	150
307	CORB-1	Corby	401	401	401	401	401	401	401
308	DEEP-1	Deeside	247.5	247.5	247.5	247.5	247.5	247.5	247.5
309	DEEP-1	Deeside	247.5	247.5	247.5	247.5	247.5	247.5	247.5
310	KILLPG-2	Killingholme 1	450	450	450	450	450	450	450
311	DIDCB6	Didcot B	750	750	750	750	750	750	750
312	KILLPG-1	Killingholme 1	450	450	450	450	450	450	450
313	SHBA-2	South Humber Bank 2	516	516	516	516	516	516	516
314	BRGG-1	Brigg	268	268	268	268	268	268	268
315	DIDCB5	Didcot B	750	750	750	750	750	750	750
316	FOYE-2	Foyers	150	150	150	150	150	150	150
317	CRUA-3	Cruachan	110	110	110	110	110	110	110
318	SEAB-2	Seabank 2	422	422	422	422	422	422	422
319	DINO-3	Dinorwig	200	274	274	274	274	274	274
320	EECL-1	Brimsdown	408	408	408	408	408	408	408
321	KLYN-A-1	Kings Lynn	340	340	340	340	340	340	340
322	KILNS-1	Killingholme 2	665	665	665	665	665	665	665
323	FFES-1	Ffestiniog	90	90	90	90	90	90	90
324	SEAB-1	Seabank 1	812	812	812	812	812	812	812
325	OLDS1	Oldbury	228.2	0	0	0	0	0	0
326	FFES-3	Ffestiniog	90	90	90	90	90	90	90
327	FFES-2	Ffestiniog	90	90	90	90	90	90	90
328	LITTD1	Littlebrook D	1000	1000	1000	1000	1000	1000	1000
329	GRAI-1	Grain	1300	1300	1300	1300	1300	1300	1300
330	FAWL3	Fawley	496	496	496	496	496	496	496
331		Fawley	506	506	506	506	506	506	506
332	FFES-4	Ffestiniog	90	90	90	90	90	90	90
333	INDQ-1	Indian Queens	140	140	140	140	140	140	140
334	DINO-6	Dinorwig	200	274	274	274	274	274	274
335	TAYL2G	Taylors Lane	144	144	144	144	144	144	144
336	LITTGT	Littlebrook D	105	105	105	105	105	105	105
337	FIDL-GT	Fiddlers Ferry	26	26	26	26	26	26	26

338	RUGGT	Rugeley B	22	22	22	22	22	22	22
339	WBUGT	West Burton A	15	15	15	15	15	15	15
340	GRAIGT	Grain	55	55	55	55	55	55	55
341	COWE1	Cowes	72.5	72.5	72.5	72.5	72.5	72.5	72.5
342	FAWLGT	Fawley	34	34	34	34	34	34	34
343	COWE2	Cowes	72.5	72.5	72.5	72.5	72.5	72.5	72.5
344	MEDPGT	Medway	20	20	20	20	20	20	20
345	DIDCGT	Didcot A GTs	100	100	100	100	100	100	100
346	ABTHGT	Aberthaw B	51	51	51	51	51	51	51
347	KINOGT	Kingsnorth	26	26	26	26	26	26	26
348	FERR-GT	Ferrybridge C	21	21	21	21	21	21	21
349	TILBGT	Tilbury B	26	26	26	26	26	26	26
350		Tilbury B	26	26	26	26	26	26	26
351	DRAXXGT	Drax	15	15	15	15	15	15	15
352	OLDS2	Oldbury	242.2	0	0	0	0	0	0
353	RATSGT	Ratcliffe-on-Soar	21	21	21	21	21	21	21

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

Zone	Zone Name	Quantity	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z1	North West (SHETL)	Effective Generation	920	1029	1074	1063	1406	1666	2021
Z1	North West (SHETL)	Demand	516	534	544	547	554	574	601
Z1	North West (SHETL)	Planned Transfer	404	495	530	516	852	1092	1420
Z2	North (SHETL)	Effective Generation	1304	1300	1291	1278	1387	1430	1425
Z2	North (SHETL)	Demand	510	527	536	541	539	556	570
Z2	North (SHETL)	Planned Transfer	794	773	755	737	848	874	855
Z3	Sloy	Effective Generation	273	336	333	330	329	396	395
Z3	Sloy	Demand	74	79	79	81	82	85	86
Z3	Sloy	Planned Transfer	199	257	254	249	247	311	309
Z4	South (SHETL)	Effective Generation	393	417	414	536	534	659	697

Z4	South (SHETL)	Demand	539	535	539	547	544	557	574
Z4	South (SHETL)	Planned Transfer	-146	-118	-125	-11	-10	102	123
Z5	North (SPT)	Effective Generation	2406	2440	2443	2418	2409	2408	2400
Z5	North (SPT)	Demand	1260	1273	1286	1299	1315	1332	1350
Z5	North (SPT)	Planned Transfer	1146	1167	1157	1119	1094	1076	1050
Z6	South (SPT)	Effective Generation	3531	3839	4755	5481	5461	5459	5555
Z6	South (SPT)	Demand	3276	3329	3375	3411	3461	3516	3566
Z6	South (SPT)	Planned Transfer	255	510	1380	2070	2000	1943	1989
Z7	North & NE England	Effective Generation	2869	2860	2841	2812	2802	2801	2790
Z7	North & NE England	Demand	3163	3153	3217	3263	3316	3369	3424
Z7	North & NE England	Planned Transfer	-294	-293	-376	-451	-514	-568	-634
Z8	Yorkshire	Effective Generation	11120	11577	11500	11382	10803	10799	10761
Z8	Yorkshire	Demand	6096	6157	6216	6275	6319	6375	6424
Z8	Yorkshire	Planned Transfer	5024	5420	5284	5107	4484	4424	4337
Z9	NW England & N Wales	Effective Generation	8204	8332	8388	7914	7742	7808	7996
Z9	NW England & N Wales	Demand	7436	7727	7927	8092	8123	8300	8351
Z9	NW England & N Wales	Planned Transfer	768	605	461	-178	-381	-492	-355
Z10	Trent	Effective Generation	4332	4668	4637	5284	5965	6648	6623
Z10	Trent	Demand	595	629	654	664	673	691	701
Z10	Trent	Planned Transfer	3737	4039	3983	4620	5292	5957	5922
Z11	Midlands	Effective Generation	3457	4458	4427	4382	4367	4365	4348
Z11	Midlands	Demand	7541	7650	7747	7850	7943	8060	8158
Z11	Midlands	Planned Transfer	-4084	-3192	-3320	-3468	-3576	-3695	-3810
Z12	Anglia & Bucks	Effective Generation	3484	3917	3891	4761	4469	4849	4833
Z12	Anglia & Bucks	Demand	5960	6101	6203	6342	6413	6500	6557

Z12	Anglia & Bucks	Planned Transfer	-2476	-2184	-2312	-1581	-1944	-1651	-1724
Z13	S Wales & Central England	Effective Generation	7360	7934	8404	8985	9586	9242	9445
Z13	S Wales & Central England	Demand	5715	5831	5911	5992	6105	6177	6257
Z13	S Wales & Central England	Planned Transfer	1645	2103	2493	2993	3481	3065	3188
Z14	London	Effective Generation	2564	1733	1722	1704	1698	1382	1377
Z14	London	Demand	10150	10472	10666	10919	11071	11186	11240
Z14	London	Planned Transfer	-7586	-8739	-8944	-9215	-9373	-9804	-9863
Z15	Thames Estuary	Effective Generation	7079	5321	4865	3473	3642	3640	3620
Z15	Thames Estuary	Demand	1959	1993	2031	2075	2103	2104	2113
Z15	Thames Estuary	Planned Transfer	5120	3328	2834	1398	1539	1536	1507
Z16	Central S Coast	Effective Generation	477	965	1208	1196	1191	1190	1186
Z16	Central S Coast	Demand	3863	3924	4006	4094	4179	4268	4360
Z16	Central S Coast	Planned Transfer	-3386	-2959	-2798	-2898	-2988	-3078	-3174
Z17	South West England	Effective Generation	1743	1736	1726	2031	2023	2023	2015
Z17	South West England	Demand	2864	2948	2990	3029	3070	3107	3149
Z17	South West England	Planned Transfer	-1121	-1212	-1264	-998	-1047	-1084	-1134
All	Total	Effective Generation	61516	62862	63919	65030	65814	66765	67487
All	Total	Demand	61517	62862	63927	65021	65810	66757	67481
All	Total	Planned Transfer	-1	0	-8	9	4	8	6

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

Boundary	Boundary NAme	Quantity	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B1	SHETL North West	Effective Generation	920	1029	1074	1063	1406	1666	2021
B1	SHETL North West	Demand	516	534	544	547	554	574	601
B1	SHETL North West	Planned Transfer	404	495	530	516	852	1092	1420
B2	SHETL North - South	Effective Generation	2224	2329	2365	2341	2793	3096	3446
B2	SHETL North - South	Demand	1026	1061	1080	1088	1093	1130	1171
B2	SHETL North - South	Planned Transfer	1198	1268	1285	1253	1700	1966	2275
B3	Sloy	Effective Generation	273	336	333	330	329	396	395
B3	Sloy	Demand	74	79	79	81	82	85	86
B3	Sloy	Planned Transfer	199	257	254	249	247	311	309
B4	SHETL - SPT	Effective Generation	2890	3082	3112	3207	3656	4151	4538

B4	SHETL - SPT	Demand	1639	1675	1698	1716	1719	1772	1831
B4	SHETL - SPT	Planned Transfer	1251	1407	1414	1491	1937	2379	2707
B5	SPT North - South	Effective Generation	5296	5522	5555	5625	6065	6559	6938
B5	SPT North - South	Demand	2899	2948	2984	3015	3034	3104	3181
B5	SPT North - South	Planned Transfer	2397	2574	2571	2610	3031	3455	3757
B6	SPT - NGET	Effective Generation	8827	9361	10310	11106	11526	12018	12493
B6	SPT - NGET	Demand	6175	6277	6359	6426	6495	6620	6747
B6	SPT - NGET	Planned Transfer	2652	3084	3951	4680	5031	5398	5746
B7	Upper North	Effective Generation	11696	12221	13151	13918	14328	14819	15283
B7	Upper North	Demand	9338	9430	9576	9689	9811	9989	10171
B7	Upper North	Planned Transfer	2358	2791	3575	4229	4517	4830	5112
B8	North - Midlands	Effective Generation	31020	32130	33039	33214	32873	33426	34040
B8	North - Midlands	Demand	22870	23314	23719	24056	24253	24664	24946
B8	North - Midlands	Planned Transfer	8150	8816	9320	9158	8620	8762	9094
B9E	Midlands - South (Export)	Effective Generation	38809	41256	42103	42880	43205	44439	45011
B9E	Midlands - South (Export)	Demand	31006	31593	32120	32570	32869	33415	33805
B9E	Midlands - South (Export)	Planned Transfer	7803	9663	9983	10310	10336	11024	11206
B9I	Midlands - South (Import)	Effective Generation	22707	21606	21816	22150	22609	22326	22476
B9I	Midlands - South (Import)	Demand	30511	31269	31807	32451	32941	33342	33676
B9I	Midlands - South (Import)	Planned Transfer	-7804	-9663	-9991	-10301	-10332	-11016	-11200

B10	South Coast	Effective Generation	2220	2701	2934	3227	3214	3213	3201
B10	South Coast	Demand	6727	6872	6996	7123	7249	7375	7509
B10	South Coast	Planned Transfer	-4507	-4171	-4062	-3896	-4035	-4162	-4308
B11	North East & Yorkshire	Effective Generation	22816	23798	24651	25300	25131	25618	26044
B11	North East & Yorkshire	Demand	15434	15587	15792	15964	16130	16364	16595
B11	North East & Yorkshire	Planned Transfer	7382	8211	8859	9336	9001	9254	9449
B12	South & South West	Effective Generation	9580	10635	11338	12212	12800	12455	12646
B12	South & South West	Demand	12442	12703	12907	13115	13354	13552	13766
B12	South & South West	Planned Transfer	-2862	-2068	-1569	-903	-554	-1097	-1120
B13	South West	Effective Generation	1743	1736	1726	2031	2023	2023	2015
B13	South West	Demand	2864	2948	2990	3029	3070	3107	3149
B13	South West	Planned Transfer	-1121	-1212	-1264	-998	-1047	-1084	-1134
B14	London	Effective Generation	2564	1733	1722	1704	1698	1382	1377
B14	London	Demand	10150	10472	10666	10919	11071	11186	11240
B14	London	Planned Transfer	-7586	-8739	-8944	-9215	-9373	-9804	-9863
B15	Thames Estuary	Effective Generation	7079	5321	4865	3473	3642	3640	3620
B15	Thames Estuary	Demand	1959	1993	2031	2075	2103	2104	2113
B15	Thames Estuary	Planned Transfer	5120	3328	2834	1398	1539	1536	1507
B16	North East, Trent & Yorkshire	Effective Generation	27148	28466	29288	30584	31096	32266	32667
B16	North East, Trent & Yorkshire	Demand	16029	16216	16446	16628	16803	17055	17296
B16	North East, Trent & Yorkshire	Planned Transfer	11119	12250	12842	13956	14293	15211	15371

B17	West Midlands	Effective Generation	3457	4458	4427	4382	4367	4365	4348
B17	West Midlands	Demand	7541	7650	7747	7850	7943	8060	8158
B17	West Midlands	Planned Transfer	-4084	-3192	-3320	-3468	-3576	-3695	-3810

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Table 7.4 - System Power Losses at Peak

Category	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Transmission Heating Losses excluding GSP Transformers (MW)	779.5	893	1015.7	1083.1	1140	1276.1	1371.2
Fixed Losses (MW)	272	273	276	276	276	276	276
GSP Transformer Heating Losses (MW)	125.2	128.1	132.8	139.5	146.5	161.2	167.1
Generator Transformer Heating Losses (MW)	127.7	128.8	128.5	129.3	134.2	139.5	137.5
Total Losses	1304.4	1422.9	1553	1627.9	1696.7	1852.8	1951.8
ACS Peak Demand (MW) excluding Losses and Station Demand	60353	61324.3	62383	63268	63987.6	64774	65366.4
Total Losses as percentage of Demand	2.16	2.32	2.49	2.57	2.65	2.86	2.99

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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	Sloy (SHETL)	SHETL	<90
Z4	South (SHETL)	SHETL	<90
Z5	North (SPT)	SPT	92
Z6	South (SPT)	SPT	93
Z7	North & NE England	NGET	98
Z8	Yorkshire	NGET	99
Z9	NW England & N Wales	NGET	100
Z10	Trent	NGET	100
Z11	Midlands	NGET	103
Z12	Anglia & Bucks	NGET	103
Z13	S Wales & Central England	NGET	105
Z14	London	NGET	105
Z15	Thames Estuary	NGET	104
Z16	Central S Coast	NGET	107

Z17	South West England	NGET	106

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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.2.3 , Figure A.3.3 and Figure A.4.3 have been used. 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 2007/08, 2009/10, 2011/12 and 2013/14 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.

