



GB Seven Year Statement 2009

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 Licence 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 Netherlands 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 25%, the full import capability is assumed. For margins of 45% or over, the full export capability is assumed. For margins between 25% and 45% a linear reduction in exports/increase in imports is assumed such that, at a margin of 35%, there are no imports or exports across the Cross Channel Link or the Netherlands Interconnector.

Throughout this methodology full export to Northern Ireland and Eire is assumed 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 attributed 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, 06/01/09), typical winter (Thursday, 04/12/08), typical summer (Thursday, 19/06/08) and summer minimum (Sunday, 20/07/08) respectively.

Figure 7.1(a)

[Click to load a larger version of Figure7.1\(a\) image](#)

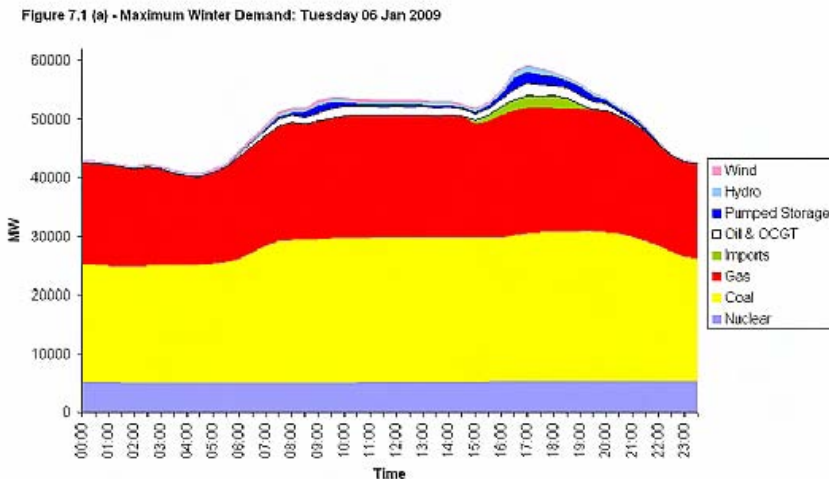


Figure 7.1(b)

[Click to load a larger version of Figure7.1\(b\) image](#)

Figure 7.1 (b) - Typical Winter Demand: Thursday 04 Dec 2008

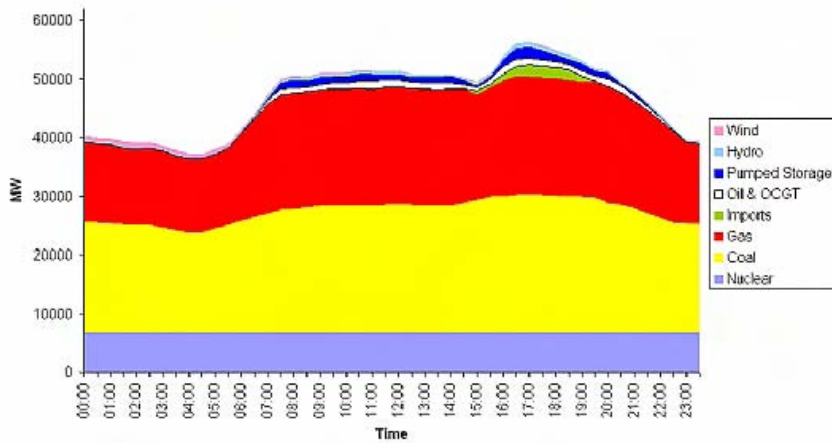


Figure 7.1(c)

[Click to load a larger version of Figure7.1\(c\) image](#)

Figure 7.1 (c) - Typical Summer Demand: Thursday 19 Jun 2008

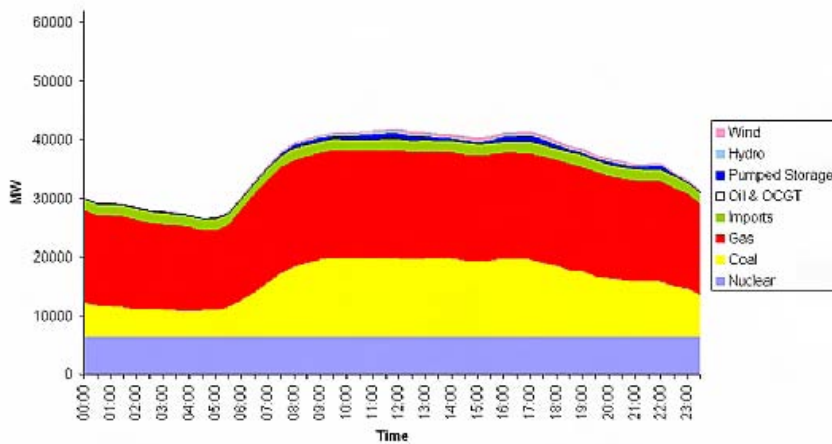
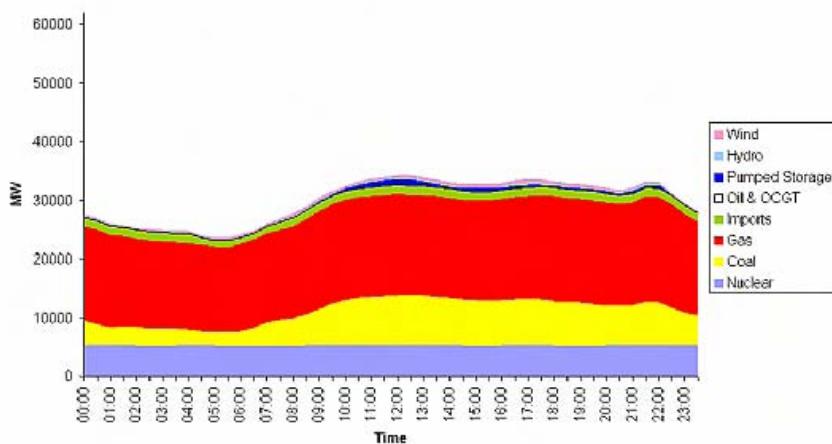


Figure 7.1(d)

[Click to load a larger version of Figure7.1\(d\) image](#)

Figure 7.1 (d) - Minimum Summer Demand: Sunday 20 Jul 2008



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 06 Jan 2009

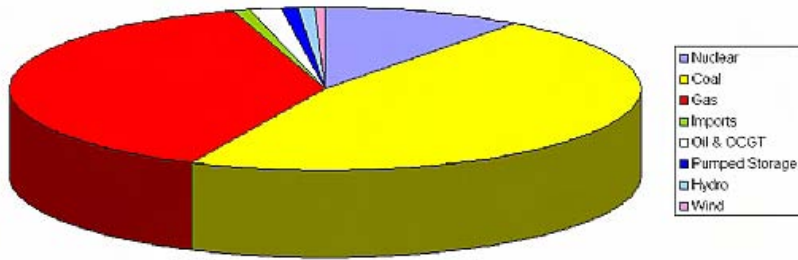


Figure 7.2(b)

[Click to load a larger version of Figure7.2\(b\) image](#)

Figure 7.2 (b) - Total Energy Supplied over Day of Typical Winter Demand: Thursday 04 Dec 2008

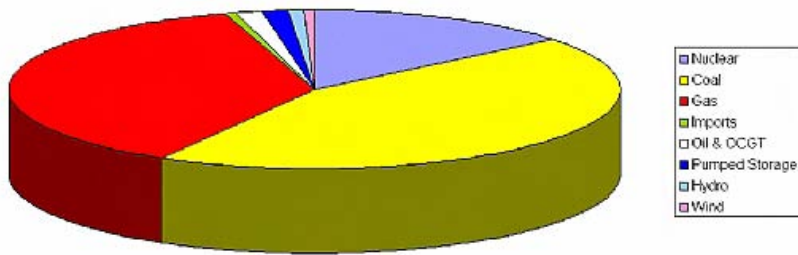


Figure 7.2(c)

[Click to load a larger version of Figure7.2\(c\) image](#)

Figure 7.2 (c) - Total Energy Supplied over Day of Typical Summer Demand: Thursday 19 Jun 2008

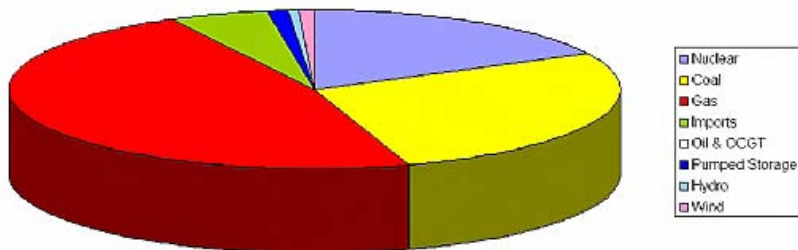
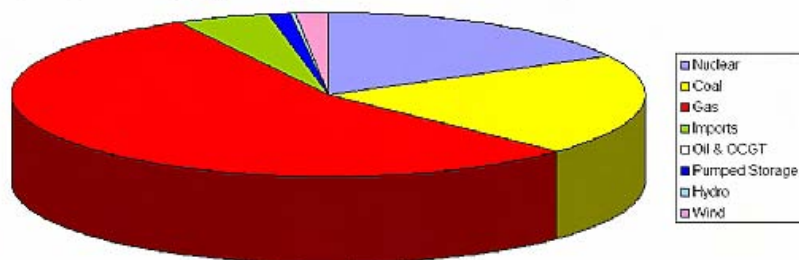


Figure 7.2(d)

[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 20 Jul 2008



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 2009/10 to 2015/16 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 2009/10 to 2015/16 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 2009/10 to 2015/16 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 26.2GW over the period 2009/10 to 2015/16 (**Table 3.5** refers). Amongst other things, **Generation Disposition** described the disposition of this future plant. In broad terms 4.9GW will be located in Scotland, 7.6GW in the north of England and 2.2GW in the midlands with the remaining 11.5GW 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. In general the '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 Thames Estuary boundary transfer appears relatively small, however this is due to much of the local generation supplying the continental export. In the case of continental import, the local generation and import combine to give a significant export out of the Thames estuary.

Figure 7.3 and **Figure 7.4** illustrate the broad power flow pattern for 2009/10 and 2015/16 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

[Click to load a larger version of Figure7.3 image](#)

Figure 7.3 - ACS Power Flow Pattern for 2009/10

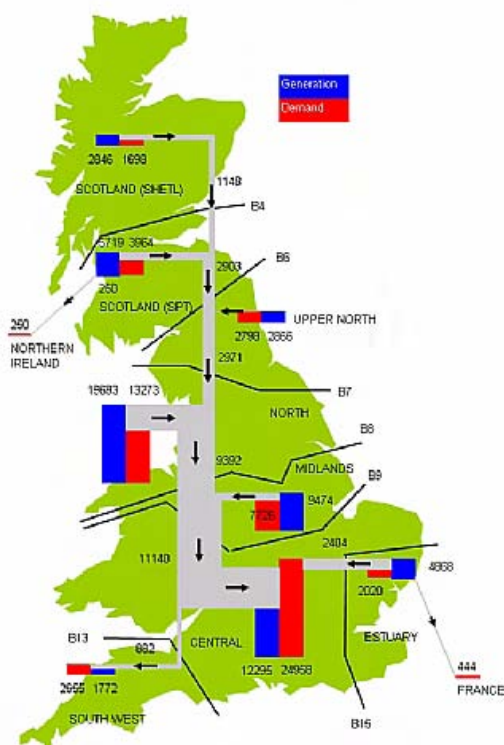
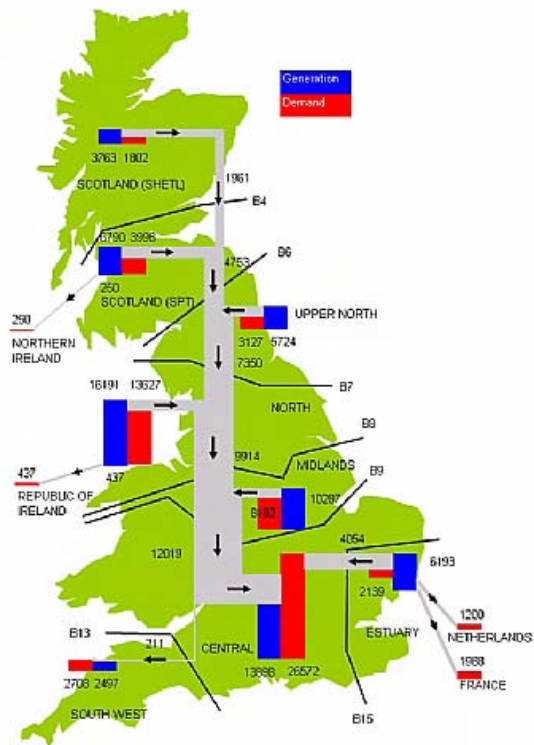


Figure 7. 4

[Click to load a larger version of Figure7. 4 image](#)

Figure 7.4 - ACS Power Flow Pattern for 2015/16



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 $\pm 1\text{GW}$ ($\pm 2\%$) 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](#)