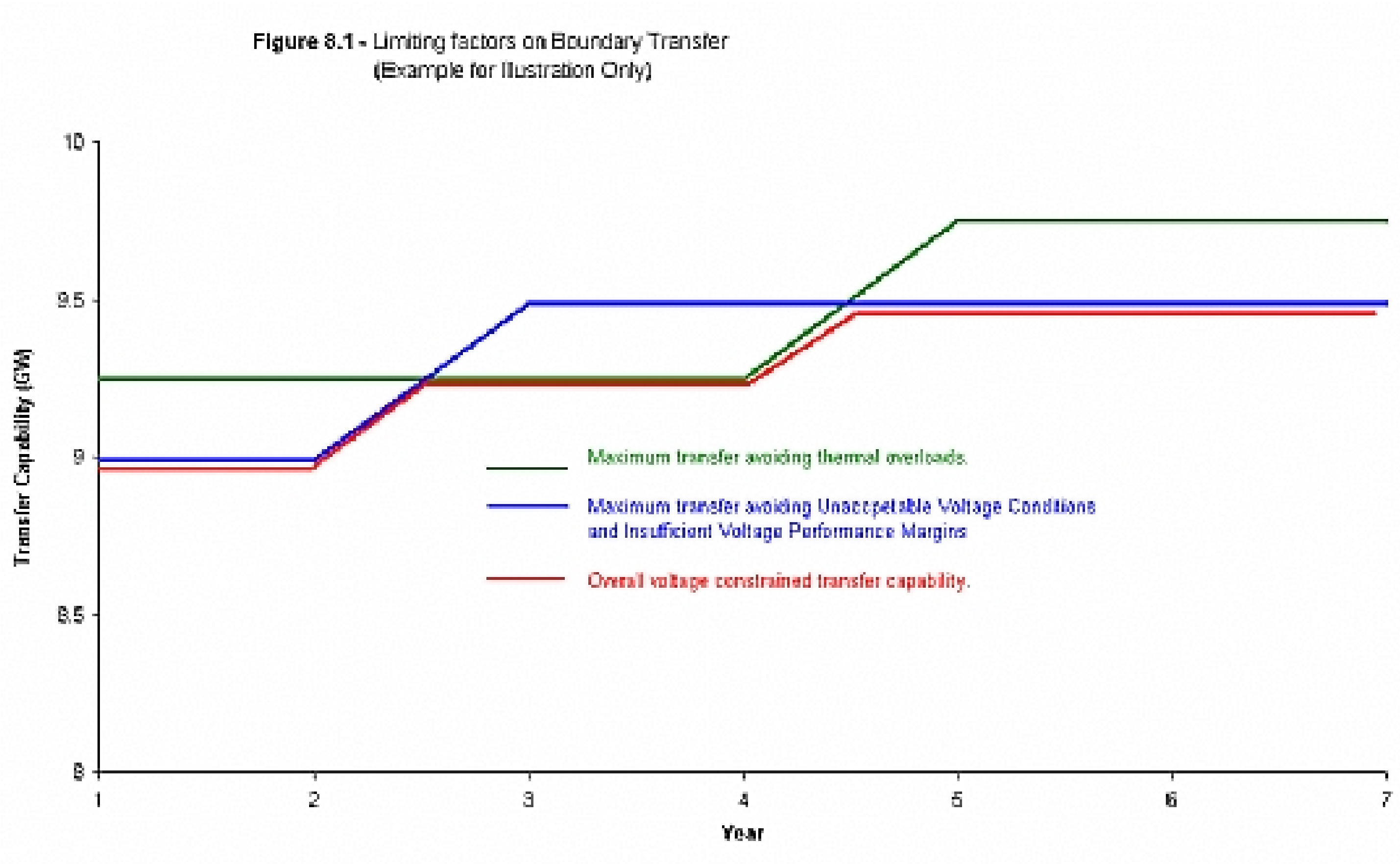
While not identical (particularly for voltage control and fault levels), in terms of flows on the system, the withdrawal of generation will have a broadly similar effect to the addition of demand and vice versa. The amount by which a boundary capability exceeds the required capability gives an indication 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

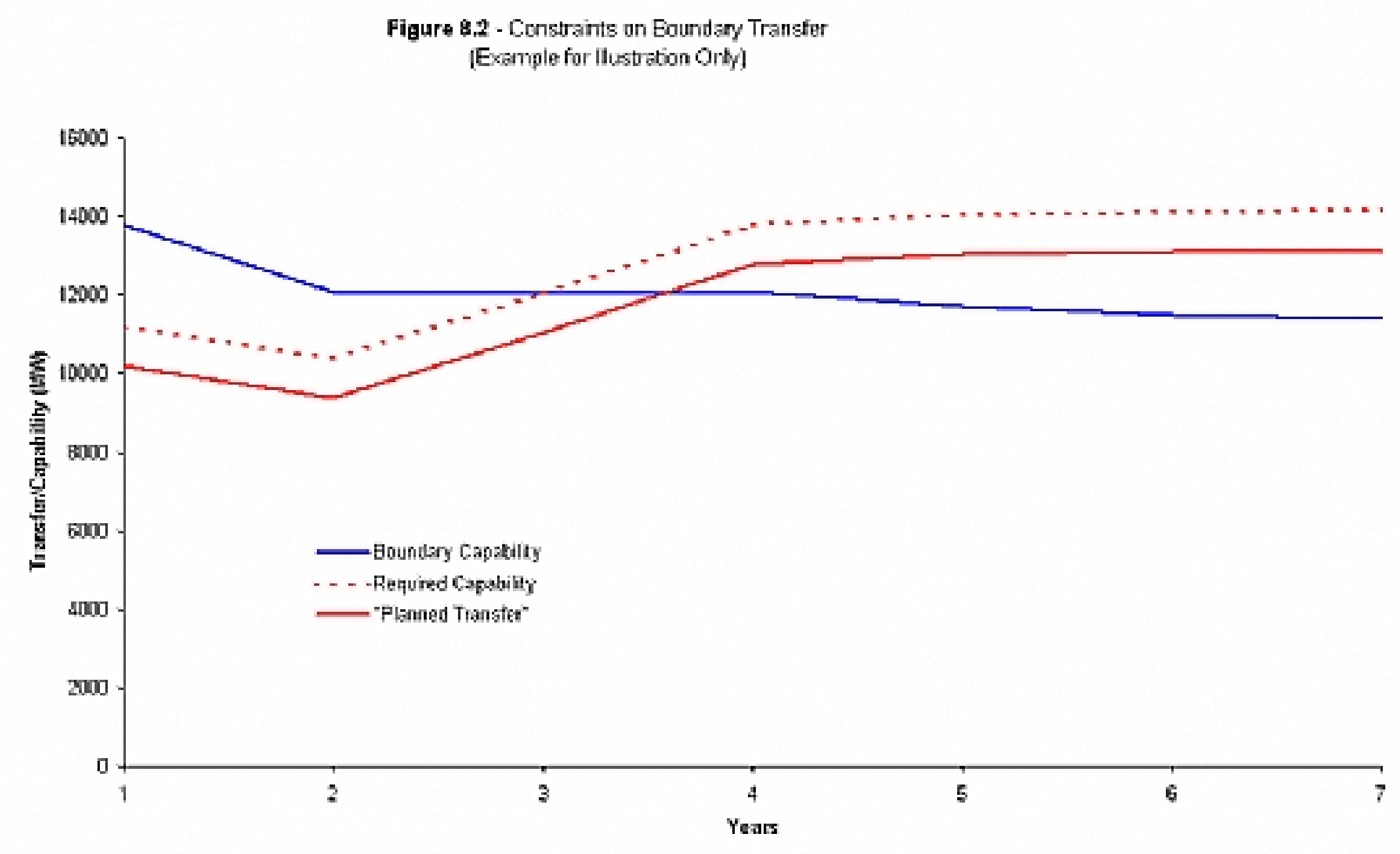
The power flows presented in this chapter are based on the deterministic SYS background. There is inherent uncertainty associated with the assumptions underlying any deterministic background. For example demand and generation may, in the event, deviate from any of the deterministic assumptions underlying 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 2007/08 to 2013/14

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

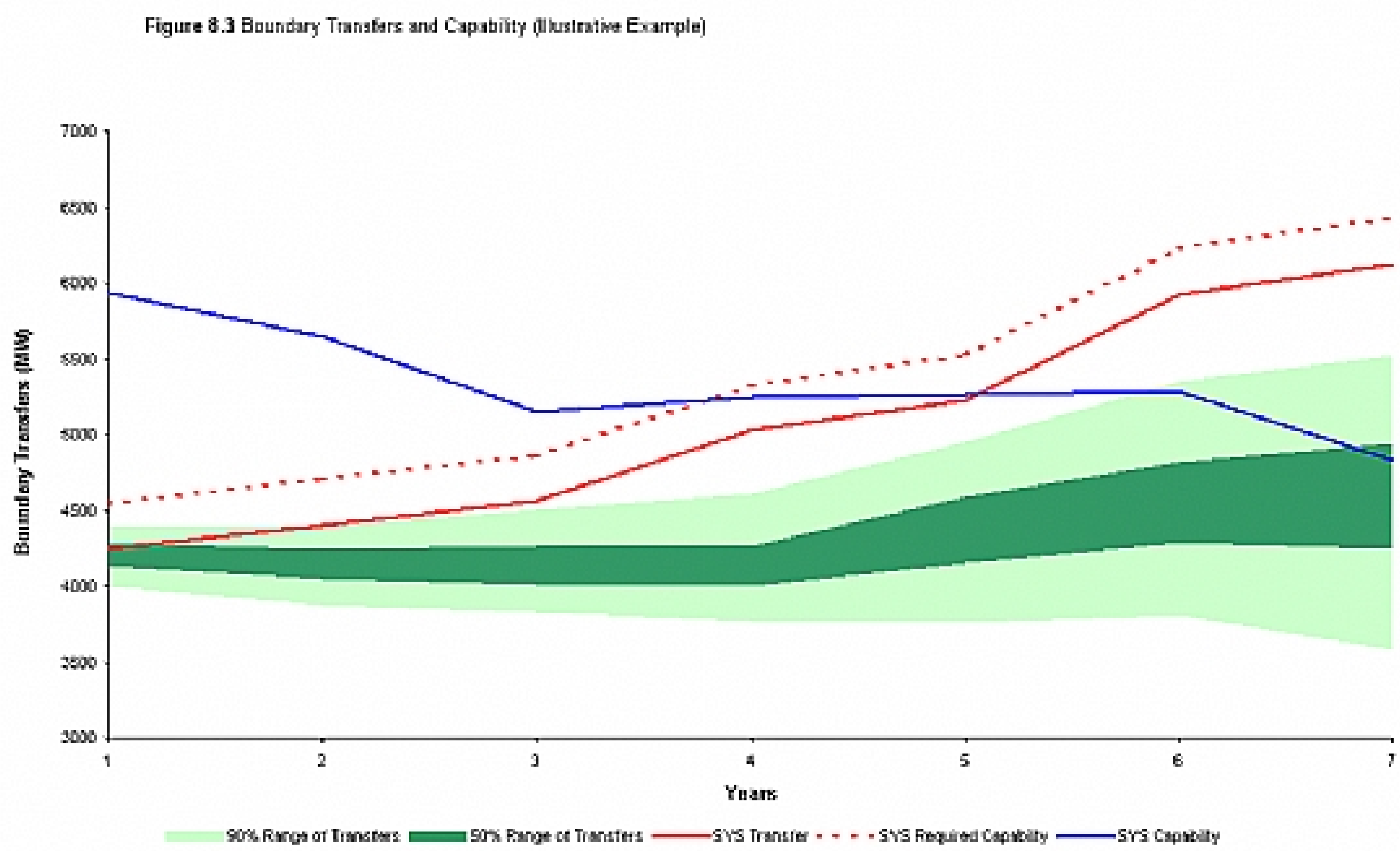
A key output of GUM is the probabilistic range of transfers over a given period for each defined boundary. For each year of the study, GUM calculates probabilistic distributions of power transfers for each boundary under peak load conditions. These distributions could be plotted as separate charts for 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 2006/07 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 2007/08 winter peak, but construction may slip such that it is unable to contribute to the system peak demand until 2008/09. 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 2007/08, 2009/10, 2011/12 and 2013/14 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 2013/14, 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.

The proposed connection of a significant volume of new transmission contracted generation in the SHETL area, substantially made up of wind farms, is dependant on the completion of transmission reinforcements, including the proposed Beauly/ Denny transmission reinforcement. The Beauly/Denny reinforcement is included as part of the SYS background for commissioning by 2011/12. However, elements of this reinforcement are currently the subject of a Public Inquiry and, consequently, the final commissioning date may vary, which would impact on the study results presented in GB Transmission System Performance and this chapter.

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

- The major north to south 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 large increases in power transfers during the period of the SYS. This increased power export through Scotland and into England is primarily due to contracted renewable energy developments throughout Scotland;
- For B8 (North to Midlands) and B9 (Midlands to South), power transfers increase in the earlier years which either slow or reduce steadily after 2009/10 due to new generation connecting in the South;
- Central London import (B14) show a trend of steadily increasing transfers reflecting the increasing demands and lack of new generation projects within these zones;
- 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 6, 7, 9, 10, 11, 14 and 16 the SYS transfers generally lie towards the top of the likely transfer range;
- for Boundaries 1, 5,,8,, and 13, the SYS transfers generally lie towards the middle of the likely transfer range;
- for Boundaries 2, 3, 4, 12, 15 and 17 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.

On the basis of the results displayed in Figure 8.B1 to Figure 8.B17, Boundaries B5 to B11, B14 & B16 would all require some form of reinforcement at some stage within the seven year period to maintain Licence Compliance against the SYS background.

Commentary

Boundary 1: SHETL North West

Figure 8.B1

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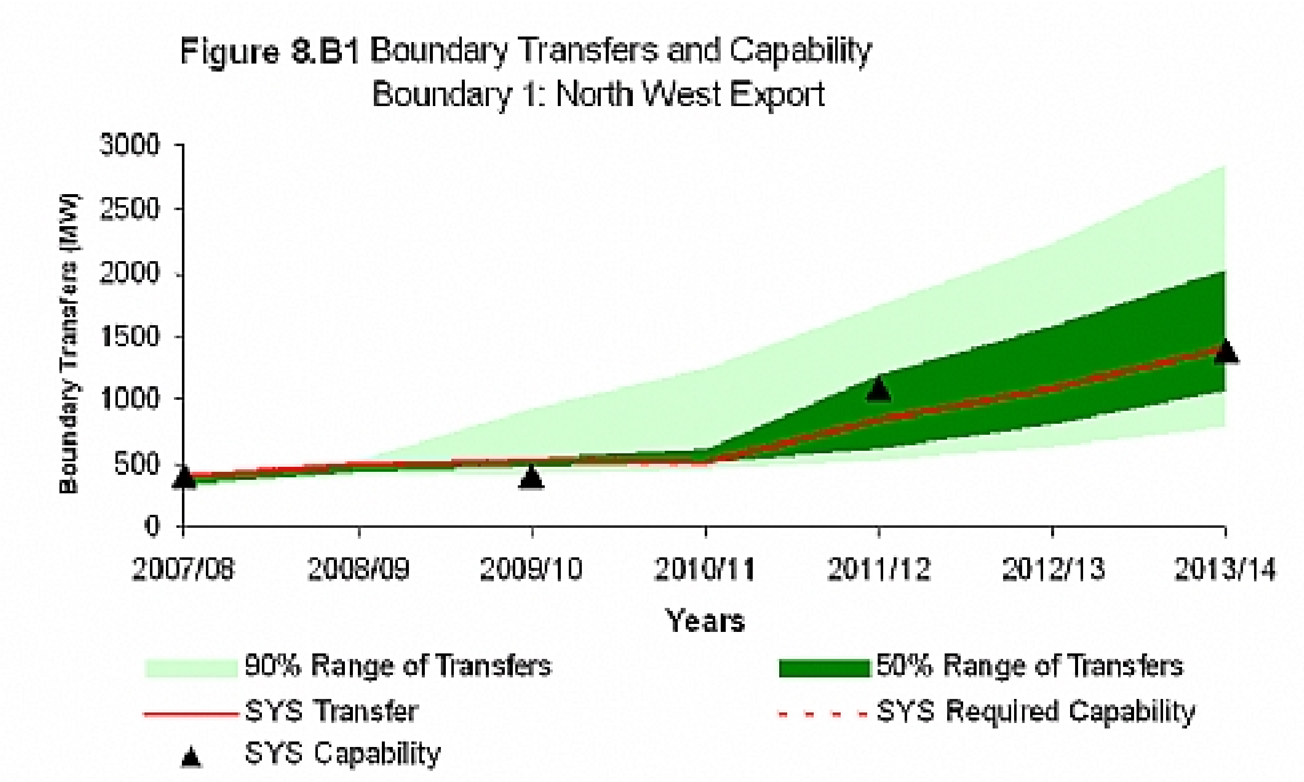

Figure 8.T1

Click to load a larger version of Figure8.T1 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B1E	SHETL NORTH WEST (EXPORT)							
	Effective Generation	920	1029	1074	1063	1406	1666	2021
	Demand	516	534	544	547	554	574	601
	Planned Transfer	404	495	530	516	852	1092	1420
B1I	SHETL NORTH WEST (IMPORT)							
	Effective Generation	60596	61833	62845	63967	64408	65099	65466
	Demand	61001	62328	63383	64474	65256	66183	66880
	Planned Transfer	-405	-495	-538	-507	-848	-1084	-1414

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.

It should be noted 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.

In the first few years the planned transfer just exceeds the 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. This reinforcement is referred to as Beauly/Denny and, at the time of writing, is the subject of a Public Inquiry. Depending on the outcome of the Inquiry and the timely granting of planning consents, this reinforcement will increase this boundary capability from 400MW to 1100MW by the winter of 2011/12. 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 next stage of reinforcement across this boundary 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 transmission line between Beauly and Blackhillock by 2013/14. 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 infrastructure will undergo detailed environmental impact assessment and will be subject to consents and planning approval.

Boundary 2: SHETL North - South

Figure 8.B2

Click to load a larger version of Figure8.B2 image

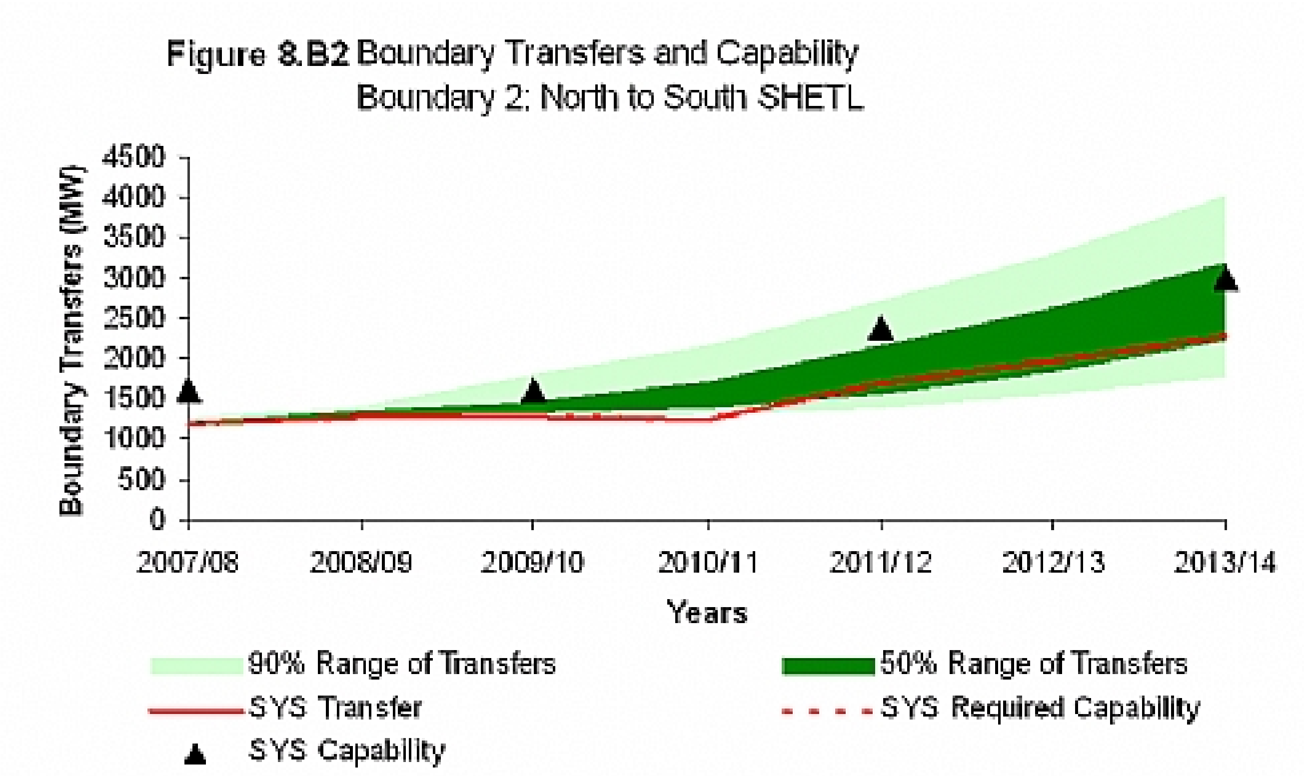

Figure 8.T2

Click to load a larger version of Figure8.T2 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B2E	**SHETL NORTH - SOUTH (EXPORT)**							
	Effective Generation	2224	2329	2365	2341	2793	3096	3446
	Demand	1026	1061	1080	1088	1093	1130	1171
	Planned Transfer	1198	1269	1285	1253	1700	1966	2275
B2I	**SHETL NORTH - SOUTH (IMPORT)**							
	Effective Generation	59292	60533	61554	62689	63021	63669	64041
	Demand	60491	61801	62847	63933	64717	65627	66310
	Planned Transfer	-1199	-1268	-1293	-1244	-1696	-1958	-2269

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

It should be noted 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 indicates the need to reinforce the transmission system in this location. The proposed Beauly to Denny reinforcement required for the north west boundary will also increase the capacity of 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 the outcome of the Public Inquiry into the Beaul/Denny reinforcement and the timely granting of planning consents, this reinforcement will increase the north south boundary capability from 1600MW to 2500MW by 2011/12. 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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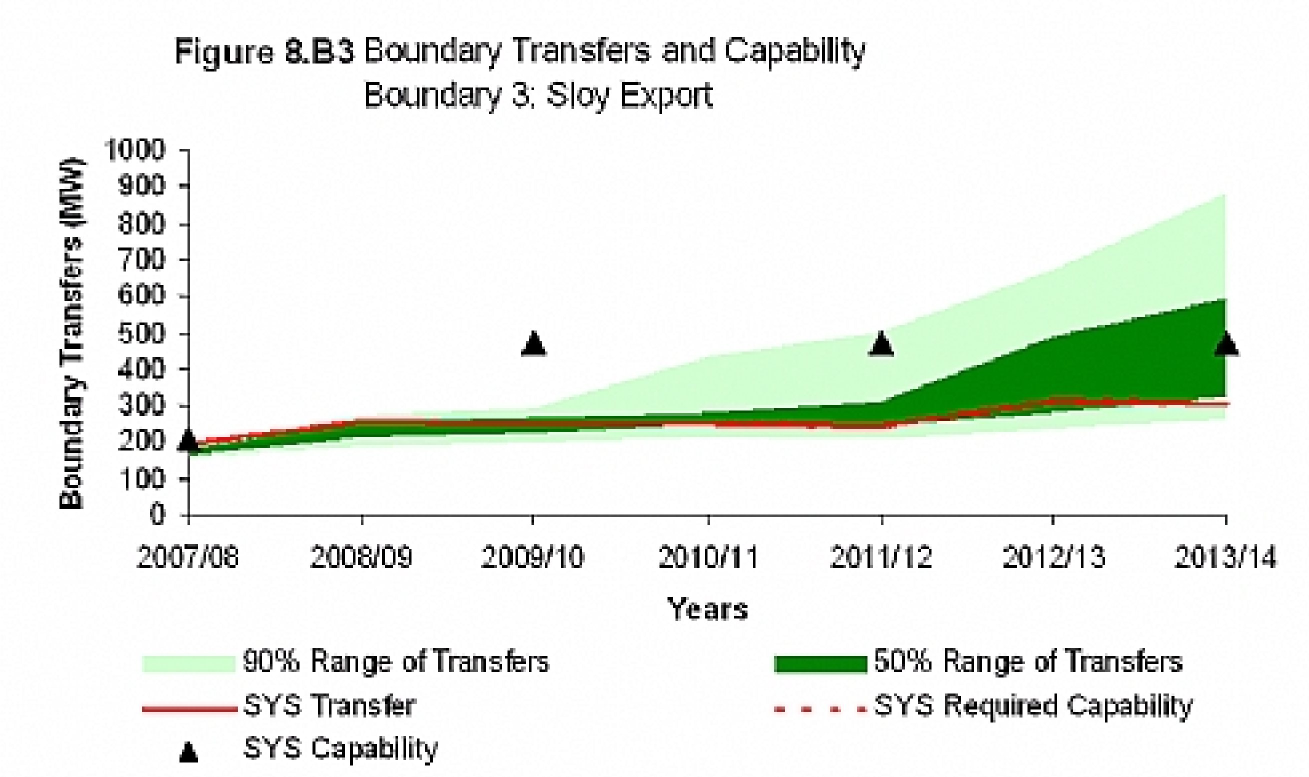

Figure 8.T3

Click to load a larger version of Figure8.T3 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B3E	**SLOY (EXPORT)**							
	Effective Generation	273	336	333	330	329	396	395
	Demand	74	79	79	81	82	85	86
	Planned Transfer	199	257	254	249	247	311	309
B3I	**SLOY (IMPORT)**							
	Effective Generation	61243	62526	63586	64700	65485	66369	67092
	Demand	61443	62783	63848	64940	65728	66672	67395
	Planned Transfer	-200	-257	-262	-240	-243	-303	-303

It should be noted 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 2007/08. The proposed reinforcement to increase the boundary capability from 210MW to 400MW is a new 275/132kV substation which links the Killin to Sloy 132kV double circuit line with the 275kV double circuit line which runs from Windyhill to Dalmally. The substation would be located at a point near to where the lines cross at the north end of Loch Lomond.

A considerable volume of 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

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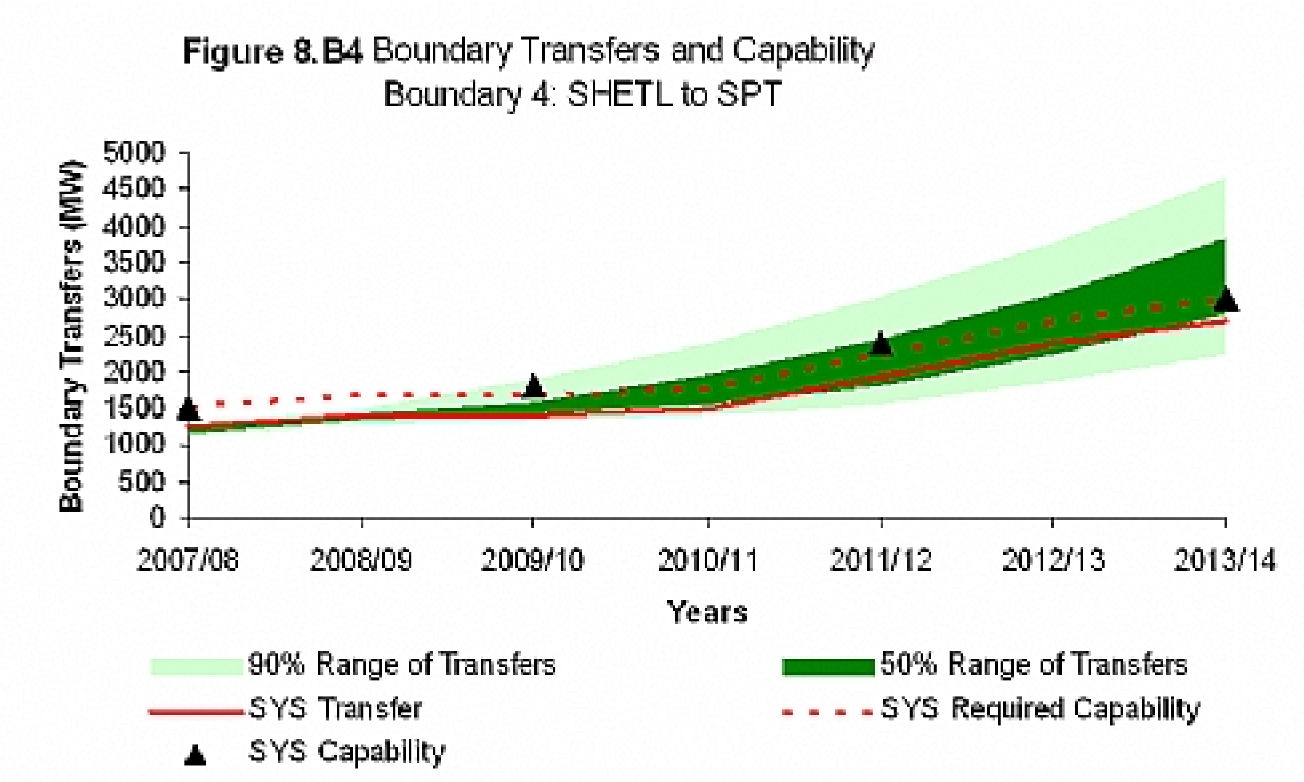

Figure 8.T4

Click to load a larger version of Figure8.T4 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B4E	SHETL - SPT (EXPORT)							
	Effective Generation	2690	3082	3112	3207	3656	4151	4538
	Demand	1639	1675	1698	1716	1719	1772	1831
	Planned Transfer	1251	1407	1414	1491	1937	2379	2707
B4I	SHETL - SPT (IMPORT)							
	Effective Generation	58626	59780	60807	61823	62158	62614	62949
	Demand	59878	61187	62229	63305	64091	64985	65650
	Planned Transfer	-1252	-1407	-1422	-1482	-1933	-2371	-2701

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.

It should be noted 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 2007/08 indicates the need to reinforce the transmission system in this location. The proposed Beauly to Denny reinforcement outlined for the North West boundary will also 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. Subject to the outcome of the Public Inquiry into the Beauly/Denny reinforcement and the timely granting of planning consents, this reinforcement will increase the boundary capability from 1500MW to around 2500MW by 2011/12. The increase in boundary capacity from 2007/08 to 2008/09 is due to the introduction of the proposed new substation at the north end of Loch Lomond as described in the Boundary 3 commentary above and the introduction of reactive compensation at Tealing.

The growing volume of renewable generation connections in the SHETL area means that further reinforcement across this boundary is required. Due to a voltage restriction in 2011/12, reactive compensation in the SPT area is required which increases the boundary capability to around 3000MW. Depending on the volume of future renewable generation applications, additional reinforcement of this boundary could 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.