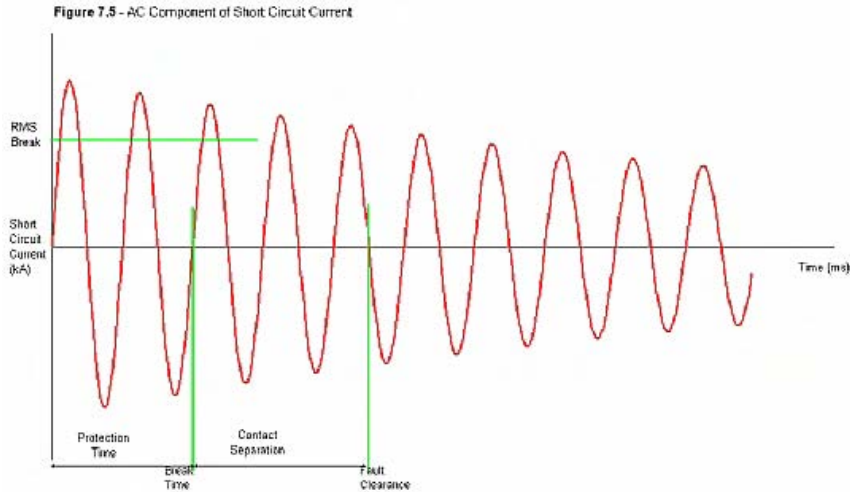
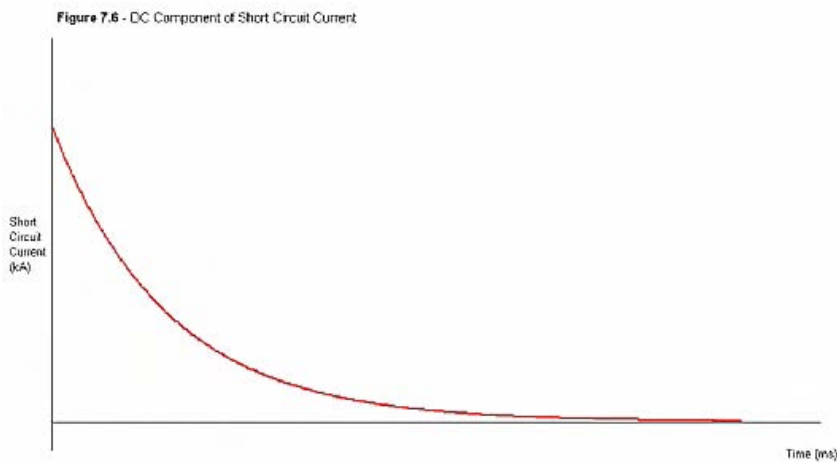


Figure 7.6

[Click to load a larger version of Figure7.6 image](#)



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.

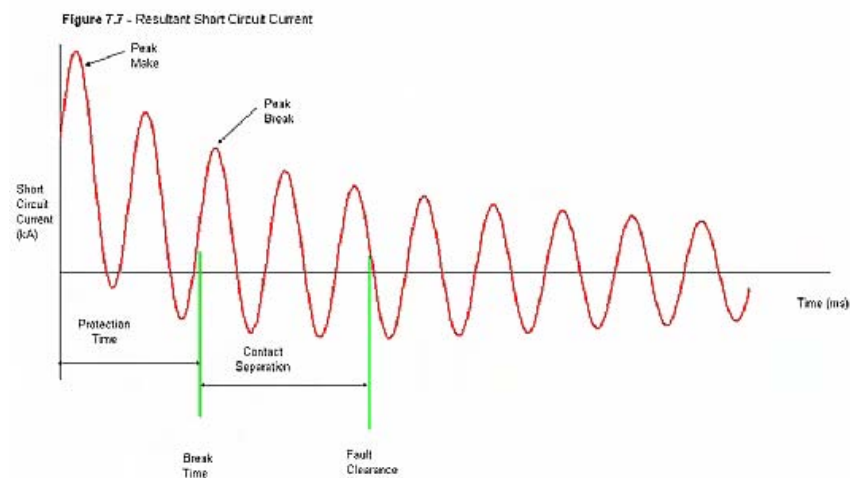
Circuit breakers associated with faulted circuits are required to interrupt fault current in order to safeguard system stability, prevent damage to plant and maintain security and quality of supply.

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 $((X_d'' + X_q'')/2)$). 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 subtransient 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 2009/10 to 2015/16 against the SYS background is given in [Table 7.4](#). The losses shown are those incurred on the system between the power station generating unit and the grid supply points and are made up of:

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

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

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

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

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

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

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

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

Relative to the system power losses reported in the 2008 GB SYS, there is a small decrease in total losses. This is also reflected in the corresponding decrease in transmission heating losses, which are the dominant component of system power losses. This reduction is due to the commissioning of new plant in the south, which 'backs off' the north to south flows.

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 2009/10 winter peak. The installation of new generation was represented by a 100MW reduction in demand spread across the nodes within the relevant zone. The computer program used in the analysis requires that the total generation matches total demand (including losses) and scales generation capacity accordingly. The studies were arranged such that the effective 100MW of new generation was compensated for by a slight reduction in the output of all other generation in the study. That is no plant was displaced from operating. This was repeated for each of the 17 zones and the change in losses, relative to a reference case where no 100MW of new generation was introduced, was calculated.

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

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

Table 7.5 shows that a small increase in generation in the zones north of zone 5 has an effectiveness of less than 90% 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 111% 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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Figure 7.1 (a) - Maximum Winter Demand: Tuesday 06 Jan 2009