In practice, generation will only be connected up to the limit of the boundary until the reinforcement is completed.

Boundary 5: SPT North - South

Figure 8.B5

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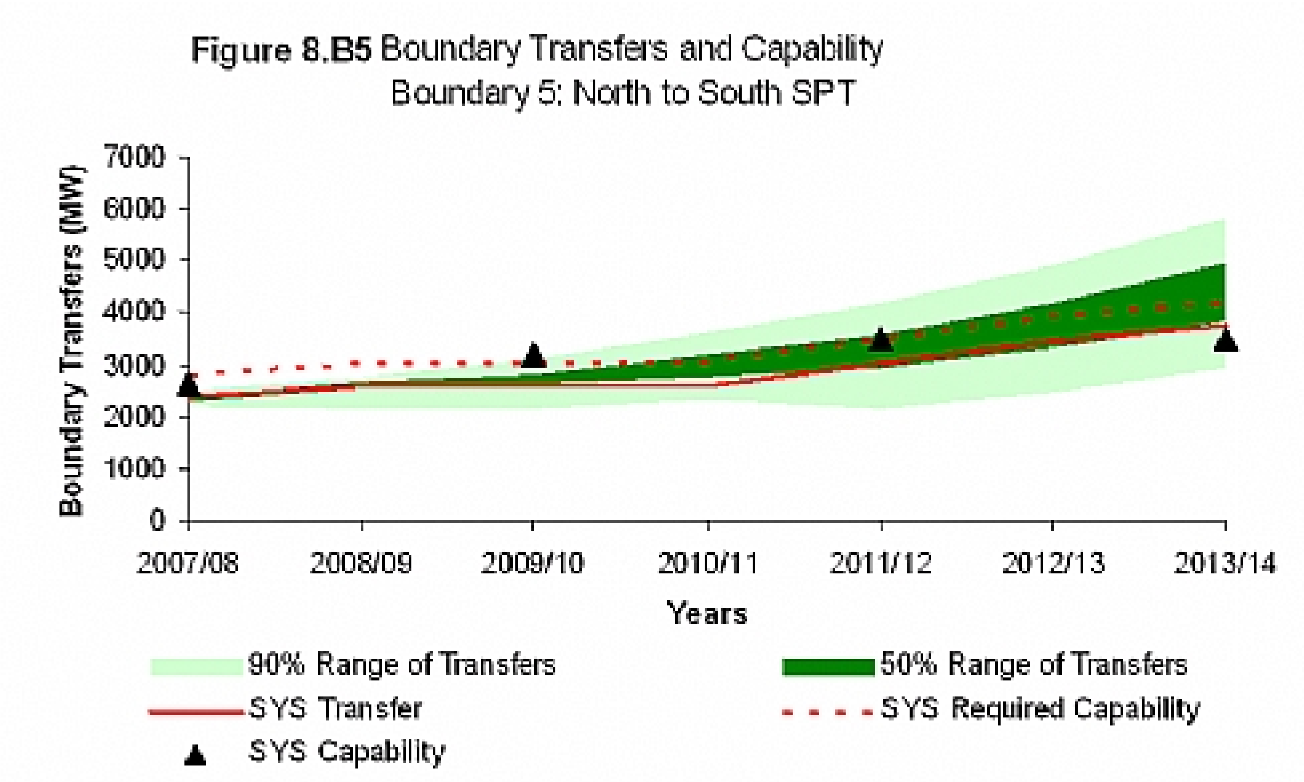

Figure 8.T5

Click to load a larger version of Figure8.T5 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B5E	SPT NORTH - SOUTH (EXPORT)							
	Effective Generation	5296	5522	5555	5625	6065	6559	6938
	Demand	2899	2948	2984	3016	3034	3104	3181
	Planned Transfer	2397	2574	2571	2610	3031	3455	3757
B5I	SPT NORTH - SOUTH (IMPORT)							
	Effective Generation	56220	57340	58364	59405	59749	60206	60549
	Demand	58618	59914	60943	62006	62776	63653	64300
	Planned Transfer	-2398	-2574	-2579	-2601	-3027	-3447	-3751

The north to south transfer across this boundary in the central belt of Scotland shows a rise throughout the years of this statement, due primarily to contracted renewable energy developments in the north of Scotland. As a consequence, the required capability rises to a level in excess of the current capability indicating a strong need for reinforcement.

SPT intend to complete two stages of reinforcement within the seven-year period. The first stage 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 on the Windyhill to Neilston 275kV circuit. The second stage will include thermal uprating/ reconfiguration of a number of 275kV circuits and installation of reactive compensation at Kincardine and Denny North 275kV substations.

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 4000MW.

It can be seen from the probabilistic range of Planned Transfers (in which the SYS Planned Transfer lies marginally below the 50% range of planned transfers by 2013/14) that there is a high probability of these reinforcement being required.

Boundary 6: SPT - NGET

Figure 8.B6

Click to load a larger version of Figure8.B6 image

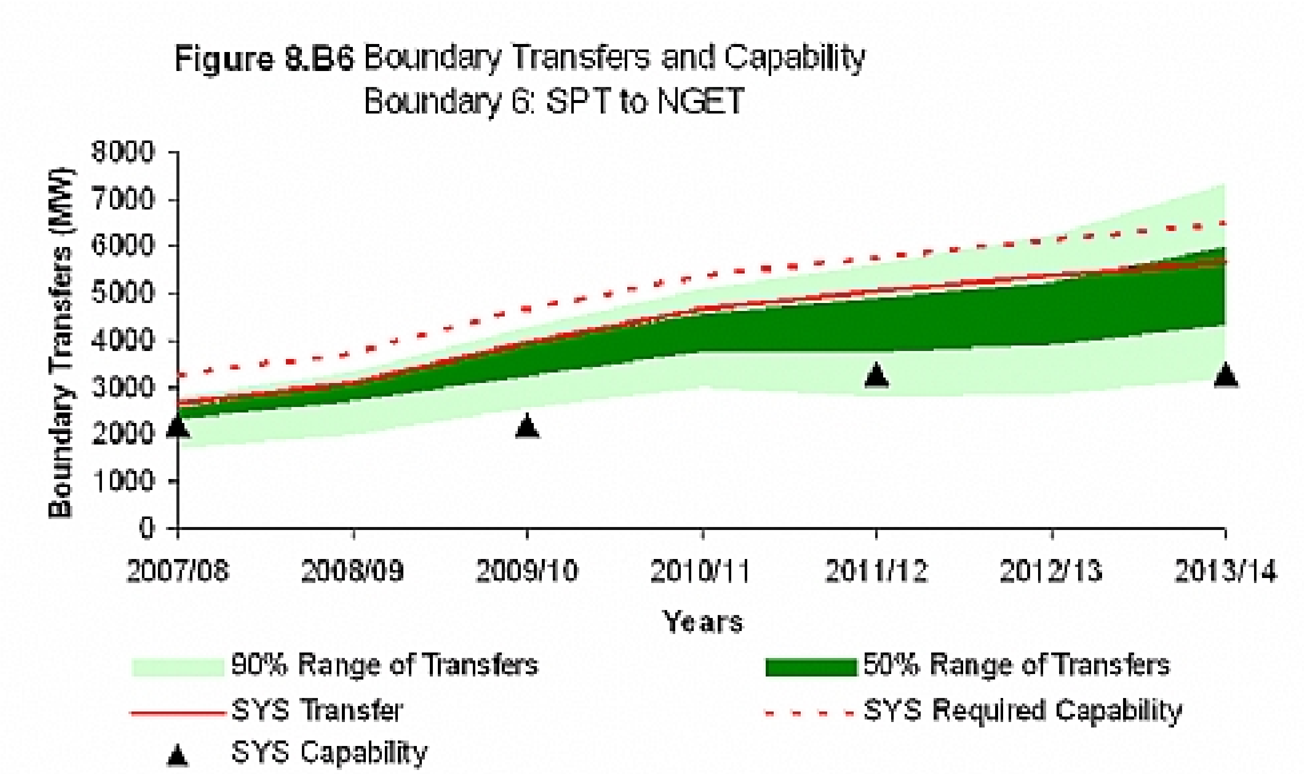

Figure 8.T6

Click to load a larger version of Figure8.T6 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B6E	**SPT - NGET (EXPORT)**							
	Effective Generation	8627	9361	10310	11106	11526	12018	12493
	Demand	6175	6277	6359	6426	6495	6620	6747
	Planned Transfer	2652	3084	3951	4680	5031	5398	5746
B6I	**SPT - NGET (IMPORT)**							
	Effective Generation	52689	53501	53609	53924	54288	54747	54994
	Demand	55342	56585	57568	58595	59315	60137	60734
	Planned Transfer	-2653	-3084	-3959	-4671	-5027	-5390	-5740

The north to south transfer across the boundary between SPT and NGC 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.

To achieve a capability of approximately 2,800MW in year 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.

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 8100MW of Large wind generation in Scotland by 2013/14) and take no account of future uncertainty. As mentioned previously, it is reasonable to suppose 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. There is hence 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 Licence 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

Click to load a larger version of Figure8.B7 image

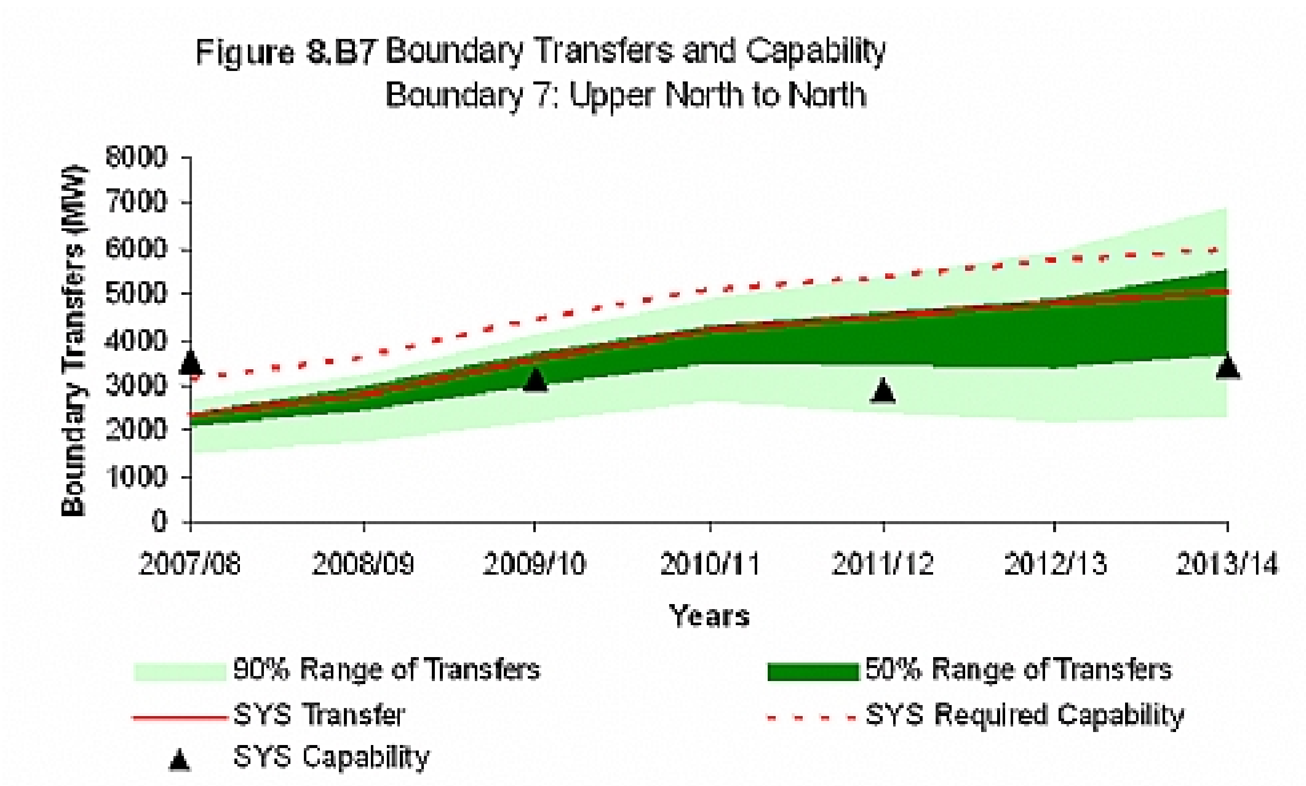

Figure 8.T7

Click to load a larger version of Figure8.T7 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B7E	**UPPER NORTH (EXPORT)**							
	Effective Generation	11696	12221	13151	13918	14328	14819	15283
	Demand	9338	9430	9576	9689	9811	9989	10171
	Planned Transfer	2358	2791	3575	4229	4517	4830	5112
B7I	**UPPER NORTH (IMPORT)**							
	Effective Generation	49820	50641	50768	51112	51486	51946	52204
	Demand	52179	53432	54351	55332	55999	56768	57310
	Planned Transfer	-2359	-2791	-3583	-4220	-4513	-4822	-5106

The Upper North boundary experiences significant transfer increase from 2008/09 onwards as a consequence of the significantly increased export from Scotland into England from new renewable generation connections.

The boundary shows insufficient transfer capability from 2009/10 onwards. Compliance however can be restored with the outlined SPT - NGC boundary reinforcements.

The planned transfer lies between the 50% and 90% range of probabilistic transfers. 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 mostly outside the 90% of probabilistic transfers which indicates that the chance of this transfer being exceeded is low.

Note also that the SYS capability from 2009/2010 onwards has reduced due to the inclusion of the Western and Eastern interconnectors. The inclusion of Anglo-Scottish reinforcements without further reinforcements south of the SPT - NGET boundary creates a lower impedance route and thus greater flows across critical circuits.