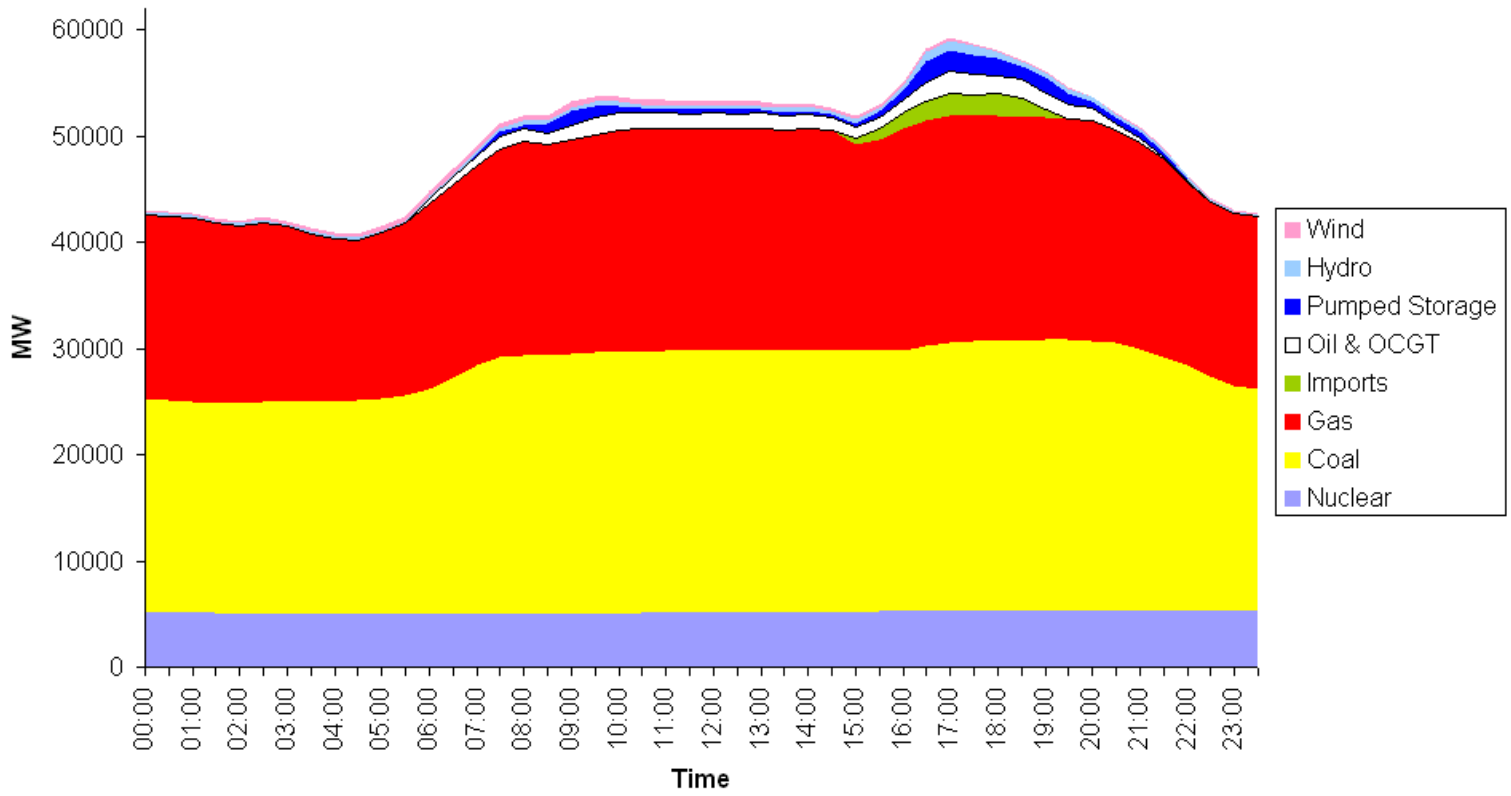


Figure 7.1 (b) - Typical Winter Demand: Thursday 04 Dec 2008

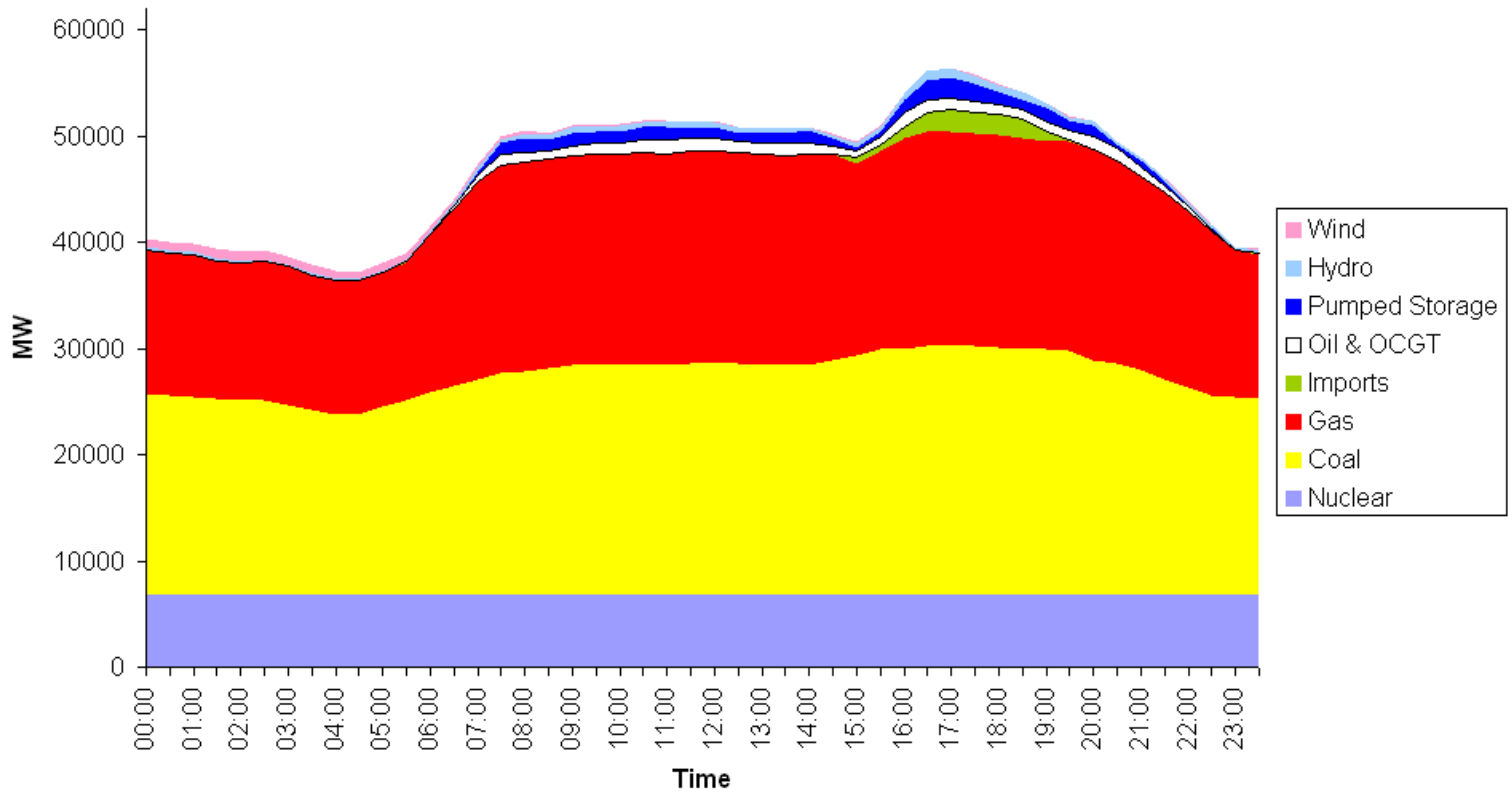


Figure 7.1 (c) - Typical Summer Demand: Thursday 19 Jun 2008

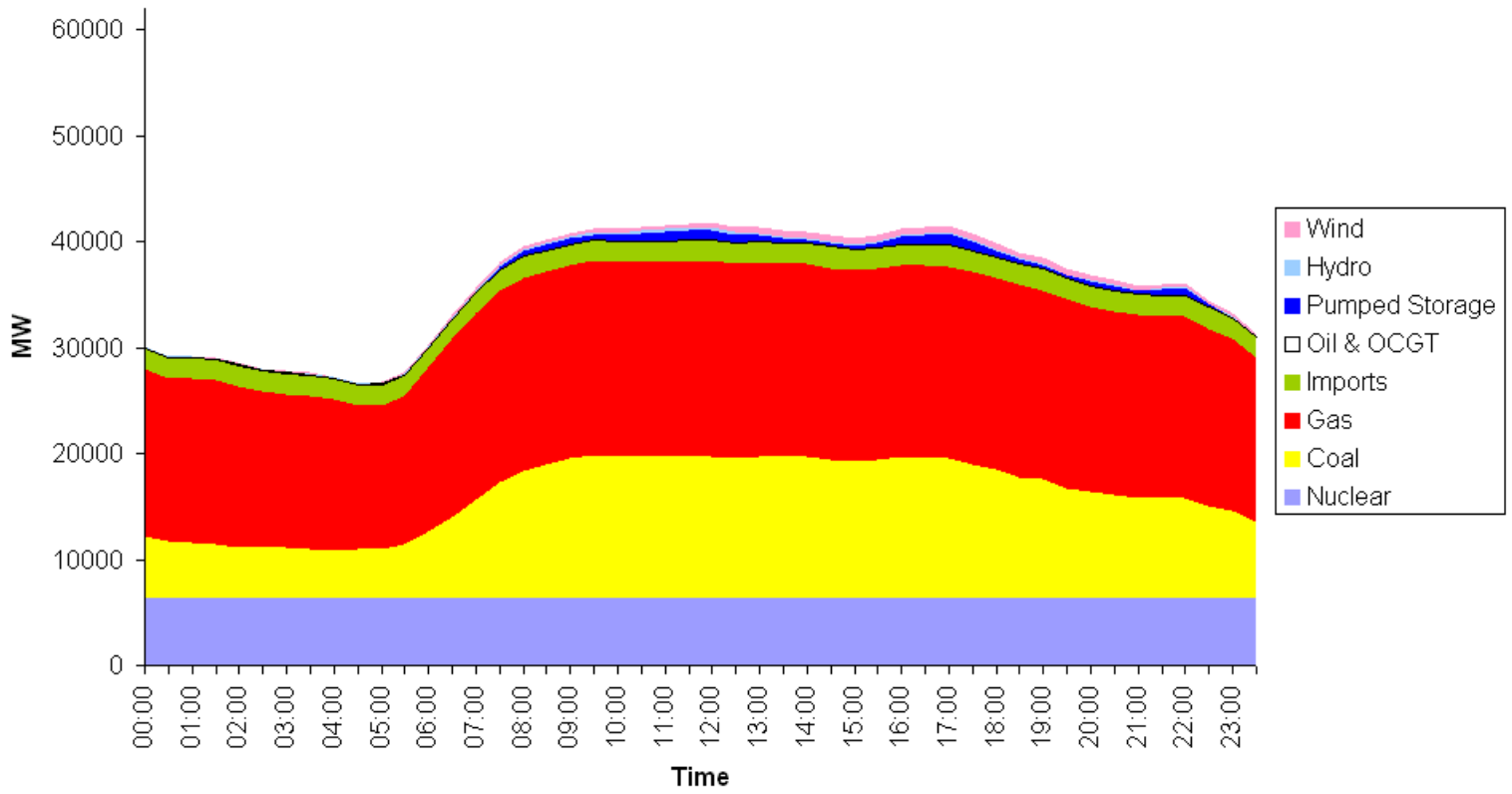


Figure 7.1 (d) - Minimum Summer Demand: Sunday 20 Jul 2008

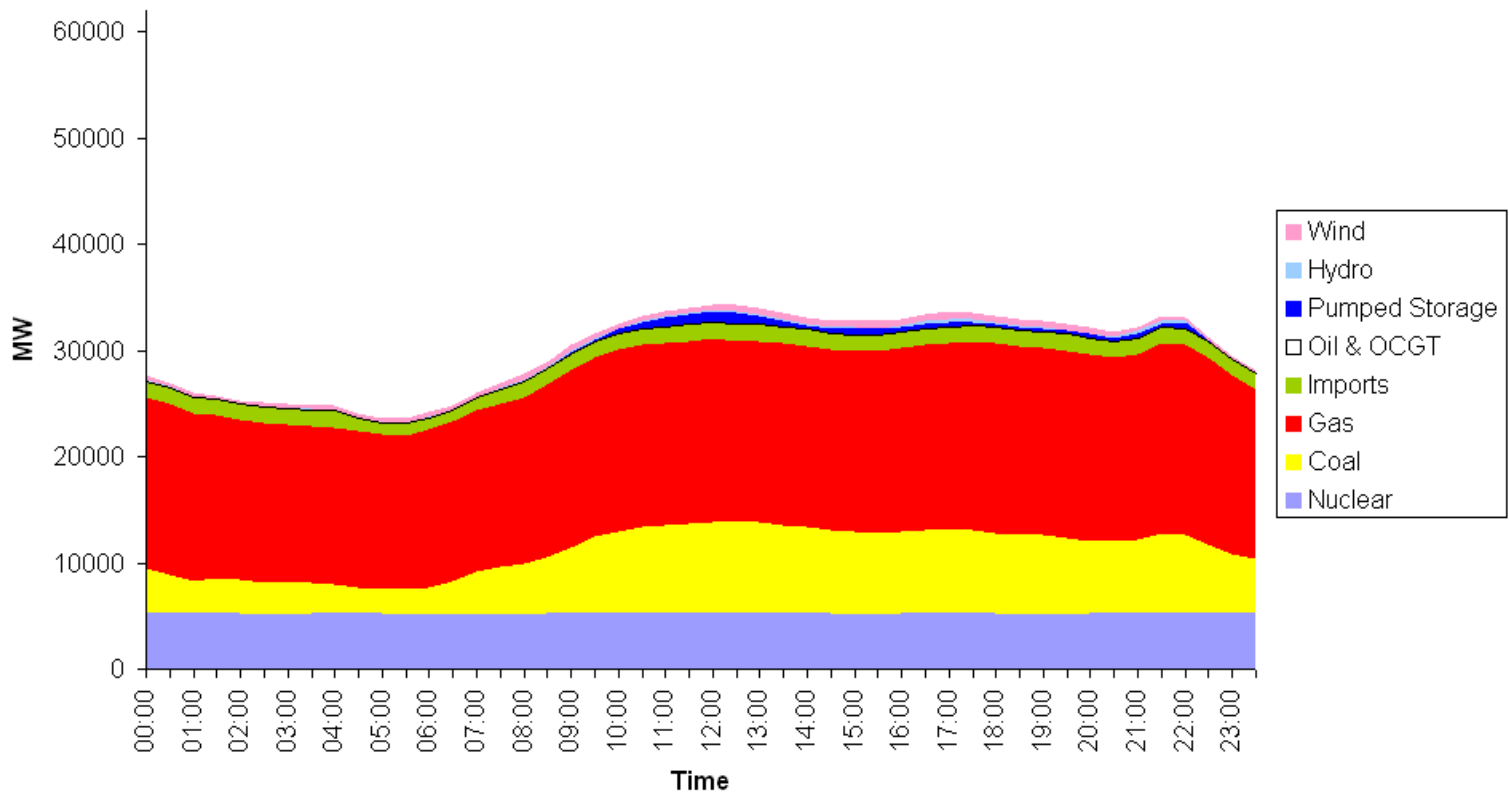


Figure 7.2 (a) - Total Energy Supplied over Day of Maximum Winter Demand: Tuesday 06 Jan 2009

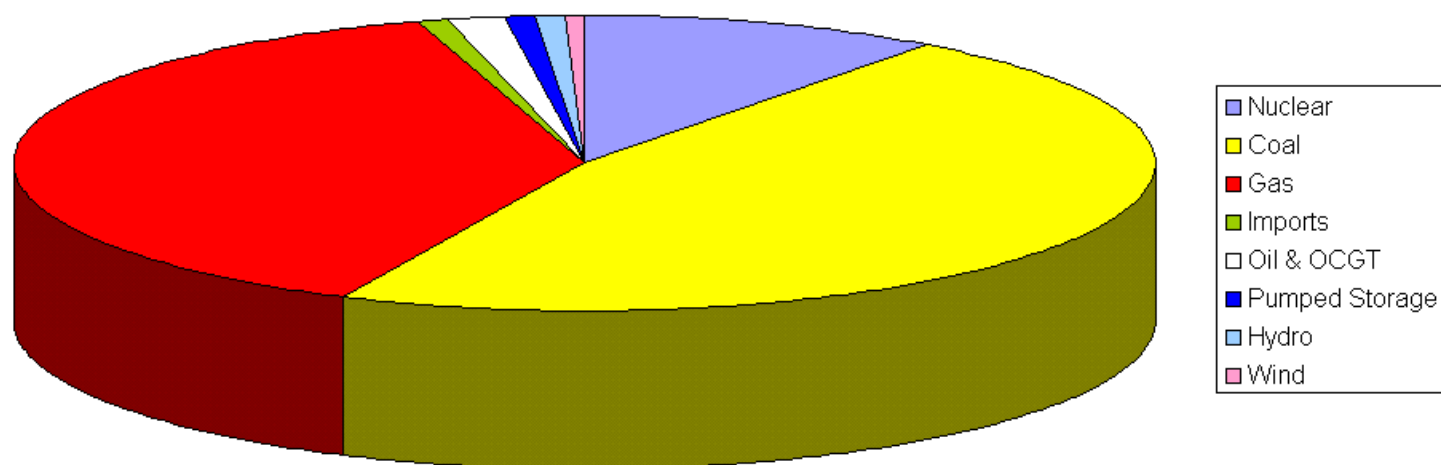


Figure 7.2 (b) - Total Energy Supplied over Day of Typical Winter Demand: Thursday 04 Dec 2008

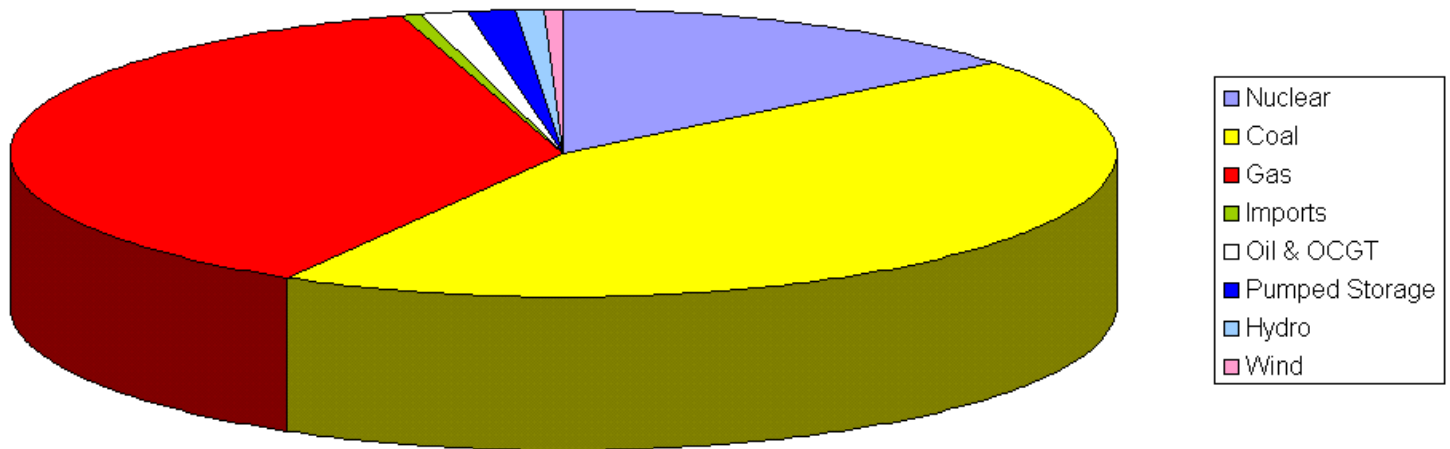


Figure 7.2 (c) - Total Energy Supplied over Day of Typical Summer Demand: Thursday 19 Jun 2008

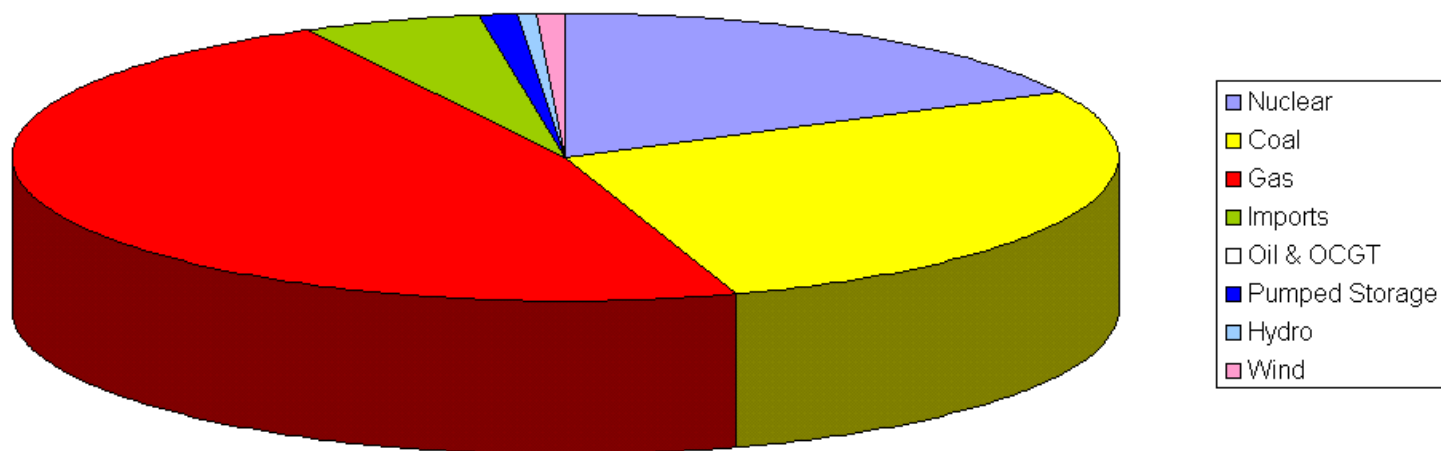


Figure 7.2 (d) - Total Energy Supplied over Day of Minimum Summer Demand: Sunday 20 Jul 2008

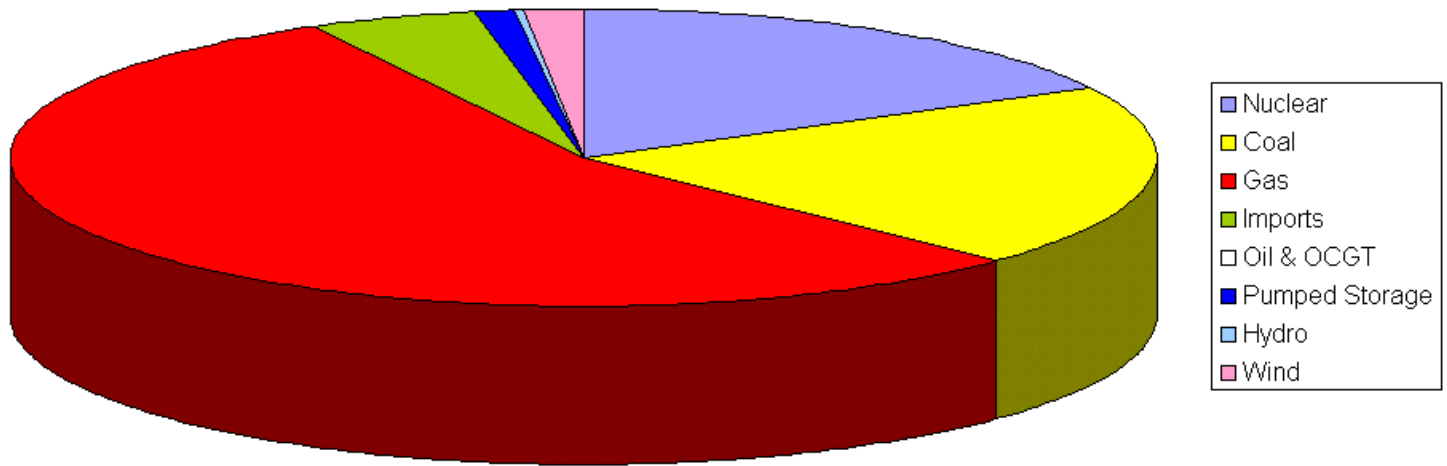


Figure 7.3 - ACS Power Flow Pattern for 2009/10

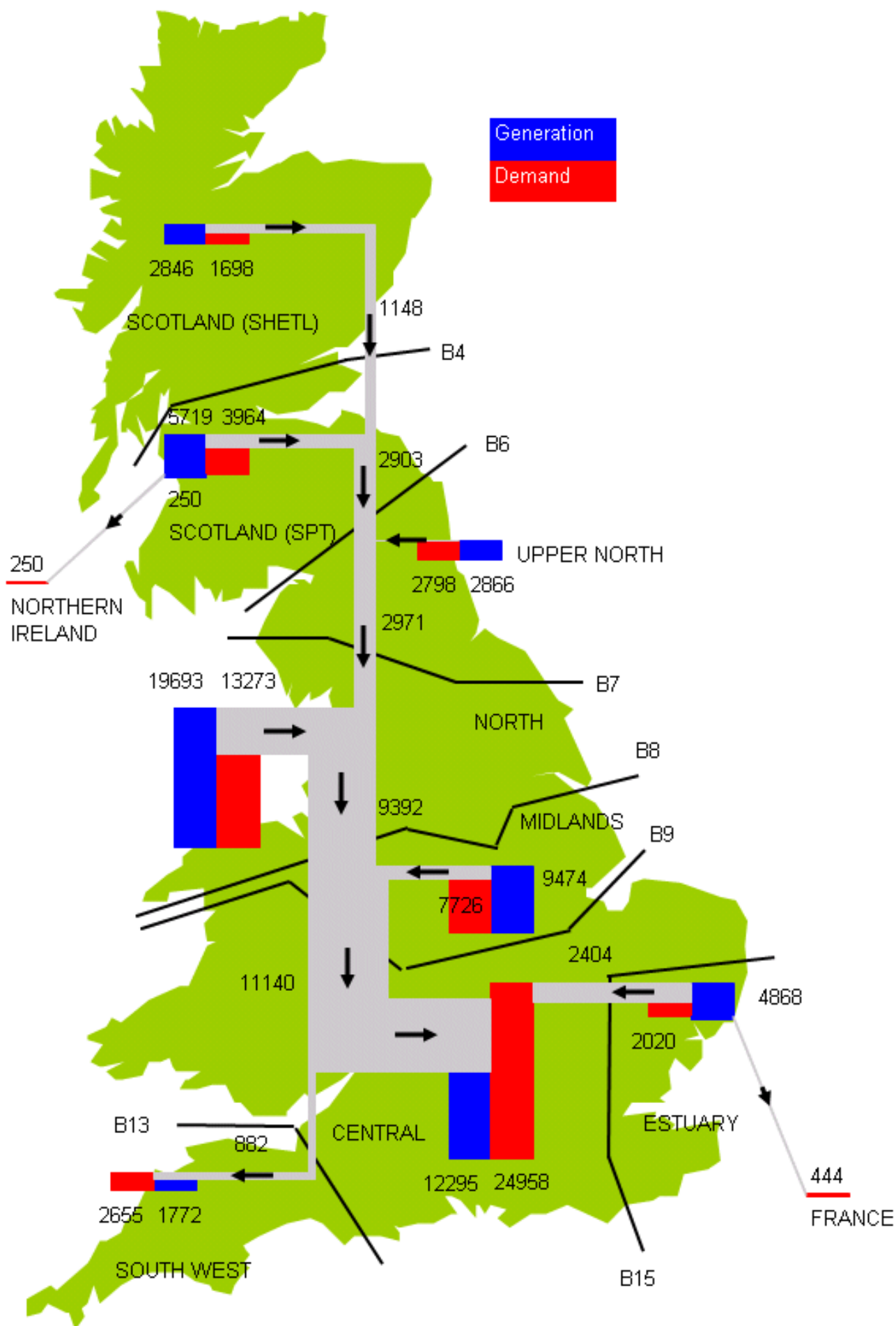


Figure 7.4 - ACS Power Flow Pattern for 2015/16

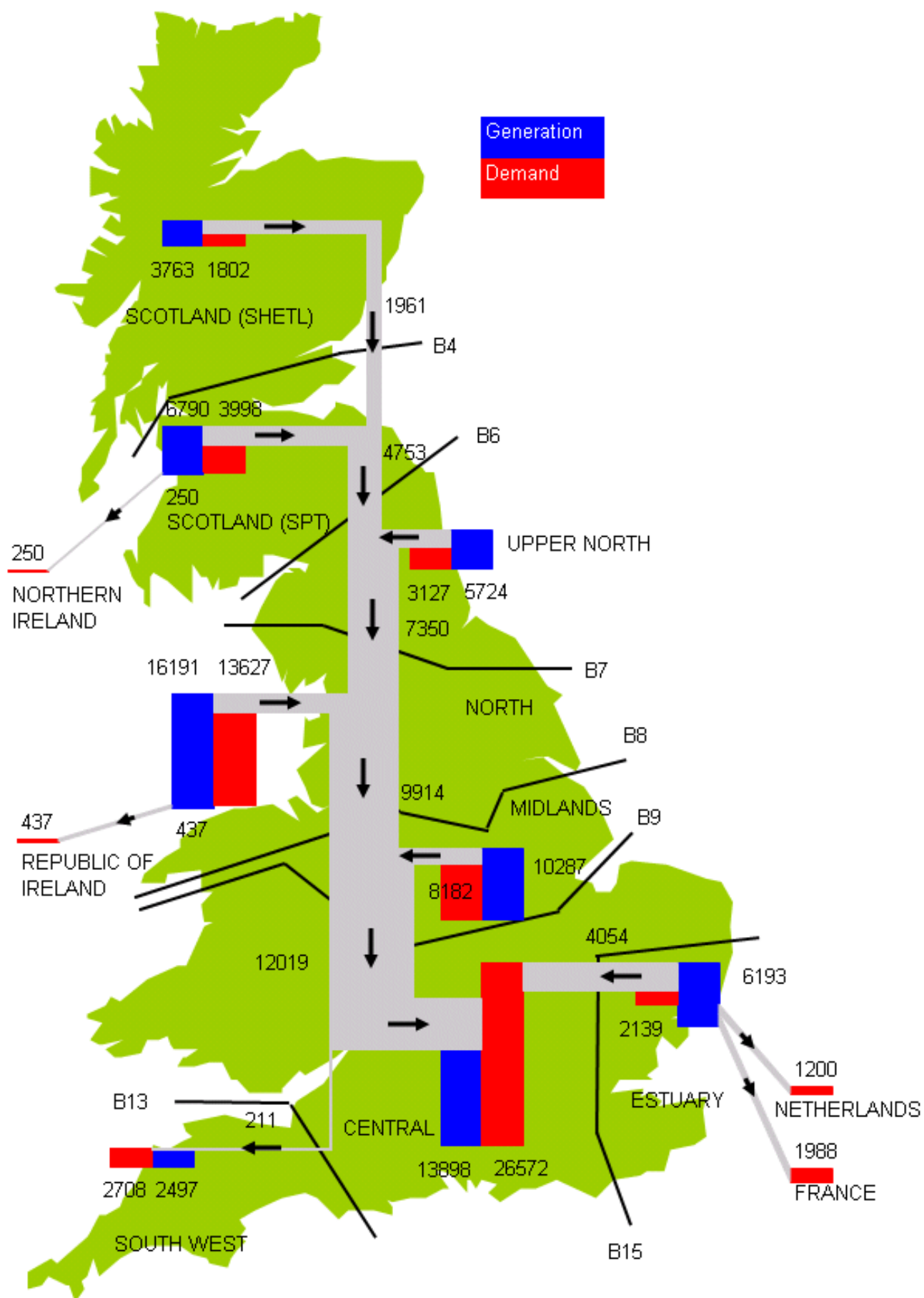


Figure 7.5 - AC Component of Short Circuit Current

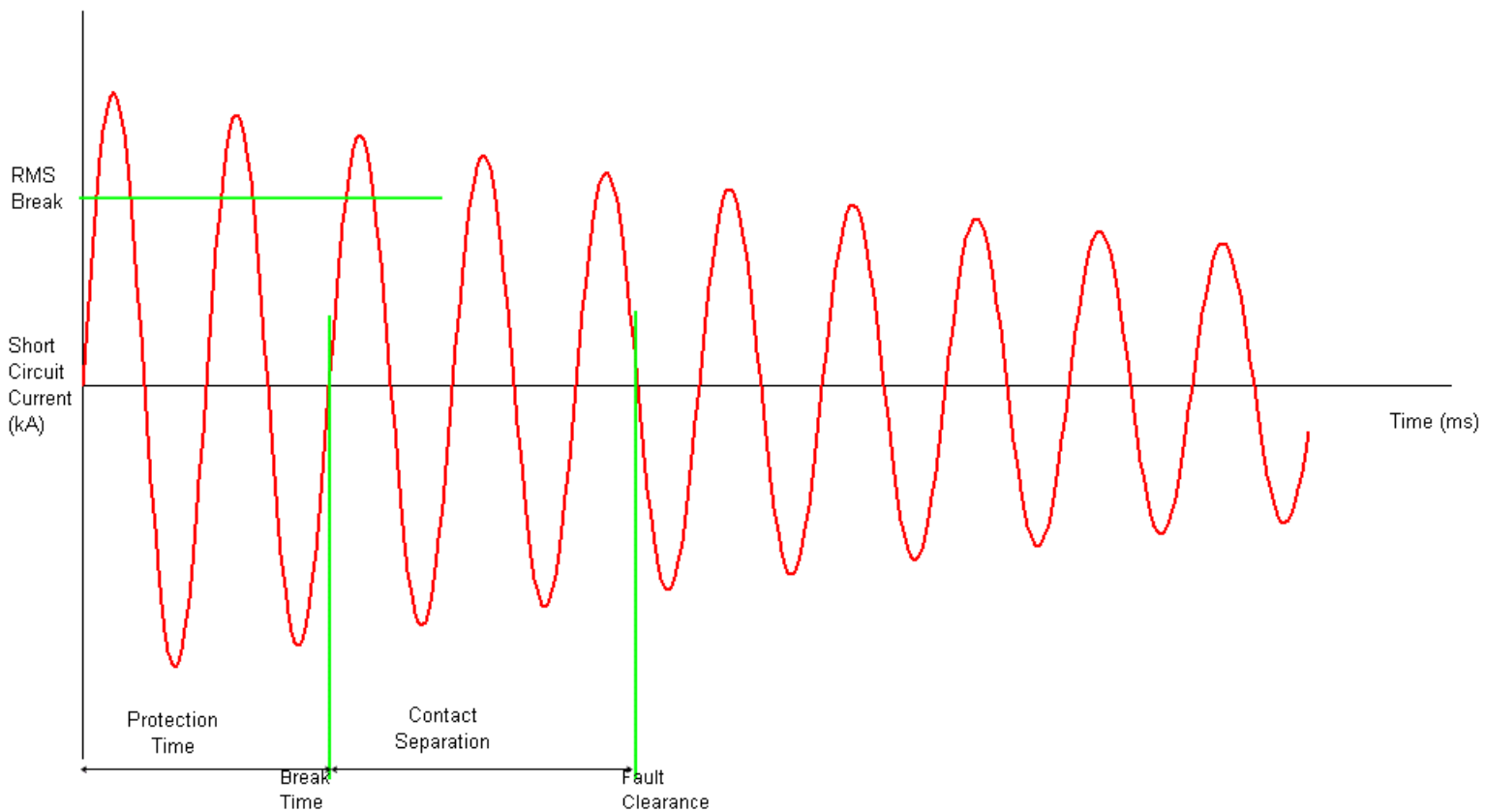


Figure 7.6 - DC Component of Short Circuit Current

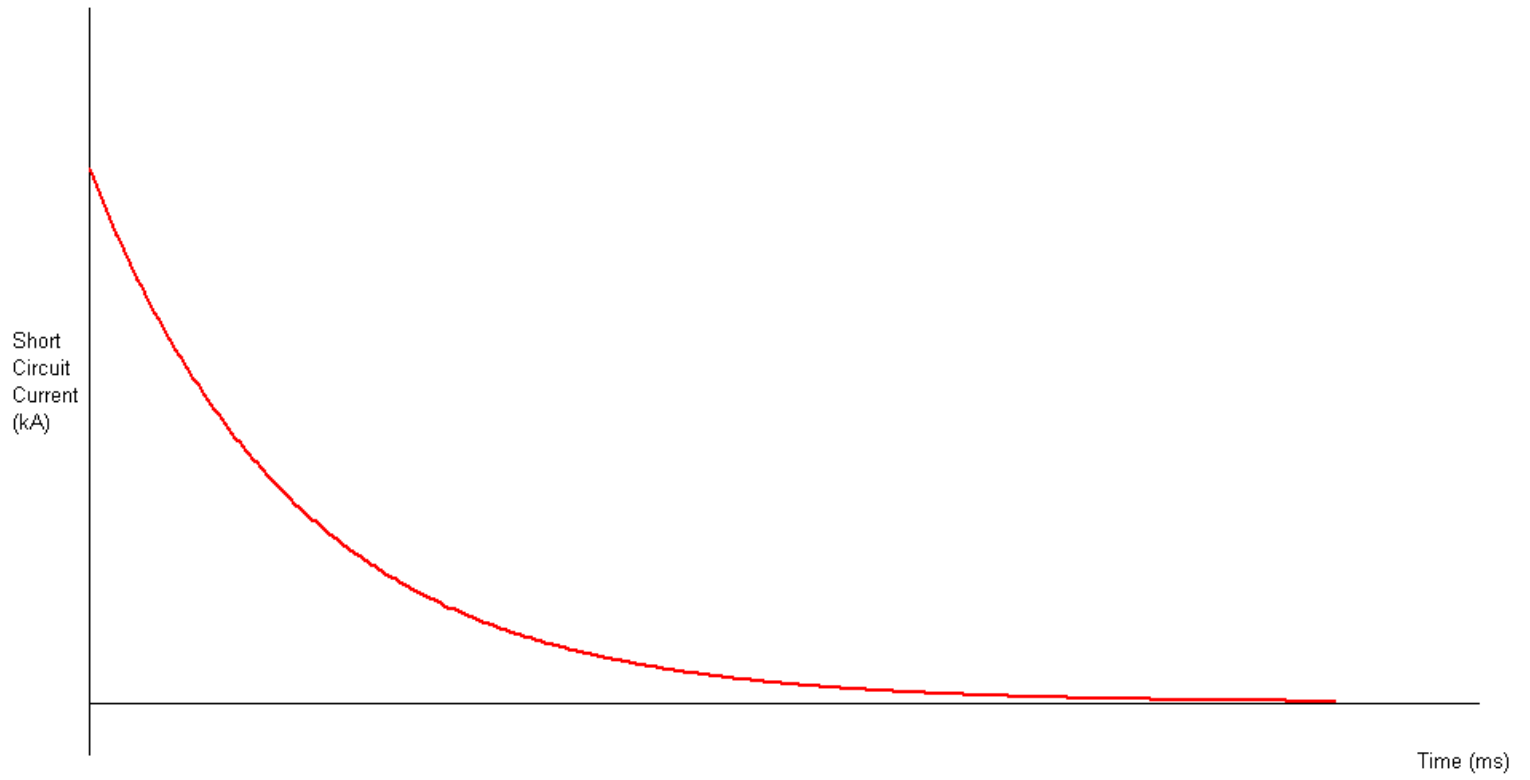


Figure 7.7 - Resultant Short Circuit Current

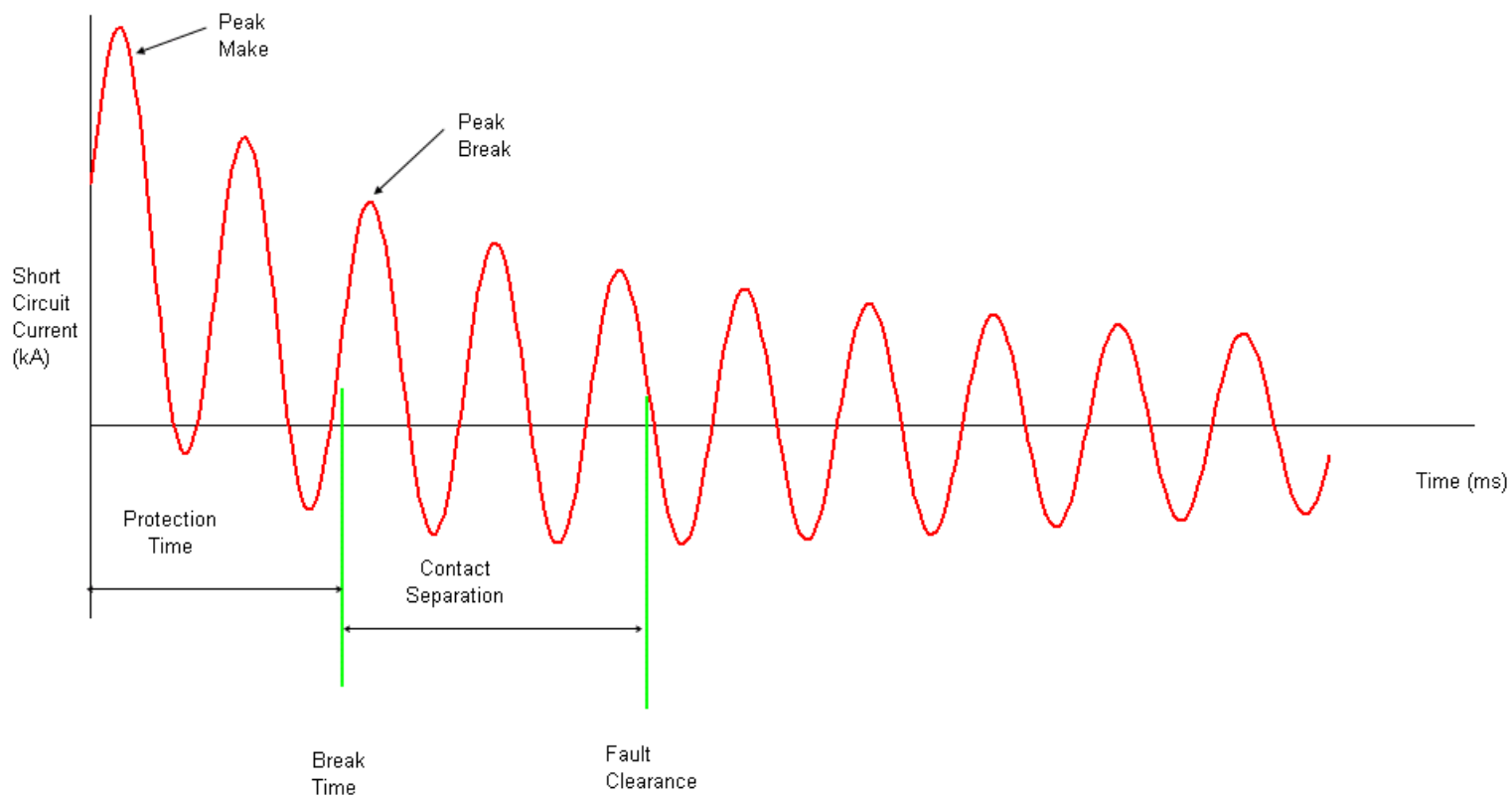


Table 7.1 - GB Generation Ranking Order

Rank	BM Unit ID	Station	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
1		IFA Bipole 1 Pole 1	-118	-497	-497	-497	-497	-497	-497
2		IFA Bipole 1 Pole 2	-118	-497	-497	-497	-497	-497	-497
3		IFA Bipole 2 Pole 1	-118	-497	-497	-497	-497	-497	-497
4		IFA Bipole 2 Pole 2	-118	-497	-497	-497	-497	-497	-497
5		Netherlands Interconnector	0	-1200	-1200	-1200	-1200	-1200	-1200
6		Moyle	-250	-250	-250	-250	-250	-250	-250
7		East-West Interconnector 1	0	0	-250	-250	-250	-250	-250
8		East-West Interconnector 2	0	0	-188	-188	-187	-188	-188
9	HUNB-7	Hunterston	544	544	544	544	544	544	544
10	HUNB-8	Hunterston	544	544	544	544	544	544	544
11	DAMC-1	Damhead Creek	805	805	805	805	805	805	805
12	DIDCB6	Didcot B	775	775	775	775	775	775	775
13	KEAD-1	Keadby	735	735	735	735	735	735	735
14	LBAR-1	Little Barford	665	665	665	665	665	665	665
15	ROCK-1	Rocksavage	810	810	810	810	810	810	810
16	SCCL-1	Saltend	367	367	367	367	366	367	367
17	SCCL-2	Saltend	367	367	367	367	366	367	367
18	SCCL-3	Saltend	367	367	367	367	366	367	367
19	SEAB-1	Seabank 1	812	812	812	812	812	812	812
20	SPLN-1	Spalding	880	880	880	880	880	880	880
21	SUTB-1	Sutton Bridge A	800	800	800	800	800	800	800
22		Exxon MossMorran	16	16	16	16	16	16	16
23	DERW-1	Willington (Derwent)	228	228	228	228	228	228	228
24	HUMR-1	Immingham Stage 1	719	719	719	719	719	719	719
25	SHOT-1	Shotton	210	210	210	210	210	210	210
26		Stoneywood Mills (Wiggins Teape Stoneywood)	12	12	12	12	12	12	12