Boundary 8: NGET North to Midlands

Figure 8.B8

Click to load a larger version of Figure8.B8 image

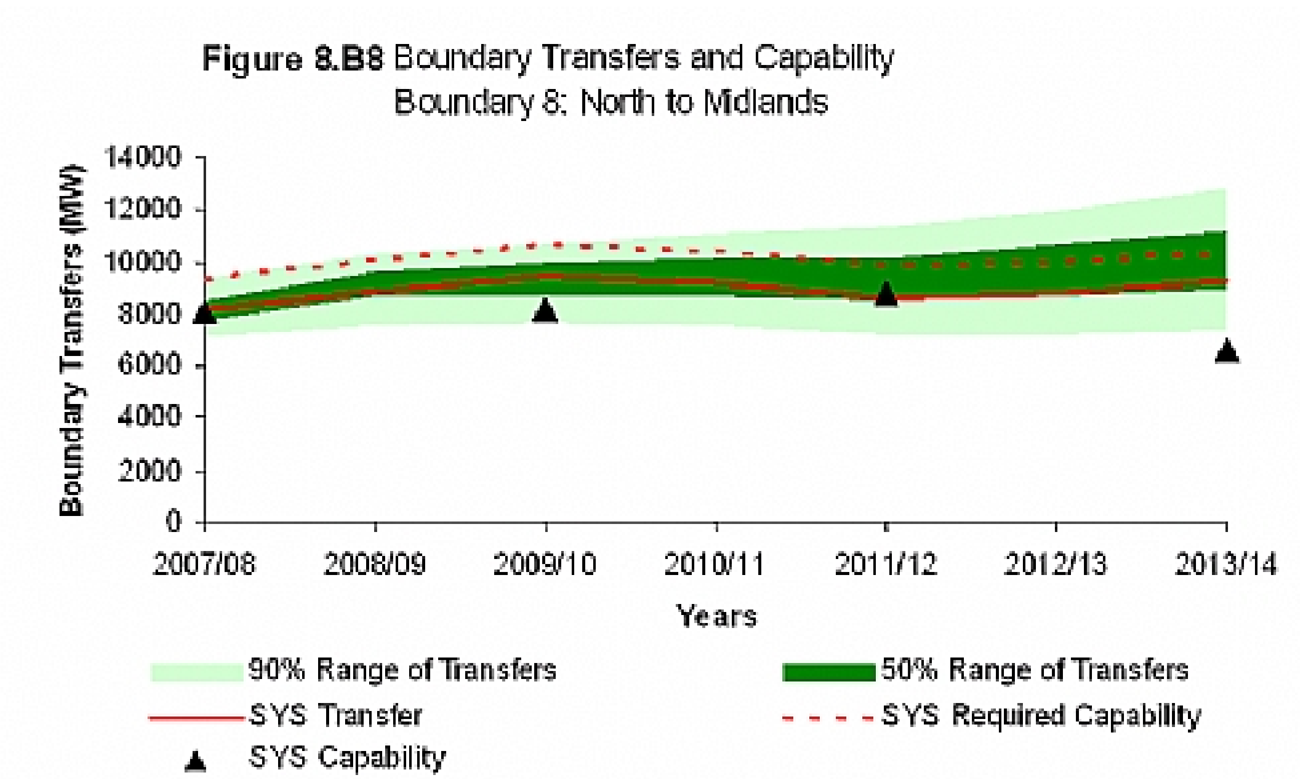

Figure 8.T8

Click to load a larger version of Figure8.T8 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B8E	NORTH TO MIDLANDS (EXPORT)							
	Effective Generation	31020	32130	33039	33214	32873	33426	34040
	Demand	22870	23314	23719	24056	24253	24664	24946
	Planned Transfer	8150	8816	9320	9158	8620	8762	9094
B8I	NORTH TO MIDLANDS (IMPORT)							
	Effective Generation	30496	30732	30880	31816	32941	33339	33447
	Demand	38647	39548	40208	40965	41557	42093	42535
	Planned Transfer	-8151	-8816	-9328	-9149	-8616	-8754	-9088

The SYS transfers increase between years 2007/08 and 2009/10, mainly because of the contractual position of new generation to the north of the boundary in the SYS background. However, for years following 2011/12 the transfer decreases due to new generation opening to the south of the boundary and the higher transfers across the long heavily loaded lines in this boundary.

For the entirety of the SYS period, planned transfers lie in the middle of the likely range of probabilistic transfers and do not meet required capability. Reinforcements will be required in order 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

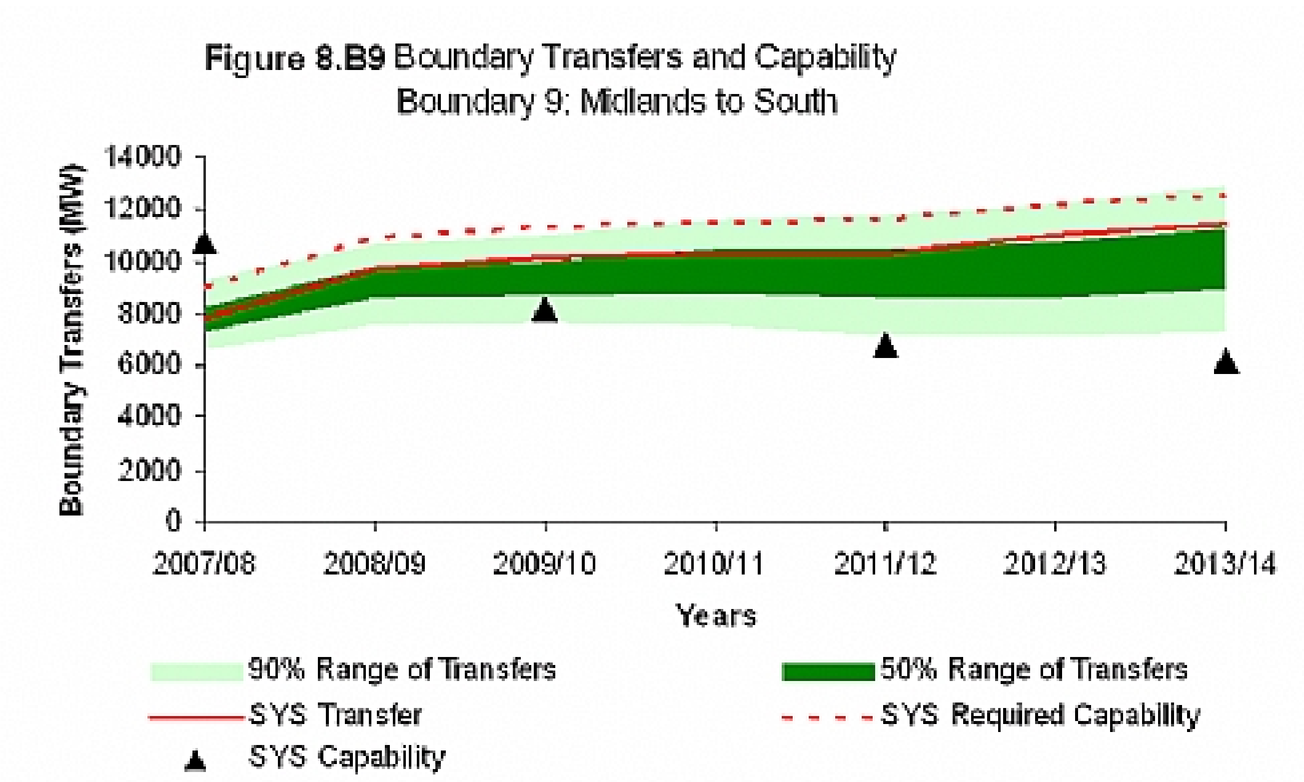

Figure 8.T9

Click to load a larger version of Figure8.T9 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B9E	MIDLANDS - SOUTH (EXPORT)							
	Effective Generation	38809	41256	42103	42880	43205	44439	45011
	Demand	31006	31593	32130	32570	32869	33415	33805
	Planned Transfer	7803	9663	9983	10310	10336	11024	11206
B9I	MIDLANDS - SOUTH (IMPORT)							
	Effective Generation	22707	21606	21816	22150	22609	22326	22476
	Demand	30511	31269	31807	32451	32941	33342	33676
	Planned Transfer	-7804	-9663	-9991	-10301	-10332	-11016	-11200

The trend for boundary 9 shows an increased SYS transfer throughout the SYS period,,mainly because of new generation to the North of the boundary and the increase in demands South of the boundary in the SYS background.

The boundary capability is shown to be higher than the required transfer in 2007/08. From 2009/10 onwards the boundary capability is lower than both the SYS transfer and the SYS required transfer, indicating the need for additional reinforcements

Boundary 10: NGET South Coast

Figure 8.B10

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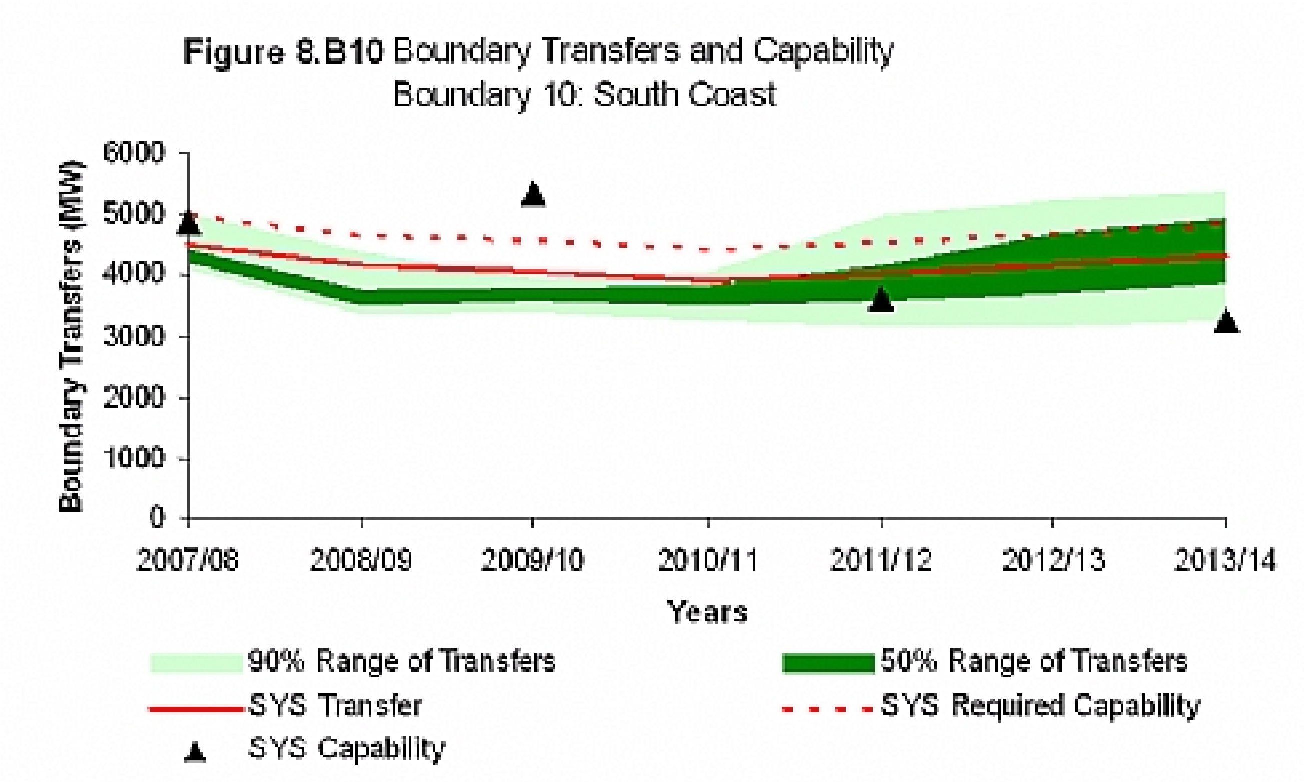

Figure 8.T10

Click to load a larger version of Figure8.T10 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B10E	**SOUTH COAST (EXPORT)**							
	Effective Generation	2220	2701	2934	3227	3214	3213	3201
	Demand	6727	6872	6996	7123	7249	7375	7509
	Planned Transfer	-4507	-4171	-4062	-3896	-4035	-4162	-4308
B10I	**SOUTH COAST (IMPORT)**							
	Effective Generation	59296	60161	60985	61803	62600	63552	64286
	Demand	54790	55990	56931	57898	58561	59382	59972
	Planned Transfer	4506	4171	4054	3906	4039	4170	4314

The South Coast area is the importing area. The SYS transfer decreases gradually from 2007/08 to 2011/12 due to new generation openings in the South Coast area. The SYS transfer increases from 2011/12 onwards, mainly due to steady demand growth.

The boundary capability is below the required transfer from 2011/12 onward. The requirement for reinforcements is more likely towards the end of the SYS period, due to the increase of demand.

Boundary 11: NGET North East and Yorkshire

Figure 8.B11

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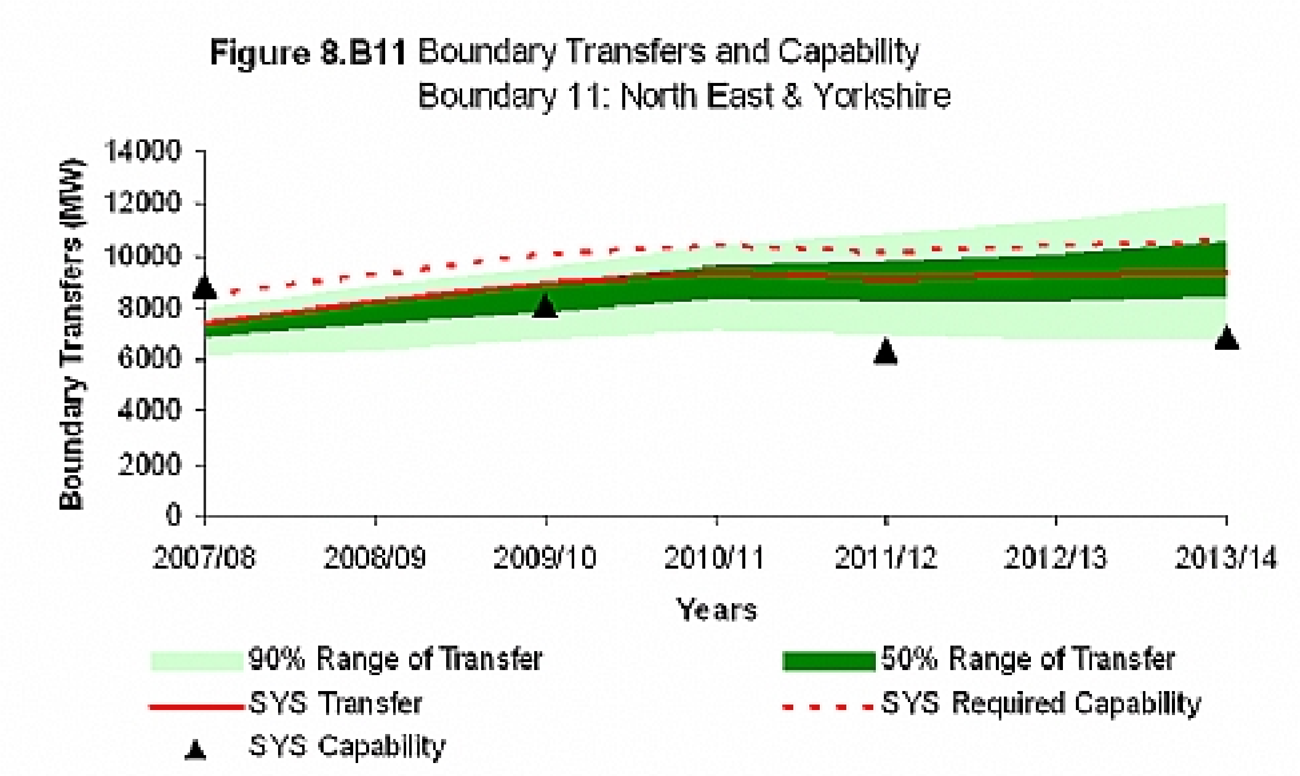

Figure 8.T11

Click to load a larger version of Figure8.T11 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B11E	NORTH EAST & YORKSHIRE (EXPORT)							
	Effective Generation	22816	23798	24651	25300	25131	25618	26044
	Demand	15434	15587	15792	15964	16130	16364	16595
	Planned Transfer	7382	8211	8859	9336	9001	9254	9449
B11I	NORTH EAST & YORKSHIRE (IMPORT)							
	Effective Generation	38700	39064	39268	39730	40683	41147	41443
	Demand	46083	47275	48135	49057	49680	50393	50886
	Planned Transfer	-7383	-8211	-8867	-9327	-8997	-9246	-9443

The transfer across boundary 11 increases between 2007/08 and 2010/11 due to the increased exports from Scotland. From 2011/12, the opening of new generation in the South of the boundary helps to bring down the transfer.

There is insufficient boundary capability from 2009/10 onwards, indicating that reinforcements are necessary.