27	DRAXX-4	Drax	648	648	648	648	648	648	648
28	RATS-4	Ratcliffe-on-Soar	500	500	500	500	500	500	500
29	WBUPS-2	West Burton A	503	503	503	503	503	503	503
30		Flotta Terminal	10	10	10	10	10	10	10

31	E_HYTHE	Lynes Common	50	50	50	50	49	50	50
32	WBUGT-2	West Burton A	8	8	8	8	7	8	8
33	CAS-BEU01	Torr Achilty	15	15	15	15	15	15	15
34	CAS-CLU01	Clunie	61	61	61	61	61	61	61
35	CAS-GAR01	Invergarry	20	20	20	20	20	20	20
36	CAS-MOR01	Glenmoriston	37	37	37	37	37	37	37
37	WYLF-2	Wylfa	245	245	0	0	0	0	0
38	WYLF-3	Wylfa	245	245	0	0	0	0	0
39	WYLF-4	Wylfa	245	245	0	0	0	0	0
40	PEHE-1	Peterhead CCGT1	1220	1220	1220	1220	1220	1220	1220
41	PEHE-2	Peterhead	304	304	304	304	304	304	304
42	DRAXX-3	Drax	648	648	648	648	648	648	648
43		Partington Stage 1	0	0	430	430	430	430	430
44		Partington Stage 2	0	0	0	430	430	430	430
45		Barking C	0	0	0	0	470	470	470
46		Amlwch	0	0	0	270	270	270	270
47		Baglan Bay 2 Stage 1	0	0	0	0	435	435	435
48		Drakelow D	0	0	1320	1320	1320	1320	1320
49		Grain Stage 1	0	860	860	860	860	860	860
50		Grain Stage 2	0	0	430	430	430	430	430
51		Langage Stage 1	905	905	905	905	905	905	905
52		Marchwood	900	900	900	900	900	900	900
53		Pembroke 1 Stage 1	0	800	800	800	800	800	800
54		Pembroke 1 Stage 2	0	1200	1200	1200	1200	1200	1200
55		Severn Power Stage 1	425	425	425	425	425	425	425
56		Severn Power Stage 2	0	425	425	425	425	425	425
57		Staythorpe Stage 1	425	425	425	425	425	425	425
58		Staythorpe Stage 2	425	425	425	425	425	425	425
59		Staythorpe Stage 3	850	850	850	850	850	850	850
60		Sutton Bridge B	0	0	0	0	1305	1305	1305
61		Brine Field	0	0	0	1020	1020	1020	1020
62		West Burton B Stage 1	435	435	435	435	435	435	435
63		West Burton B Stage 2	0	870	870	870	870	870	870
64		Wilton	50	50	50	50	50	50	50
65		Immingham Stage 2	601	601	601	601	601	601	601
66		Blyth	0	0	0	0	0	1600	1600
67		Teesport	0	0	0	0	0	925	925
68		Hatfield	0	0	800	800	800	800	800
69	DEEP-1	Deeside	505	505	505	505	505	505	505
70	COSO-1	Coryton	800	800	800	800	800	800	800

71	BARK-1	Barking	394	394	394	394	394	394	394
72	FAWN-1	Fawley CHP	158	158	158	158	158	158	158
73	DRAXX-6	Drax	648	648	648	648	648	648	648
74	EGGPS-4	Eggborough	488	488	488	488	487	488	488
75	EGGPS-1	Eggborough	482	482	482	482	482	482	482
76	CNQPS-4	Connah's Quay	345	345	345	345	345	345	345
77	GRMO-1	BP Grangemouth	120	120	120	120	120	120	120
78	FASN-1	Fasnakyle G1	23	23	23	23	23	23	23
79	FASN2	Fasnakyle G3	23	23	23	23	23	23	23
80	FASN2	Fasnakyle G2	23	23	23	23	23	23	23
81	FASN-4	Fasnakyle unit 4	0	0	0	0	0	8	8
82	FINL-1	Finlarig	16	16	16	16	16	16	16
83	LOCH	Lochay	47	47	47	47	47	47	47
84	MOSS	Mossford	19	19	19	19	18	19	19
85	ORRI	Orrin	18	18	18	18	18	18	18
86	PITL	Pitlochry	15	15	15	15	15	15	15
87	QUOD	Quoich	18	18	18	18	18	18	18
88	RANN-1	Rannoch	15	15	15	15	14	15	15
89	RANN-2	Rannoch	15	15	15	15	14	15	15
90	RANN-3	Rannoch	15	15	15	15	14	15	15
91	SHIN-1	Shin	9	9	9	9	9	9	9
92	SHIN-2	Shin	9	9	9	9	9	9	9
93	TONG-1	Tongland	11	11	11	11	11	11	11
94	TONG-2	Tongland	11	11	11	11	11	11	11
95	TONG-3	Tongland	11	11	11	11	11	11	11
96	HINB-7	Hinkley Point B	644	644	644	644	644	644	644
97	RUGPS-7	Rugeley B	498	498	498	498	498	498	498
98	WBUPS-1	West Burton A	483	483	483	483	483	483	483
99	SIZB-1	Sizewell B	600	600	600	600	600	600	600
100	SIZB-2	Sizewell B	600	600	600	600	600	600	600
101	DRAXX-2	Drax	648	648	648	648	648	648	648
102	FELL-1	Hutton (Sellafield)	155	155	155	155	155	155	155
103	GYAR-1	Great Yarmouth	420	420	420	420	420	420	420
104	COCK-1	Cockenzie 1	276	276	276	276	275	276	276
105	HEYM27	Heysham 2	600	600	600	600	600	600	600
106	RUGPS-6	Rugeley B	498	498	498	498	498	498	498
107	WBUPS-3	West Burton A	503	503	503	503	503	503	503
108	KILLPG-1	Killingholme 1	450	450	450	450	450	450	450
109	FAARW-1	Farr Wind Farm, Tomatin	46	46	46	46	46	46	46

110	COTPS-2	Cottam	505	505	505	505	505	505	505
111	SEAB-2	Seabank 2	422	422	422	422	422	422	422
112	RYHPS-1	Rye House	715	715	715	715	715	715	715
113	COTPS-4	Cottam	495	495	495	495	495	495	495
114	FAARW-2	Farr Wind Farm, Tomatin	46	46	46	46	46	46	46
115	DRAXX-5	Drax	648	648	648	648	648	648	648
116	SHBA-2	South Humber Bank 2	516	516	516	516	516	516	516
117	SHBA-1	South Humber Bank 1	769	769	769	769	769	769	769
118		Afton	0	0	0	77	77	77	77
119		Aikengall	48	48	48	48	48	48	48
120		Andershaw	0	45	45	45	45	45	45
121		Arecleoch	0	150	150	150	150	150	150
122		Auchencorth	0	45	45	45	45	45	45
123		Aultmore Windfarm	0	0	0	0	0	60	60
124		Baillie & Bardnaheigh Wind	0	0	0	0	0	57	57
125		Ballindalloch Muir Wind Farm, Balfron	0	0	21	21	20	21	21
126		Barmoor	0	30	30	30	30	30	30
127		Berry Burn	0	0	0	0	82	82	82
128		Black Craig	0	0	0	0	71	71	71
129		Black Craig 40MW Windfarm, Dunoon	0	0	0	0	40	40	40
130		Black Craig 90MW Windfarm, Dunoon	0	0	0	0	0	90	90
131		Boyndie Wind, Banff (Add. Cap.)	7	7	7	7	7	7	7
132		Beinn an Tuirc 2	0	38	38	38	38	38	38
133		Carscreugh	0	0	0	0	21	21	21
134		Calliachar Wind	0	0	0	0	0	62	62
135		Camster Windfarm, Caithness	0	0	0	0	0	62	62
136		Careston	0	0	0	0	0	0	32
137		Causeymire (Phase 2), Mybster	0	0	7	7	6	7	7
138		Clashindarroch Wind, Huntly	0	0	0	0	0	113	113
139		Clyde	0	519	519	519	519	519	519
140		Crystal Rig 2	200	200	200	200	200	200	200
141		Dersalloch	0	0	69	69	69	69	69
142		Drone Hill	0	38	38	38	37	38	38

143		Dunbeath Wind Farm	0	0	0	0	0	55	55
144		Dun Law Extension	30	30	30	30	29	30	30
145		Edinbane Wind, Skye	42	42	42	42	42	42	42
146		Earlshaugh	0	0	108	108	108	108	108
147		Eishken Estate, Isle of Lewis	0	0	0	0	0	300	300
148		Ewe Hill	0	0	66	66	66	66	66
149		Fairburn Wind (Orrin)	40	40	40	40	40	40	40
150		Fallago	0	0	144	144	144	144	144
151		Carraig Gheal	0	75	75	75	75	75	75
152		Gordonbush Wind, Caithness	70	70	70	70	70	70	70
153		Griffin Windfarm, near Aberfeldy	0	204	204	204	204	204	204
154		Harrows Law	0	0	55	55	55	55	55
155		Harestanes	0	0	140	140	140	140	140
156		Hearthstones B	0	0	0	81	81	81	81
157		Kingsburn Wind Farm, Fintry, Stirling	0	20	20	20	20	20	20
158		Kyle	0	0	300	300	300	300	300
159		Lairg - Achany Wind Farm	50	50	50	50	50	50	50
160		Longpark	38	38	38	38	38	38	38
161		Mark's Hill	0	99	99	99	99	99	99
162		Margree	0	0	0	0	70	70	70
163		Mid Hill Wind, Stonehaven	0	0	0	0	75	75	75
164		Montreathmont Moor Wind	0	0	0	0	0	40	40
165		Neilston	0	0	0	100	100	100	100
166		Newfield	0	0	60	60	60	60	60
167		North Nesting Wind, Shetland	0	0	0	0	0	250	250
168		Novar 2 Windfarm, Alness	0	0	0	0	0	32	32
169		Pairc (South Lochs) Wind, Lewis	0	0	0	0	94	94	94
170		Paul's Hill Wind (Add. Cap)	14	14	14	14	14	14	14
171		Pencloe	0	0	0	63	63	63	63
172		Shira	0	0	0	0	0	52	52
173		Stacain Wind Farm, Sron Mor, Inverary	0	0	0	0	42	42	42

174		Stroupster Windfarm, near Wick, Caithness	0	0	0	0	0	32	32
175		Strathy North & South Wind	0	0	0	0	226	226	226
176		Tangy (Add Capacity)	6	6	6	6	6	6	6
177		Toddleburn	36	36	36	36	36	36	36
178		Tomatin Windfarm	0	0	0	0	30	30	30
179		Tormywheel	0	32	32	32	32	32	32
180		Ulzieside	0	0	0	69	69	69	69
181		Waterhead Moor	0	0	72	72	72	72	72
182		Whiteside Hill	0	0	0	27	27	27	27
183		Brockloch Rig	0	0	0	60	60	60	60
184	ARDK	Ardkinglas, Clachan (SRO)	19	19	19	19	19	19	19
185	BNAKW-1	Ben Aketil Wind, Dunvegan	28	28	28	28	28	28	28
186	BOYNW-1	Boyndie Wind, Banff	14	14	14	14	14	14	14
187	BRDUW-1	Braes of Doune Wind, Braco	74	74	74	74	74	74	74
188	BTUIW-1	Beinn an Tuirc Wind (SRO)	30	30	30	30	30	30	30
189	CAIRW-1	Cairn Uish Wind, Rothes	51	51	51	51	50	51	51
190	CAUSW-1	Causeymire	48	48	48	48	48	48	48
191	CRMHW-1	Cruach Mhor Farm	30	30	30	30	29	30	30
192	CRYRW-1	Crystal Rig 1	62	62	62	62	62	62	62
193	DALSW-1	Dalswinton	30	30	30	30	30	30	30
194	DEUCW-1	Deucherin Hill Wind	15	15	15	15	15	15	15
195	DRUW	Drumderg Wind Farm, Dalrulzion	32	32	32	32	32	32	32
196	EARBW-1	Earlsburn	35	35	35	35	35	35	35
197	ERED	Eredine Forest Wind (An Suidhe)	30	30	30	30	30	30	30
198	HOUW	Houstary Wind, Dunbeath	14	14	14	14	14	14	14
199	INSW	Insch Windfarm, Inch	10	10	10	10	10	10	10
200	MILWW-1	Millennium Wind, Ceannacroc	65	65	65	65	65	65	65
201	MINSW-1	Minsca	38	38	38	38	37	38	38
202	NOVAW-1	Novar (SRO), Alness	18	18	18	18	18	18	18
203	PAUHW-1	Paul's Hill Wind	56	56	56	56	56	56	56
204	STRB	Kilbraur Wind Farm	67	67	67	67	67	67	67
205	TANBW-1	Tangy (1) Wind, Argyll	13	13	13	13	12	13	13

206	TULW	Tullo Wind Farm, Laurencekirk	14	14	14	14	13	14	14
207	WHIL	Whitelee	322	322	322	322	322	322	322
208	AIGA	Aigas	20	20	20	20	20	20	20
209		Glendoe Hydro, Fort Augustus	52	52	52	52	100	100	100
210	CASH	Cashlie	11	11	11	11	11	11	11
211	CEAN	Ceannacroc	20	20	20	20	20	20	20
212	CLAC-1	Clachan	40	40	40	40	40	40	40
213	DEAN	Deanie	38	38	38	38	38	38	38
214	GRUB-1	Grudie Bridge	11	11	11	11	11	11	11
215	GRUB-2	Grudie Bridge	11	11	11	11	11	11	11
216	KIOR	Kilmorack	20	20	20	20	20	20	20
217	LUIC	Luichart	34	34	34	34	34	34	34
218	NANT-1	Nant	15	15	15	15	15	15	15
219	SFIL-1	St Fillans	17	17	17	17	16	17	17
220	TUMB	Tummel	34	34	34	34	34	34	34
221	DNGB21	Dungeness B	540	540	540	540	540	540	540
222	DNGB22	Dungeness B	540	540	540	540	540	540	540
223	HEYM11	Heysham 1	607	607	607	607	607	607	607
224	HEYM12	Heysham 1	596	596	596	596	596	596	596
225	HEYM28	Heysham 2	602	602	602	602	602	602	602
226	HINB-8	Hinkley Point B	617	617	617	617	617	617	617
227	HRTL-1	Hartlepool	604	604	604	604	603	604	604
228	HRTL-2	Hartlepool	604	604	604	604	603	604	604
229	TORN-1	Torness	600	600	600	600	600	600	600
230	TORN-2	Torness	600	600	600	600	600	600	600
231	KINO-2	Kingsnorth	485	485	485	485	485	485	485
232	OLDS1	Oldbury	228	228	0	0	0	0	0
233	OLDS2	Oldbury	242	242	0	0	0	0	0
234	WYLF-1	Wylfa	245	245	0	0	0	0	0
235		Roths Bioplant	0	52	52	52	52	52	52
236		Steven's Croft	45	45	45	45	45	45	45
237	ROOS-1	Roosecote	229	229	229	229	229	229	229
238	TILB-8	Tilbury B	368	368	368	368	368	368	368
239	WBUPS-4	West Burton A	483	483	483	483	483	483	483
240	DIDC2	Didcot A	527	527	527	527	527	527	527
241	KILLPG-2	Killingholme 1	450	450	450	450	450	450	450
242	TESI-1	Teesside	938	938	938	938	937	938	938
243	TESI-2	Teesside	938	938	938	938	937	938	938