Boundary 12: NGET South & South West

Figure 8.B12

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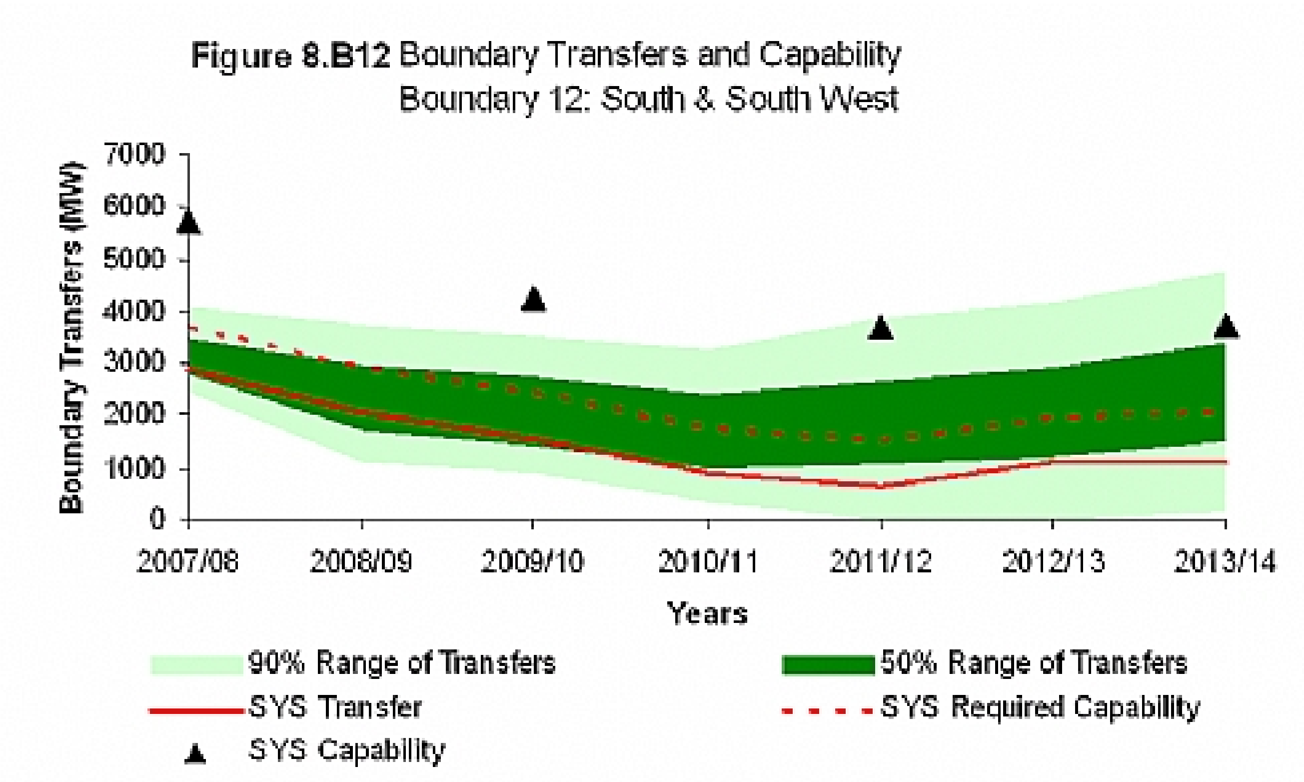

Figure 8.T12

Click to load a larger version of Figure8.T12 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B12E	SOUTH & SOUTH WEST (EXPORT)							
	Effective Generation	9580	10635	11338	12212	12800	12455	12646
	Demand	12442	12703	12907	13115	13354	13552	13766
	Planned Transfer	-2862	-2068	-1569	-903	-554	-1097	-1120
B12I	SOUTH & SOUTH WEST (IMPORT)							
	Effective Generation	51936	52227	52581	52818	53014	54310	54841
	Demand	49075	50159	51020	51906	52456	53205	53715
	Planned Transfer	2861	2068	1561	912	558	1105	1126

New generation projects on the importing side of the South and South West boundary result in a significant reduction of boundary transfer between years 2007/08 and 2013/14.

SYS studies indicate that the boundary capability is greater than the SYS required transfer, and that no reinforcements are required.

Boundary 13: NGET South West

Figure 8.B13

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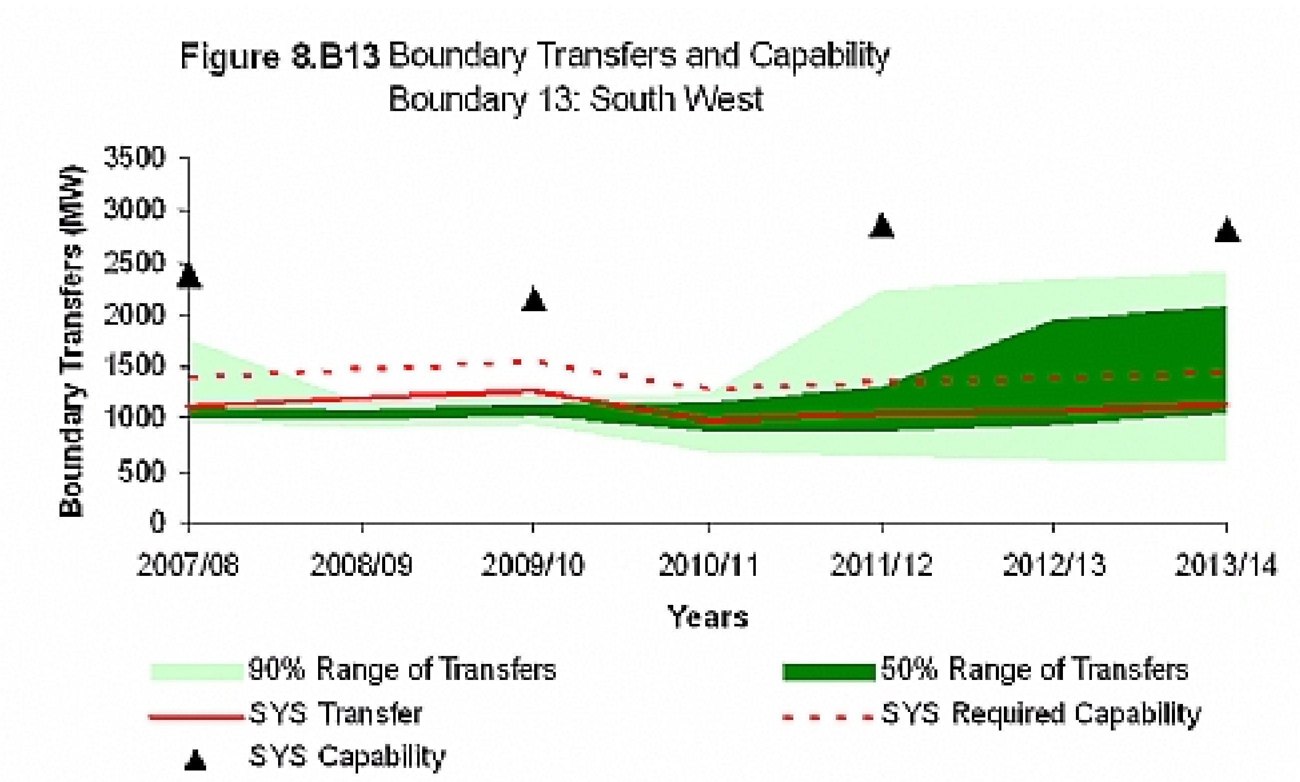

Figure 8.T13

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B13E	SOUTH WEST (EXPORT)							
	Effective Generation	1743	1736	1726	2031	2023	2023	2015
	Demand	2864	2948	2990	3029	3070	3107	3149
	Planned Transfer	-1121	-1212	-1264	-998	-1047	-1084	-1134
B13I	SOUTH WEST (IMPORT)							
	Effective Generation	59773	61126	62193	62998	63791	64742	65472
	Demand	58653	59914	60937	61992	62740	63650	64332
	Planned Transfer	1120	1212	1256	1007	1051	1092	1140

The SYS Planned Transfer remains relatively steady across the whole SYS period apart from a minor decrease in 2010/11 resulting from the connection of new generation.

The spread of likely transfers is extremely narrow until 2009/10, which is representative of the lack of proposed generation developments in the group during the initial years. The probabilistic transfer then begins to widen out reflecting uncertainties associated with possible new generation and station closures in the group. The SYS Transfer and SYS required capability are likely to be exceeded, however the transfers are unlikely to exceed the SYS capability, suggesting that further reinforcement will not be required.

Boundary 14: NGET London

Figure 8.B14

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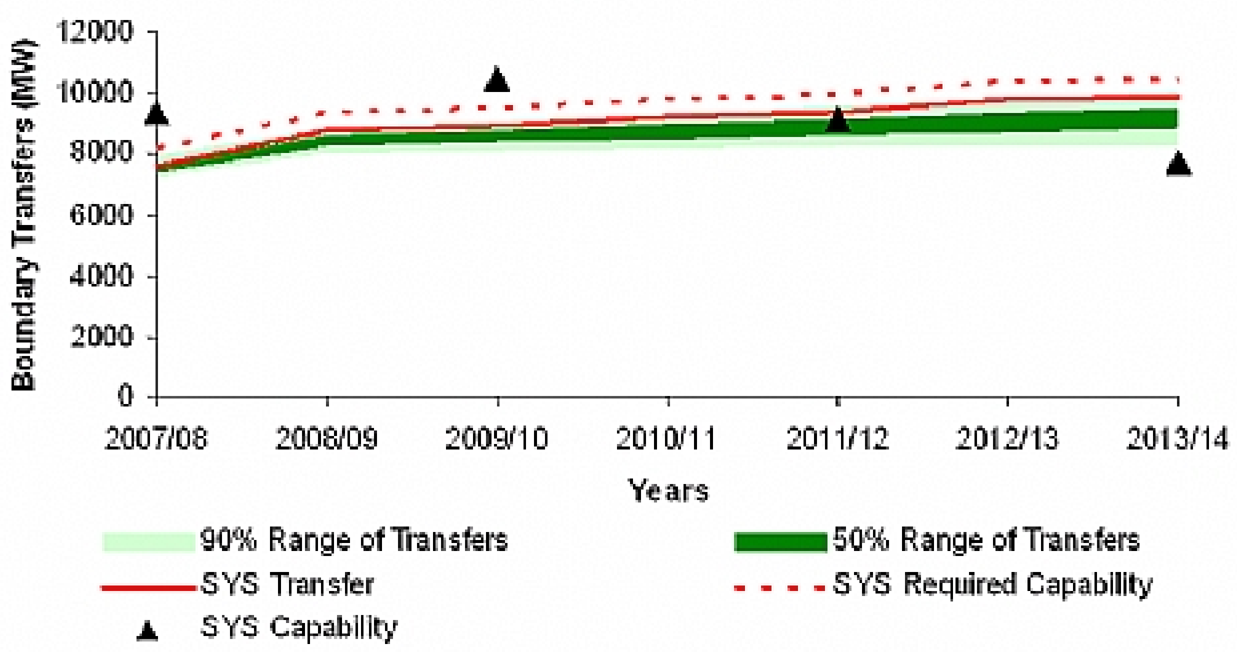

Figure 8.B14 Boundary Transfers and Capability
Boundary 14: London

Figure 8.T14

Click to load a larger version of Figure8.T14 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B14E	LONDON (EXPORT)							
	Effective Generation	2564	1733	1722	1704	1698	1382	1377
	Demand	10150	10472	10666	10919	11071	11186	11240
	Planned Transfer	-7586	-8739	-8944	-9215	-9373	-9804	-9863
B14I	LONDON (IMPORT)							
	Effective Generation	58952	61129	62197	63326	64116	65383	66110
	Demand	51367	52390	53261	54102	54739	55571	56241
	Planned Transfer	7585	8739	8936	9224	9377	9812	9869

London imports a significant proportion of its demand. Over the SYS period planned transfer increases gradually, primarily as a result of demand growth.

The spread of likely transfers for Boundary 14 is narrow due to the high level of demand and the relatively low volatility and volume of the generation in the group. From 2010/11, the SYS capability is below the required capability indicating a requirement for reinforcement.

Boundary 15: NGET Thames Estuary

Figure 8.B15

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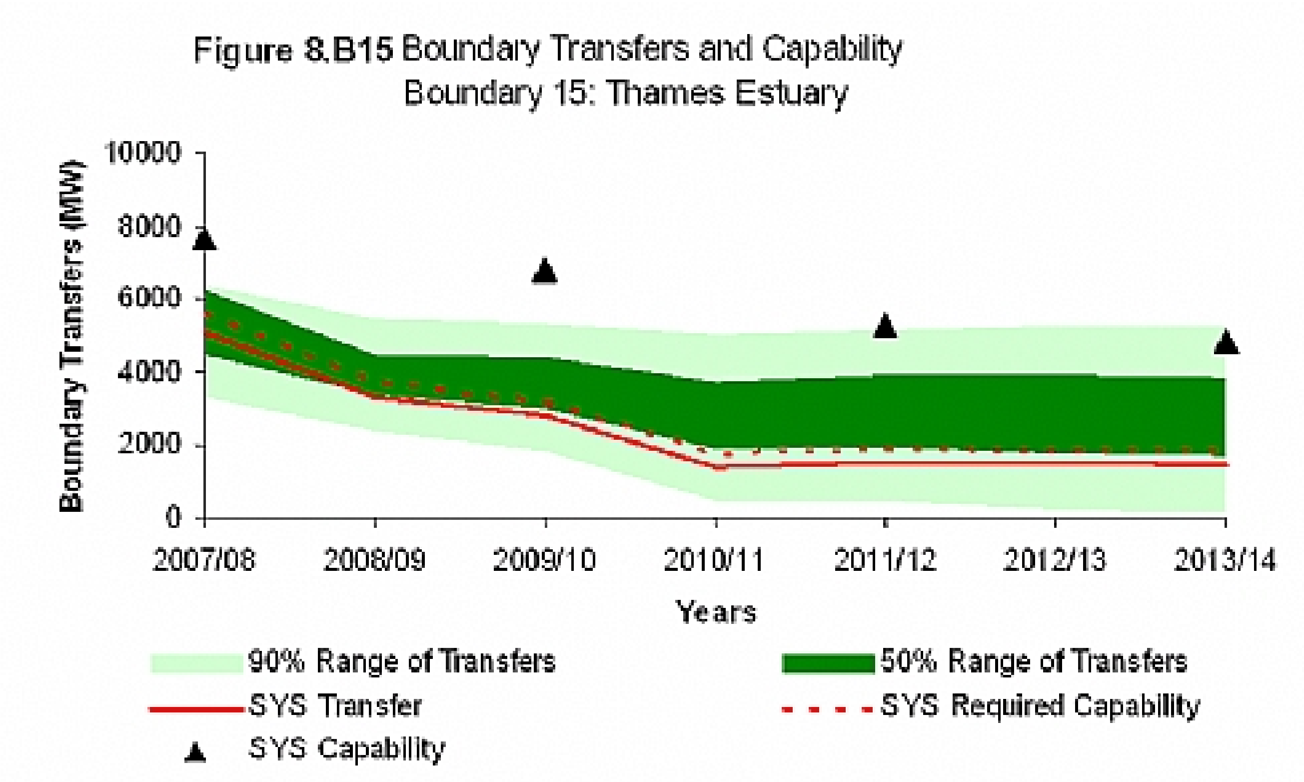