244	CNQPS-3	Connah's Quay	345	345	345	345	345	345	345
245	RATS-1	Ratcliffe-on-Soar	500	500	500	500	500	500	500
246	COCK-3	Cockenzie 3	276	276	276	276	275	276	276
247	COTPS-3	Cottam	505	505	505	505	505	505	505
248		Bristol Channel Offshore Windfarm	0	0	0	0	0	1512	1512
249		London Array Stage 1	0	0	630	630	630	630	630
250		London Array Stage 2	0	0	0	0	0	370	370
251		Humber Gateway Stage 1	0	0	220	220	220	220	220
252		Humber Gateway Stage 2	0	0	80	80	80	80	80
253		Heysham Offshore Wind	0	140	140	140	140	140	140
254		Greater Gabbard Offshore Windfarm	500	500	500	500	500	500	500
255		Thanet Offshore Windfarm	300	300	300	300	300	300	300
256		Sheringham Shoal	0	315	315	315	315	315	315
257		Gwynt Y Mor Stage 1	0	0	294	294	294	294	294
258		Gwynt Y Mor Stage 2	0	0	0	294	294	294	294
259		Gwynt Y Mor Stage 3	0	0	0	0	147	147	147
260		Docking Shoal Windfarm	0	0	500	500	500	500	500
261		Lincs Offshore Windfarm	0	250	250	250	250	250	250
262		Race Bank Windfarm	0	0	0	0	500	500	500
263		Llanbrynmair South	0	0	0	0	0	0	110
264		Carnedd Wen	0	0	0	0	0	0	191
265		Mid Wales West	0	0	0	0	0	0	408
266		Pen Y Comoedd	0	0	0	299	299	299	299
267	BETHW-1	Ben Tharsuinn Wind, E Ross	29	29	29	29	29	29	29
268	BLLA-1	Black Law	134	134	134	134	134	134	134
269	GLOFW-1	Glens of Foudland Wind (SRO)	26	26	26	26	26	26	26
270	HADHW-1	Hadyard Hill	117	117	117	117	117	117	117
271		Portbury	0	0	0	150	150	150	150
272		Tees Renewable Energy Plant	0	0	0	299	299	299	299
273		Port Talbot	0	0	350	350	350	350	350
274	CASS-1	Cassley	2	2	2	2	2	2	2
275	CASS-2	Cassley	8	8	8	8	7	8	8

276	CULL	Culligran	19	19	19	19	19	19	19
277	ERRO-1	Errochty	25	25	25	25	25	25	25
278	ERRO-2	Errochty	25	25	25	25	25	25	25
279	ERRO-3	Errochty	25	25	25	25	25	25	25
280	INAW-1	Inverawe	25	25	25	25	25	25	25
281	KILO	Kinlochleven	20	20	20	20	20	20	20
282	LIVI	Livishie	15	15	15	15	15	15	15
283	SLOY-1	Sloy G1	36	36	36	36	36	36	36
284	SLOY-2	Sloy G2	40	40	40	40	40	40	40
285	SLOY-3	Sloy G3	40	40	40	40	40	40	40
286	SLOY-4	Sloy G4	36	36	36	36	36	36	36
287	EGGPS-3	Eggborough	488	488	488	488	487	488	488
288	TILB-9	Tilbury B	368	368	368	368	368	368	368
289	EECL-1	Brimsgate	408	408	408	408	408	408	408
290	KINO-1	Kingsnorth	485	485	485	485	485	485	485
291	COTPS-1	Cottam	495	495	495	495	495	495	495
292	BRYP-1	Barry	245	245	245	245	245	245	245
293	COCK-4	Cockenzie 4	276	276	276	276	275	276	276
294	USKM-14	Uskmouth	121	121	121	121	121	121	121
295	CNQPS-1	Connah's Quay	345	345	345	345	345	345	345
296	BRGG-1	Brigg	260	260	260	260	260	260	260
297	EGGPS-2	Eggborough	482	482	482	482	482	482	482
298	KINO-3	Kingsnorth	485	485	485	485	485	485	485
299	RATS-2	Ratcliffe-on-Soar	500	500	500	500	500	500	500
300	COCK-2	Cockenzie 2	276	276	276	276	275	276	276
301	IRNPS-1	Ironbridge B	482	482	482	482	482	482	482
302	DINO-5	Dinorwig	274	274	274	274	274	274	274
303	USKM-13	Uskmouth	121	121	121	121	121	121	121
304	FERR-1	Ferrybridge C	491	491	491	491	491	491	491
305	LOAN-1	Longannet 1	576	576	576	576	576	576	576
306	LOAN-2	Longannet 2	576	576	576	576	576	576	576
307	LOAN-3	Longannet 3	576	576	576	576	576	576	576
308	LOAN-4	Longannet 4	576	576	576	576	576	576	576
309	DIDC3	Didcot A	527	527	527	527	527	527	527
310	TILB10	Tilbury B	368	368	368	368	368	368	368
311	RATS-3	Ratcliffe-on-Soar	500	500	500	500	500	500	500
312	CRUA-1	Cruachan	120	120	120	120	120	120	120
313	FIDL-3	Fiddlers Ferry	485	485	485	485	485	485	485
314	DINO-1	Dinorwig	274	274	274	274	274	274	274
315	FERR-2	Ferrybridge C	491	491	491	491	491	491	491

316	CORB-1	Corby	401	401	401	401	401	401	401
317	DIDC4	Didcot A	527	527	527	527	527	527	527
318	FERR-4	Ferrybridge C	491	491	491	491	491	491	491
319	KINO-4	Kingsnorth	485	485	485	485	485	485	485
320	DIDC1	Didcot A	527	527	527	527	527	527	527
321	ALCN-1	Alcan Lynemouth	420	420	420	420	420	420	420
322	ABTH9	Aberthaw B	547	547	547	547	547	547	547
323	IRNPS-2	Ironbridge B	482	482	482	482	482	482	482
324	ABTH8	Aberthaw B	547	547	547	547	547	547	547
325	CRUA-2	Cruachan	120	120	120	120	120	120	120
326	FERR-3	Ferrybridge C	491	491	491	491	491	491	491
327	PETEM1	Peterborough	405	405	405	405	405	405	405
328	CNQPS-2	Connah's Quay	345	345	345	345	345	345	345
329	ABTH7	Aberthaw B	547	547	547	547	547	547	547
330	FIDL-4	Fiddlers Ferry	506	506	506	506	506	506	506
331	USKM-15	Uskmouth	121	121	121	121	121	121	121
332	DINO-4	Dinorwig	274	274	274	274	274	274	274
333	FIDL-2	Fiddlers Ferry	485	485	485	485	485	485	485
334	FIFE-1	Fife Energy	123	123	123	123	123	123	123
335	DINO-6	Dinorwig	274	274	274	274	274	274	274
336	FOYE-1	Foyers	150	150	150	150	150	150	150
337	KLYN-A-1	Kings Lynn	340	340	340	340	340	340	340
338	CRUA-3	Cruachan	100	100	100	100	100	100	100
339	KILNS-1	Killingholme 2	665	665	665	665	665	665	665
340	CDCL-1	CDCL	395	395	395	395	395	395	395
341	FIDL-1	Fiddlers Ferry	485	485	485	485	485	485	485
342	SHOS-1	Shoreham	420	420	420	420	420	420	420
343	CRUA-4	Cruachan	100	100	100	100	100	100	100
344	DINO-3	Dinorwig	274	274	274	274	274	274	274
345	DRAXX-1	Drax	648	648	648	648	648	648	648
346	GRAI-4	Grain	650	650	650	650	650	650	650
347	GRAI-1	Grain	650	650	650	650	650	650	650
348	BAGE-2	Baglan Bay	32	32	32	32	32	32	32
349	BARKB2	Barking	606	606	606	606	605	606	606
350	DIDCB5	Didcot B	775	775	775	775	775	775	775
351	MEDP-1	Medway	700	700	700	700	700	700	700
352	BAGE-1	Baglan Bay	520	520	520	520	520	520	520
353	DINO-2	Dinorwig	274	274	274	274	274	274	274
354	FOYE-2	Foyers	150	150	150	150	150	150	150
355	LITTD1	Littlebrook D	570	570	570	570	570	570	570

356	FFES-3	Ffestiniog	90	90	90	90	90	90	90
357	INDQ-1	Indian Queens	140	140	140	140	140	140	140
358	LITTD2	Littlebrook D	570	570	570	570	570	570	570
359	FFES-2	Ffestiniog	90	90	90	90	90	90	90
360	FAWL3	Fawley	506	506	506	506	506	506	506
361	FFES-4	Ffestiniog	90	90	90	90	90	90	90
362	FAWL1	Fawley	496	496	496	496	496	496	496
363	FFES-1	Ffestiniog	90	90	90	90	90	90	90
364	RUGGT-6	Rugeley B	22	22	22	22	22	22	22
365	WBUGT-1	West Burton A	8	8	8	8	7	8	8
366	TAYL3G	Taylors Lane	72	72	72	72	72	72	72
367	TAYL2G	Taylors Lane	72	72	72	72	72	72	72
368	LITT2G	Littlebrook D	35	35	35	35	35	35	35
369	LITT1G	Littlebrook D	35	35	35	35	35	35	35
370	ABTH7G	Aberthaw B	17	17	17	17	17	17	17
371	LITT3G	Littlebrook D	35	35	35	35	35	35	35
372	ABTH9G	Aberthaw B	17	17	17	17	17	17	17
373	ABTH8G	Aberthaw B	17	17	17	17	17	17	17
374	FAWL3G	Fawley	17	17	17	17	17	17	17
375	FAWL1G	Fawley	17	17	17	17	17	17	17
376	COWE1	Cowes	72	72	72	72	72	72	72
377	GRAI1G	Grain	28	28	28	28	27	28	28
378	PEHE-3	Peterhead	0	0	0	0	0	0	0
379	GRAI4G	Grain	28	28	28	28	27	28	28
380	PEHE-4	Peterhead	0	0	0	0	0	0	0
381	COWE2	Cowes	72	72	72	72	72	72	72
382	FIDL-2G	Fiddlers Ferry	13	13	13	13	13	13	13
383	FIDL-3G	Fiddlers Ferry	13	13	13	13	13	13	13
384	KINO1G	Kingsnorth	13	13	13	13	13	13	13
385	KINO4G	Kingsnorth	13	13	13	13	13	13	13
386	RATSGT-2	Ratcliffe-on-Soar	10	10	10	10	10	10	10
387	DIDC3G	Didcot A GT	25	25	25	25	25	25	25
388	FERR-8G	Ferrybridge C	10	10	10	10	10	10	10
389	DIDC1G	Didcot A GT	25	25	25	25	25	25	25
390	DIDC4G	Didcot A GT	25	25	25	25	25	25	25
391	DRAXX-9G	Drax	15	15	15	15	15	15	15
392	RATSGT-4	Ratcliffe-on-Soar	11	11	11	11	11	11	11
393	TILB9G	Tilbury B	13	13	13	13	13	13	13
394	FERR-5G	Ferrybridge C	10	10	10	10	10	10	10
395	DIDC2G	Didcot A GT	25	25	25	25	25	25	25

396	TILB8G	Tilbury B	13	13	13	13	13	13	13
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Table 7.2 - SYS Study Zones, Studied Zonal Generation, Demand and Transfer (MW)

Zone	Zone Name	Quantity	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z1	North West (SHETL)	Effective Generation	961	954	942	792	1075	1437	1434
Z1	North West (SHETL)	Demand	506	512	516	523	529	536	543
Z1	North West (SHETL)	Planned Transfer	455	442	426	269	546	901	891
Z2	North (SHETL)	Effective Generation	1271	1262	1244	1269	1306	1468	1464
Z2	North (SHETL)	Demand	583	593	600	605	610	615	622
Z2	North (SHETL)	Planned Transfer	688	669	644	664	696	853	842
Z3	Sloy	Effective Generation	258	322	318	317	315	311	311
Z3	Sloy	Demand	66	67	65	66	67	68	69
Z3	Sloy	Planned Transfer	192	255	253	251	248	243	242
Z4	South (SHETL)	Effective Generation	356	473	467	465	485	538	554
Z4	South (SHETL)	Demand	543	537	544	550	556	562	568
Z4	South (SHETL)	Planned Transfer	-187	-64	-77	-85	-71	-24	-14
Z5	North (SPT)	Effective Generation	2388	2408	2353	2169	2182	2075	2089
Z5	North (SPT)	Demand	1188	1190	1175	1157	1158	1186	1183
Z5	North (SPT)	Planned Transfer	1200	1218	1178	1013	1024	889	906
Z6	South (SPT)	Effective Generation	3581	4072	4637	4905	4973	4949	4952
Z6	South (SPT)	Demand	3026	3035	3053	3047	3058	3074	3066
Z6	South (SPT)	Planned Transfer	555	1037	1584	1858	1915	1875	1886
Z7	North & NE England	Effective Generation	2867	2826	2773	3801	3780	5723	5724
Z7	North & NE England	Demand	2798	2786	2795	2855	2890	3063	3127
Z7	North & NE England	Planned Transfer	68	40	-22	945	890	2660	2597
Z8	Yorkshire	Effective Generation	11505	10825	11618	11027	10971	10371	10378
Z8	Yorkshire	Demand	5904	5643	5869	6072	6114	6190	6207
Z8	Yorkshire	Planned Transfer	5602	5182	5749	4955	4857	4180	4171