Figure 8.T15

Click to load a larger version of Figure8.T15 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B15E	THAMES ESTUARY (EXPORT)							
	Effective Generation	7079	5321	4865	3473	3642	3640	3620
	Demand	1959	1993	2031	2075	2103	2104	2113
	Planned Transfer	5120	3328	2834	1398	1539	1536	1507
B15I	THAMES ESTUARY (IMPORT)							
	Effective Generation	54437	57541	59054	61557	62172	63125	63867
	Demand	59558	60869	61896	62946	63707	64653	65368
	Planned Transfer	-5121	-3328	-2842	-1389	-1535	-1528	-1501

The SYS Planned Transfer lies at the bottom of the probabilistic transfer throughout the entire period. The SYS transfer appears to decrease steadily to a low level from 2010/11. This is due to changes in interconnector flows ranging from importing from the continent to exporting. If the interconnectors were to import from the continent the SYS transfer would be greatly increased, possibly exceeding the boundary capability, thus requiring reinforcements

Boundary 16: NGET North East, Trent & Yorkshire

Figure 8.B16

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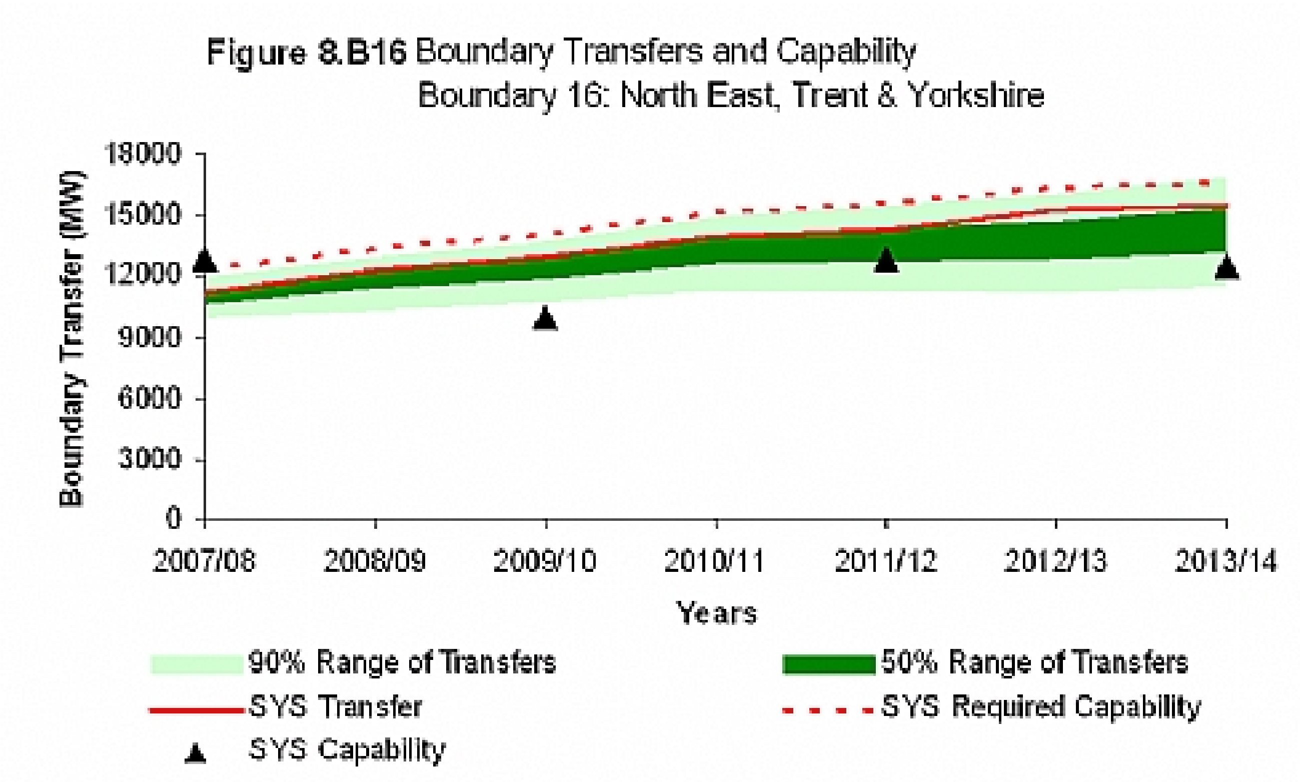

Figure 8.T16

Click to load a larger version of Figure8.T16 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B16E	NORTH EAST, TRENT & YORKSHIRE (EXPORT)							
	Effective Generation	27148	28466	29268	30584	31096	32266	32667
	Demand	16029	16216	16446	16628	16803	17055	17296
	Planned Transfer	11119	12250	12842	13956	14293	15211	15371
B16I	NORTH EAST, TRENT & YORKSHIRE (IMPORT)							
	Effective Generation	34368	34396	34631	34446	34718	34499	34820
	Demand	45488	46646	47481	48393	49007	49702	50185
	Planned Transfer	-11120	-12250	-12850	-13947	-14289	-15203	-15365

New generation openings and a steady demand increase characterise this boundary. The boundary shows insufficient transmission capability from 2007/2008 onwards. Compliance can be restored using the proposed reinforcements for boundary 6.

The probabilistic range and SYS transfer for this boundary increase over the SYS period. The SYS capability for this boundary gradually reduces until 2009/10, when reinforcements occur. There is a significant likelihood that some further reinforcements additional to those outlined above will be required late in the period to facilitate higher flows.

Boundary 17: NGET West Midlands

Figure 8.B17

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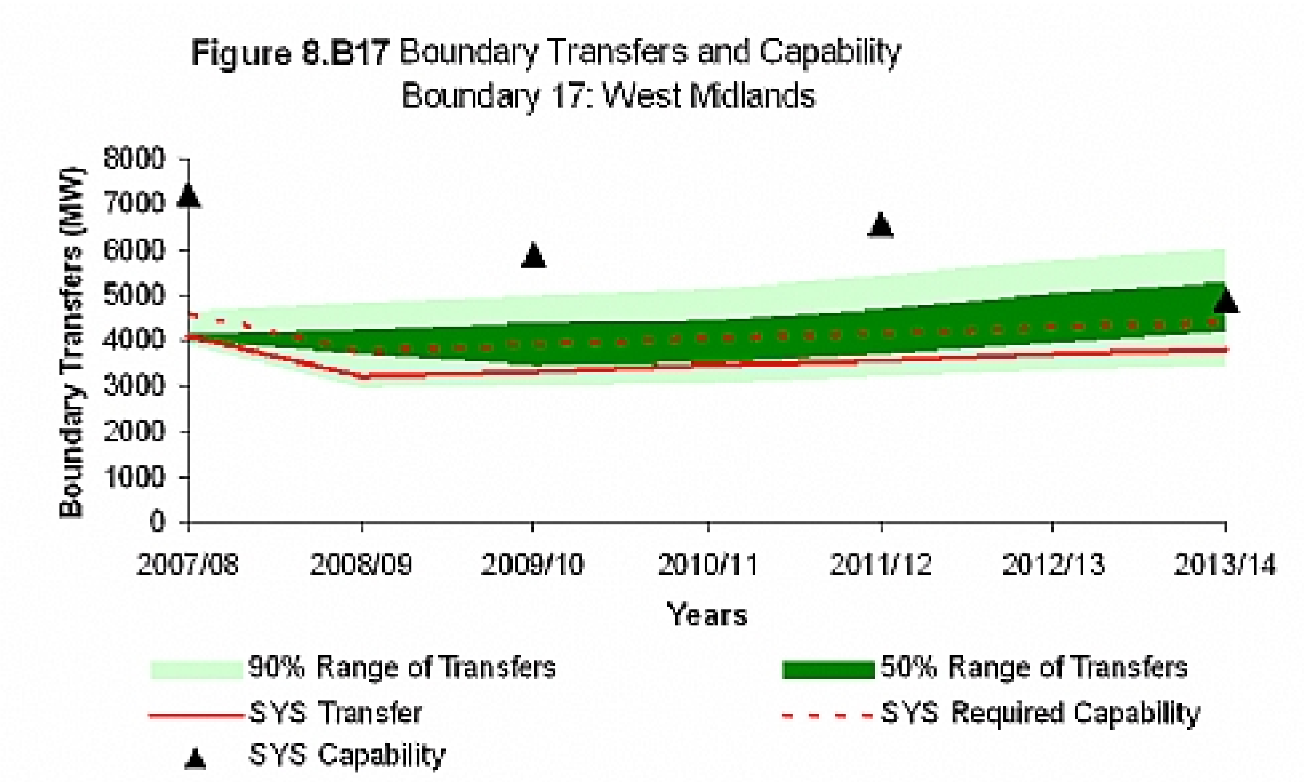

Figure 8.T17

Click to load a larger version of Figure8.T17 image

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

	BOUNDARY	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
B17E	**WEST MIDLANDS (EXPORT)**							
	Effective Generation	3457	4458	4427	4382	4367	4365	4348
	Demand	7541	7650	7747	7850	7943	8060	8158
	Planned Transfer	-4084	-3192	-3320	-3468	-3576	-3695	-3810
B17I	**WEST MIDLANDS (IMPORT)**							
	Effective Generation	58059	58404	59492	60648	61447	62400	63139
	Demand	53976	55212	56180	57171	57867	58697	59323
	Planned Transfer	4083	3192	3312	3477	3580	3703	3816

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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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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Table 8.2 - Indicative Developments for Licence Compliance

Location/Circuit	Works	Affected Boundaries/Licensee
Denny-Strathaven	Establish a 400kV link between Denny and Wishaw and the Strathaven - Torness 400kV circuit	SPT North - South
Strathaven	Reconfigure 400kV substation. Establish second 1000MVA 400/275kV transformer.	SPT-NGET
Strathaven-Harker / Eccles-Stella West	Install reactive shunt compensation equipment at several locations.	SPT-NGET
Strathaven-Harker / Eccles-Stella West	Install reactive series compensation in the interconnector circuits	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.	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 400kB substations at Rainhill, Fiddlers Ferry and Frodsham	NGET
Iver	Replace the two interbus transformers at Ivers with higher rates units	NGET
Blyth to Hawthorne Pit	Uprate the 275kV circuits between Blyth and Hawthorne Pit to 400kV operation	NGET
Hawthorne Pit to Norton	Uprate the 275kV circuit between Hawthorne Pit to Norton to 400kV operation	NGET
Tilbury-West Thurrock	Reconductor the Tilbury to West Thurrock circuits with higher rating	NGET
Elstree	Install a new Quad Booster at Elstree	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 (1 MSC)	NGET
Padiham	Install reactive compensation (1 MSC)	NGET
Stoke Bardolph	Install reactive compensation (1 MSC)	NGET
Bramley	Install reactive compensation (2 MSCs)	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 78.4GW in 2007/08 to 101.9GW by 2013/14. The largest change is due to a 12.9GW increase in CCGT plant capacity, which constitutes a 16.5% increase in overall capacity over the period. On this basis, the capacity of CCGT plant will overtake that of coal by 2008/09. By 2013/14, CCGT capacity will exceed coal capacity by 9.5GW and account for 37.8% 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 8.7% increase and offshore wind accounting for a 3.2% increase in overall capacity. Wind generation capacity (both onshore and offshore) is set to rise to 11GW by 2013/14.

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 23.6GW 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 23.6GW 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 reinforcements, including the proposed Beauly/Denny transmission reinforcement. The Beauly/Denny reinforcement is included as part of the SYS background for commissioning by 2011/12. However, elements of this reinforcement are currently the subject of a Public Inquiry and, consequently, the final commissioning date may vary, which would impact on the study results presented in GB Transmission System Performance and GB Transmission System Capability 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. By 2007/08 these boundaries will be 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. As a result there is unlikely to 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.

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

Click to load a larger version of Figure9.1 image

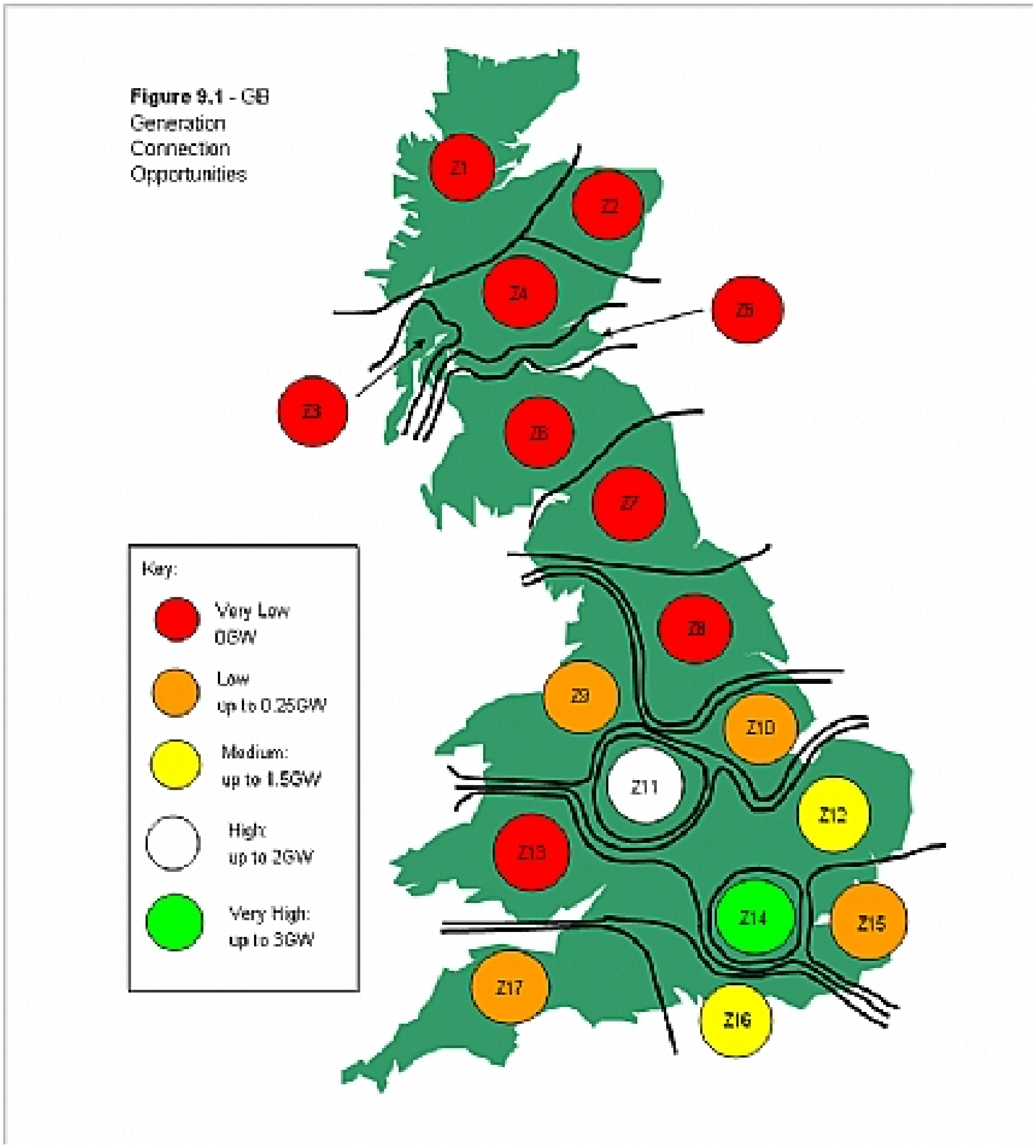

Figure 9.1 - GB Generation Connection Opportunities

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.

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 relative effectiveness of locating generation in each of the 17 SYS Study Zones. The ranking order displayed in Table 7.5 broadly follows the ranking of generation opportunities of the previous section and the ranking order of generation TNUoS charges.

For comparison, Schedule 1 of our 2007/08 '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 2005/06 to 2011/12 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 2007/08 to 2013/14 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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z1	NORTH WEST (SHETL)							
	Effective Generation	920	1029	1074	1063	1406	1666	2021
	Demand	516	534	544	547	554	574	601
	Planned Transfer	404	495	530	516	852	1092	1420

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z2	NORTH (SHETL)							
	Effective Generation	1304	1300	1291	1278	1387	1430	1425
	Demand	510	527	536	541	539	556	570
	Planned Transfer	794	773	755	737	848	874	855

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z3	SLOY							
	Effective Generation	273	336	333	330	329	396	395
	Demand	74	79	79	81	82	85	86
	Planned Transfer	199	257	254	249	247	311	309

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z4	SOUTH (SHETL)							
	Effective Generation	393	417	414	536	534	659	697
	Demand	539	535	539	547	544	557	574
	Planned Transfer	-146	-118	-125	-11	-10	102	123

Zone 4 encompasses the southern part of the SHETL system outside of 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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z5	NORTH (SPT)							
	Effective Generation	2406	2440	2443	2418	2409	2408	2400
	Demand	1260	1273	1286	1299	1315	1332	1350
	Planned Transfer	1146	1167	1157	1119	1094	1076	1050

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z6	SOUTH (SPT)							
	Effective Generation	3531	3839	4755	5481	5461	5459	5555
	Demand	3276	3329	3375	3411	3461	3516	3568
	Planned Transfer	255	510	1380	2070	2000	1943	1989

Zone 6 includes a significant capacity of generating plant and the HVDC interconnection to Northern Ireland. The zone has a surplus of generation over demand and provides a path for exports from Scotland to England.

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

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z7	**NORTH & NE ENGLAND**							
	Effective Generation	2869	2860	2841	2812	2802	2801	2790
	Demand	3163	3153	3217	3263	3316	3369	3424
	Planned Transfer	-294	-293	-376	-451	-514	-568	-634

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z8	**YORKSHIRE**							
	Effective Generation	11120	11577	11500	11382	10803	10799	10761
	Demand	6096	6157	6216	6275	6319	6375	6424
	Planned Transfer	5024	5420	5284	5107	4484	4424	4337

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 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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z9	NW ENGLAND & N WALES							
	Effective Generation	8204	8332	8388	7914	7742	7808	7996
	Demand	7436	7727	7927	8092	8123	8300	8351
	Planned Transfer	768	605	461	-178	-381	-492	-355

This zone is enclosed by the North East & Yorkshire boundary among others towards the East and the North to Midlands boundary in the South. 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.

The probabilistic analyses in the previous chapter showed a high probability of actual peak flows in excess of the capability of the North to Midlands boundary. 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 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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z10	TRENT							
	Effective Generation	4332	4668	4637	5284	5965	6648	6623
	Demand	595	629	654	664	673	691	701
	Planned Transfer	3737	4039	3983	4620	5292	5957	5922

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z11	MIDLANDS							
	Effective Generation	3457	4458	4427	4382	4367	4365	4348
	Demand	7541	7650	7747	7850	7943	8060	8158
	Planned Transfer	-4084	-3192	-3320	-3468	-3576	-3695	-3810

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. Overall opportunities remain for the connection of generation within the zone, particularly medium sized developments within the 275kV system. Further opportunities for new generation would arise given any closures of existing generation.

New generation projects are contracted for Zone 11 in the 2007 SYS background. As the demand in this area exceeds generation by over 3GW, there is still a 'high' opportunity for new generation as detailed above. Despite this, large-scale generation projects connecting to the 275kV network would require reinforcement.

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z12	ANGLIA & BUCKS							
	Effective Generation	3484	3917	3891	4761	4469	4849	4833
	Demand	5960	6101	6203	6342	6413	6500	6557
	Planned Transfer	-2476	-2184	-2312	-1581	-1944	-1651	-1724

This zone is enclosed by the Midlands to South, South and South West, London and Thames Estuary boundaries. The zone has a significant deficit of generation and strongly contributes to transport of power from North towards the South. 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 'Medium'.

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z13	**S WALES & CENTRAL ENGLAND**							
	Effective Generation	7360	7934	8404	8985	9586	9242	9445
	Demand	5715	5831	5911	5992	6105	6177	6257
	Planned Transfer	1645	2103	2493	2993	3481	3065	3188

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z14	**LONDON**							
	Effective Generation	2564	1733	1722	1704	1698	1382	1377
	Demand	10150	10472	10666	10919	11071	11186	11240
	Planned Transfer	-7586	-8739	-8944	-9215	-9373	-9804	-9863

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z15	THAMES ESTUARY							
	Effective Generation	7079	5321	4865	3473	3642	3640	3620
	Demand	1959	1993	2031	2075	2103	2104	2113
	Planned Transfer	5120	3328	2834	1398	1539	1536	1507

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. Renewable generation is also planned to connect during the period.

Current opportunities for new generation are 'medium', but would drop to 'low' given that the above generation connects within this zone. It should be stressed that opportunities in the Estuary are very sensitive to precise location.

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z16	CENTRAL S COAST							
	Effective Generation	477	965	1208	1196	1191	1190	1186
	Demand	3863	3924	4006	4094	4179	4268	4360
	Planned Transfer	-3386	-2959	-2798	-2898	-2988	-3078	-3174

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	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Z17	SOUTH WEST ENGLAND							
	Effective Generation	1743	1736	1726	2031	2023	2023	2015
	Demand	2864	2948	2990	3029	3070	3107	3149
	Planned Transfer	-1121	-1212	-1264	-998	-1047	-1084	-1134

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. In the SYS 2007 background, new generation is due to connect in 2007/08 and 2010/11. As the local demand exceeds local generation by around 1GW, the opportunity for generation development can be regarded as 'medium' to 'low', given the fact that Z17 is connected to the adjacent zones by 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 £2.05/Mvarh and £2.82/Mvarh during 2006/07.

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 2006 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.

nationalgrid

GB Seven Year Statement 2007

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Table 9.1 - Transmision Network Generation Use of System Charges - 2007/08

Generation Zone	Zone Name	GB Zonal Tariff (£/kW)
1	North Scotland	21.590831
2	Peterhead	19.233718
3	Western Highland & Skye	19.858255
4	Central Highlands	16.436431
5	Argyll	14.677167
6	Stirlingshire	14.031535
7	South Scotland	13.017061
8	Auchencrosh	10.137439
9	Humber, Lancashire & SW Scotland	5.88307
10	North East England	9.253848
11	Anglesey	6.409118
12	Dinorwig	9.281586
13	South Yorks & North Wales	3.996719
14	Midlands	1.97364
15	South Wales & Gloucester	-2.457186
16	Central London	-5.714694

17	South East	0.908414
18	Oxon & South Coast	-0.26523
19	Wessex	-4.098569
20	Peninsula	-8.568052
	Small Generators Discount	4.481939

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Table 9.2 - Transmission Network Demand Use of System Charges - 2007/08

Demand Zone	Zone Name	HH Zonal Tariff (£/kW)	NHH Zonal Tariff (p/kWh)
1	Northern Scotland	1.445659	0.183742
2	Southern Scotland	6.362303	0.830136
3	Northern	9.884146	1.287148
4	North West	13.646168	1.73489
5	Yorkshire	13.61527	1.750626
6	N Wales & Mersey	14.084355	1.805802
7	East Midlands	16.370802	2.129626
8	Midlands	17.807318	2.301762
9	Eastern	17.060375	2.240442
10	South Wales	21.537451	2.713949
11	South East	20.076054	2.58619
12	London	22.164365	2.710106
13	Southern	21.100281	2.738161
14	South Western	23.77056	3.000403
	Small Generators Adjustment	0.055127	0.00709

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Table 9.3 - Reactive Utilisation (metered output) April 1995 to September 2006 (TVArh)

StartDate	EndDate	Scotland Lead	Scotland Lag	NORTH LEAD	NORTH LAG	MIDLANDS LEAD	MIDLANDS LAG	SOUTH LEAD	SOUTH LAG	TOTAL LEAD	TOTAL LAG
01/04/2005	01/03/2006	2.38	1.19	4.17	7.84	1.59	2.95	3.95	2.51	12.09	14.49
01/04/2006		1.09	0.56	2.29	3	0.74	0.67	1.79	0.87	5.91	5.09
01/04/1995	01/03/1996			5.26	22.23	0.71	6.19	2.69	5.33	8.67	33.75
01/04/1996	01/03/1997			5.58	22.5	0.73	5.01	3.23	5.01	9.54	32.52
01/04/1997	01/03/1998			5.67	19.32	0.72	4.67	3.41	3.78	9.8	27.77
01/04/1998	01/03/1999			4.06	17.55	0.8	4.12	3.28	3.05	8.15	24.72
01/04/1999	01/03/2000			3.75	17.7	0.64	3.65	2.62	3.59	7	24.97
01/04/2000	01/03/2000			2.96	13.71	0.88	4.41	3.07	3.05	6.91	21.17
01/04/2001	01/03/2001			3.5	10.38	1.08	4.83	3.44	2.96	8.03	18.18
01/04/2002	01/03/2003			3.3	10.43	0.99	3.46	3.29	2.98	7.58	16.87
01/04/2003	01/03/2004			3.68	9.44	0.9	3.48	3.61	3.65	8.19	16.57
01/04/2004	01/03/2005			4.15	9.23	1.15	2.92	4.01	3.28	9.67	15.43

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.

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

Click to load a larger version of Figure 10.1 image

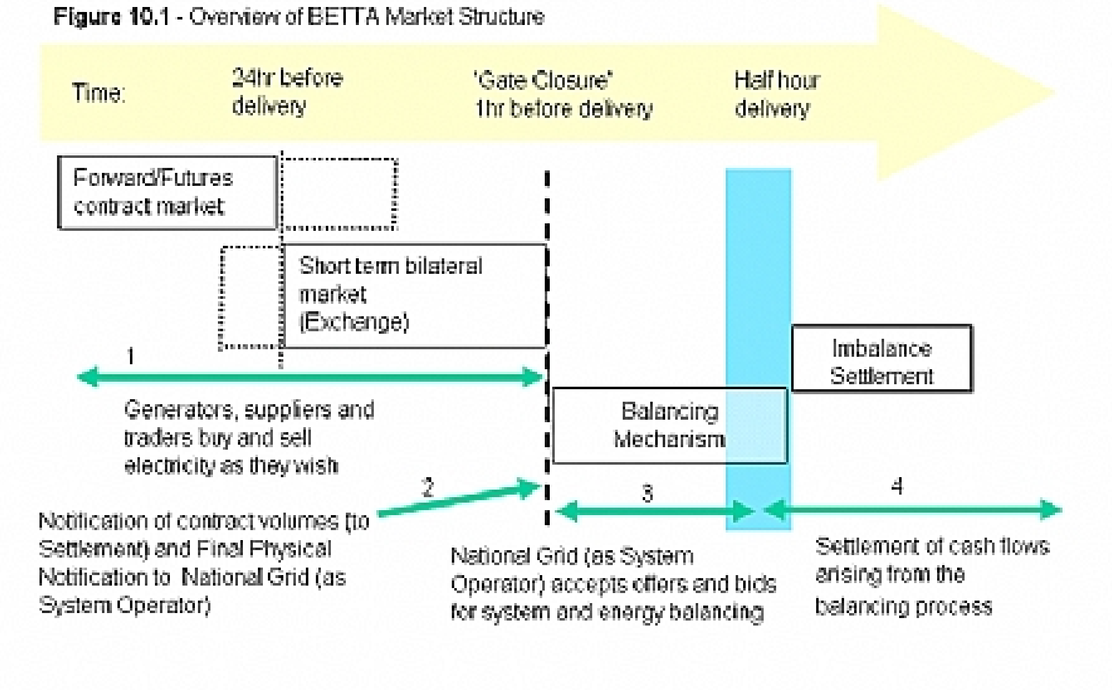


Figure 10.1 - Overview of BETTA Market Structure

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.

<u>Forwards and Futures Contract Market</u>

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.

<u>Short-term Bilateral Markets (Power Exchanges)</u>

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

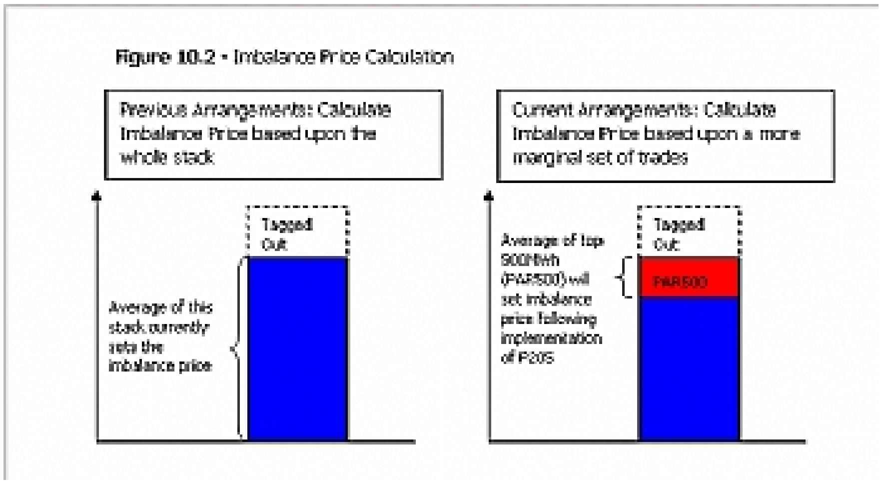
SBP was the price at which deficits were charged and, when the system was short, reflected the average price at which the system had to buy in order to make good the deficit on behalf of the party (i.e. the average of accepted offers). SSP was the price at which surpluses were charged and, when the system 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

Click to load a larger version of Figure 10.2 image

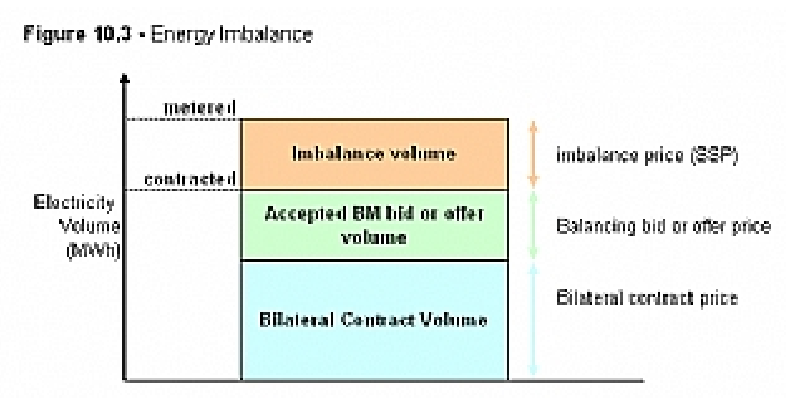


Under these revised arrangements the "reverse price" i.e. SBP when the system is long and SSP when the system is short, will continue to be based upon a forward market price derived from Power Exchange trades.

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



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 Owner 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