Z9	NW England & N Wales	Effective Generation	8188	8156	7132	7591	6376	6246	6250
Z9	NW England & N Wales	Demand	7370	7420	7816	7776	7809	7874	7858
Z9	NW England & N Wales	Planned Transfer	819	736	-684	-186	-1432	-1628	-1607
Z10	Trent	Effective Generation	6048	6665	6227	6191	6158	6032	6038
Z10	Trent	Demand	719	762	759	769	757	778	784
Z10	Trent	Planned Transfer	5329	5903	5467	5422	5402	5254	5253
Z11	Midlands	Effective Generation	3427	3379	4360	4334	4313	3854	4250
Z11	Midlands	Demand	7008	7132	7201	7263	7306	7364	7398
Z11	Midlands	Planned Transfer	-3580	-3752	-2841	-2928	-2993	-3510	-3147
Z12	Anglia & Bucks	Effective Generation	3904	4179	4385	4091	5373	4953	4957
Z12	Anglia & Bucks	Demand	5729	5822	5749	5795	5862	5917	5959
Z12	Anglia & Bucks	Planned Transfer	-1825	-1643	-1365	-1704	-488	-964	-1002
Z13	S Wales & Central England	Effective Generation	5940	7816	7571	7814	7592	6598	6603
Z13	S Wales & Central England	Demand	4907	5020	5015	5052	5101	5119	5136
Z13	S Wales & Central England	Planned Transfer	1033	2796	2556	2762	2491	1480	1467
Z14	London	Effective Generation	1242	1224	1201	1195	1557	1525	1526
Z14	London	Demand	10029	10331	10482	10738	10833	10756	11062
Z14	London	Planned Transfer	-8787	-9107	-9281	-9542	-9275	-9232	-9536
Z15	Thames Estuary	Effective Generation	4425	2483	2960	2937	2905	3003	3006
Z15	Thames Estuary	Demand	2021	2107	2108	2139	2160	2172	2140
Z15	Thames Estuary	Planned Transfer	2404	376	851	798	745	832	866
Z16	Central S Coast	Effective Generation	1210	1192	837	833	828	811	812
Z16	Central S Coast	Demand	4294	4352	4337	4357	4388	4412	4415
Z16	Central S Coast	Planned Transfer	-3084	-3160	-3500	-3525	-3560	-3601	-3604
Z17	South West England	Effective Generation	1773	1747	1714	1704	1696	2496	2497
Z17	South West England	Demand	2655	2676	2654	2670	2690	2703	2709
Z17	South West England	Planned Transfer	-882	-929	-939	-966	-994	-208	-211
All	Total	Effective Generation	59344	59986	60739	61435	61887	62390	62846

All	Total	Demand	59344	59986	60739	61435	61887	62390	62846
All	Total	Planned Transfer	0	0	0	0	0	0	0

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

Boundary	Boundary Name	Quantity	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B1	SHETL North West	Effective Generation	961	954	942	792	1075	1437	1437
B1	SHETL North West	Demand	506	512	516	523	529	536	536
B1	SHETL North West	Planned Transfer	455	442	426	269	546	901	901
B2	SHETL North - South	Effective Generation	2232	2216	2186	2061	2381	2905	2905
B2	SHETL North - South	Demand	1089	1105	1116	1128	1139	1151	1151
B2	SHETL North - South	Planned Transfer	1143	1111	1070	933	1242	1754	1754
B3	Sloy	Effective Generation	258	322	318	317	315	311	311
B3	Sloy	Demand	66	67	65	66	67	68	68
B3	Sloy	Planned Transfer	192	255	253	251	248	243	243
B4	SHETL - SPT	Effective Generation	2846	3011	2971	2843	3181	3754	3754
B4	SHETL - SPT	Demand	1698	1709	1725	1744	1762	1781	1781
B4	SHETL - SPT	Planned Transfer	1148	1302	1246	1099	1419	1973	1973
B5	SPT North - South	Effective Generation	5234	5419	5324	5012	5363	5829	5829
B5	SPT North - South	Demand	2886	2899	2900	2901	2920	2967	2967
B5	SPT North - South	Planned Transfer	2348	2520	2424	2112	2443	2862	2862
B6	SPT - NGET	Effective Generation	8815	9491	9961	9917	10336	10778	10778
B6	SPT - NGET	Demand	5912	5934	5953	5948	5978	6041	6041
B6	SPT - NGET	Planned Transfer	2903	3557	4008	3970	4358	4737	4737
B7	Upper North	Effective Generation	11682	12317	12734	13718	14116	16501	16501
B7	Upper North	Demand	8711	8720	8748	8803	8867	9104	9104

B7	Upper North	Planned Transfer	2972	3597	3986	4915	5248	7397	7397
B8	North - Midlands	Effective Generation	31376	31299	31484	32335	31463	33117	33117
B8	North - Midlands	Demand	21984	21784	22433	22651	22790	23168	23168
B8	North - Midlands	Planned Transfer	9392	9515	9051	9684	8673	9950	9950
B9E	Midlands - South (Export)	Effective Generation	40851	41343	42071	42861	41935	43004	43004
B9E	Midlands - South (Export)	Demand	29710	29678	30393	30683	30853	31310	31310
B9E	Midlands - South (Export)	Planned Transfer	11141	11666	11677	12177	11082	11694	11694
B9I	Midlands - South (Import)	Effective Generation	18494	18642	18668	18574	19952	19386	19386
B9I	Midlands - South (Import)	Demand	29634	30308	30345	30752	31034	31079	31079
B9I	Midlands - South (Import)	Planned Transfer	-11141	-11666	-11677	-12177	-11082	-11694	-11694
B10	South Coast	Effective Generation	2983	2940	2552	2537	2524	3307	3307
B10	South Coast	Demand	6949	7028	6990	7028	7078	7116	7116
B10	South Coast	Planned Transfer	-3966	-4088	-4439	-4491	-4554	-3809	-3809
B11	North East & Yorkshire	Effective Generation	23188	23143	24352	24745	25087	26871	26871
B11	North East & Yorkshire	Demand	14614	14364	14617	14875	14982	15294	15294
B11	North East & Yorkshire	Planned Transfer	8573	8779	9735	9870	10105	11577	11577
B12	South & South West	Effective Generation	8923	10756	10123	10351	10116	9905	9905
B12	South & South West	Demand	11856	12048	12006	12080	12180	12234	12234
B12	South & South West	Planned Transfer	-2933	-1292	-1883	-1729	-2063	-2329	-2329
B13	South West	Effective Generation	1773	1747	1714	1704	1696	2496	2496
B13	South West	Demand	2655	2676	2654	2670	2690	2703	2703
B13	South West	Planned Transfer	-882	-929	-939	-966	-994	-208	-208
B14	London	Effective Generation	1242	1224	1201	1195	1557	1525	1525
B14	London	Demand	10029	10331	10482	10738	10833	10756	10756

B14	London	Planned Transfer	-8787	-9107	-9281	-9542	-9275	-9232	-9232
B15	Thames Estuary	Effective Generation	4425	2483	2960	2937	2905	3003	3003
B15	Thames Estuary	Demand	2021	2107	2108	2139	2160	2172	2172
B15	Thames Estuary	Planned Transfer	2404	376	851	798	745	832	832
B16	North East, Trent & Yorkshire	Effective Generation	29235	29808	30579	30936	31245	32903	32903
B16	North East, Trent & Yorkshire	Demand	15333	15126	15376	15644	15738	16072	16072
B16	North East, Trent & Yorkshire	Planned Transfer	13902	14682	15202	15292	15507	16831	16831
B17	West Midlands	Effective Generation	3427	3379	4360	4334	4313	3854	3854
B17	West Midlands	Demand	7008	7132	7201	7263	7306	7364	7364
B17	West Midlands	Planned Transfer	-3580	-3752	-2841	-2928	-2993	-3510	-3510

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Table 7.4 - System Power Losses at Peak

Category	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Transmission Heating Losses excluding GSP Transformers (MW)	760	912.5	884.3	930.2	915.8	1090.1	1106.8
Fixed Losses (MW)	273	276	276	276	282	284	285
GSP Transformer Heating Losses (MW)	103.2	108.4	112.7	118.8	121.2	129.3	134.5
Generator Transformer Heating Losses (MW)	103.4	111	108.2	137.4	133.2	135.8	135.8
Total Losses	1239.6	1407.9	1381.2	1462.4	1452.2	1639.2	1662.1
ACS Peak Demand (MW) excluding Losses and Station Demand	58145.6	58774	59512.1	60194.4	60637.2	61129.9	61577
Total Losses as percentage of Demand	2.1	2.4	2.3	2.4	2.4	2.7	2.7

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Table 7.5 - Effectiveness of Marginal Generation due to Transmission Losses

Zone Number	Zone Name	Licensee	Effectiveness(%)
Z1	North West (SHETL)	SHETL	<90
Z2	North (SHETL)	SHETL	<90
Z3	South (SHETL)	SHETL	<90
Z4	Sloy (SHETL)	SHETL	<90
Z5	North (SPT)	SPT	90.9
Z6	South (SPT)	SPT	93.8
Z7	North & NE England	NGET	98.1
Z8	Yorkshire	NGET	100.3
Z9	NW England & N Wales	NGET	100.6
Z10	Trent	NGET	100.4
Z11	Midlands	NGET	106.2
Z12	Anglia & Bucks	NGET	106
Z13	S Wales & Central England	NGET	108.3
Z14	London	NGET	109
Z15	Thames Estuary	NGET	109.7
Z16	Central S Coast	NGET	111.2
Z17	South West England	NGET	110.8

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GB Seven Year Statement 2009

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.

In addition, a new section has been incorporated that refers to the work undertaken by the ENSG (Electricity Networks Strategy Group) in analysing what reinforcements would be required to meet the UK environmental targets, but in particular the electricity share of the renewable 2020 target.

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

System Boundaries

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

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

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

Boundary Capabilities and Required Capabilities

Two types of system limitation, relating to the transfer of power across a boundary, have been considered. The first relates to thermal capability and the second to voltage capability. The boundary capabilities have been evaluated for the time of the system winter peak demand of 2009/10, 2011/12, 2013/14 and 2015/16 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:

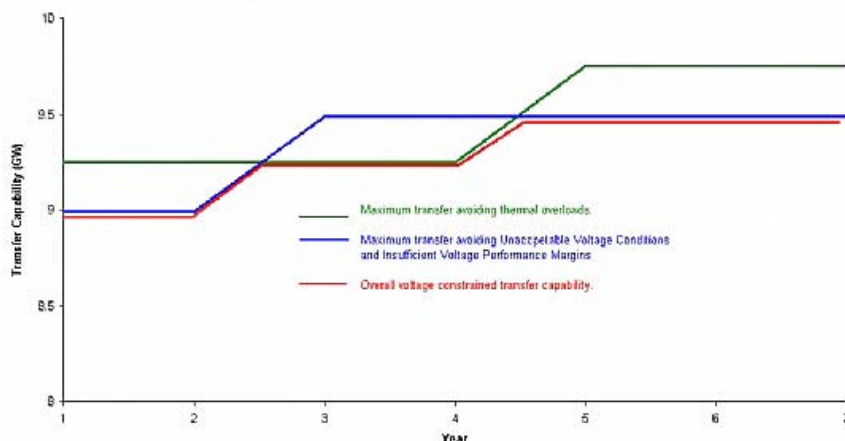
- there may be a need for 'local' reinforcements not directly related to the boundary;
- as additional generation or demand is connected to the system, the background against which both the required capability and boundary capability are assessed changes; and
- the security criteria must be satisfied 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](#)

Figure 8.1 - Limiting factors on Boundary Transfer
(Example for Illustration Only)



Deterministic Transfers

The power flows presented in this chapter are based on the deterministic SYS background. There is inherent uncertainty associated with the

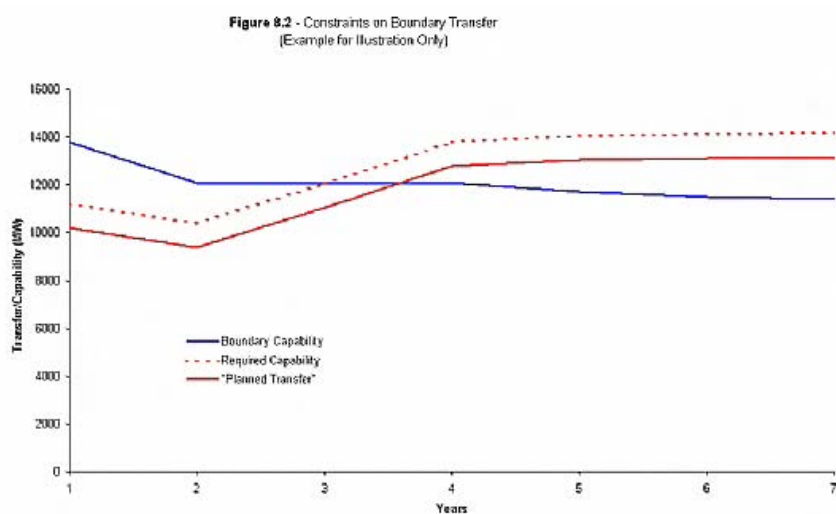
assumptions underlying any deterministic background. For example demand and generation may, in the event, deviate from any of the deterministic assumptions underlying the background. Uncertainty must also therefore be attributed to both the resultant deterministic power flows and any consequent perceived 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 2009/10 to 2015/16.

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 B1, 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

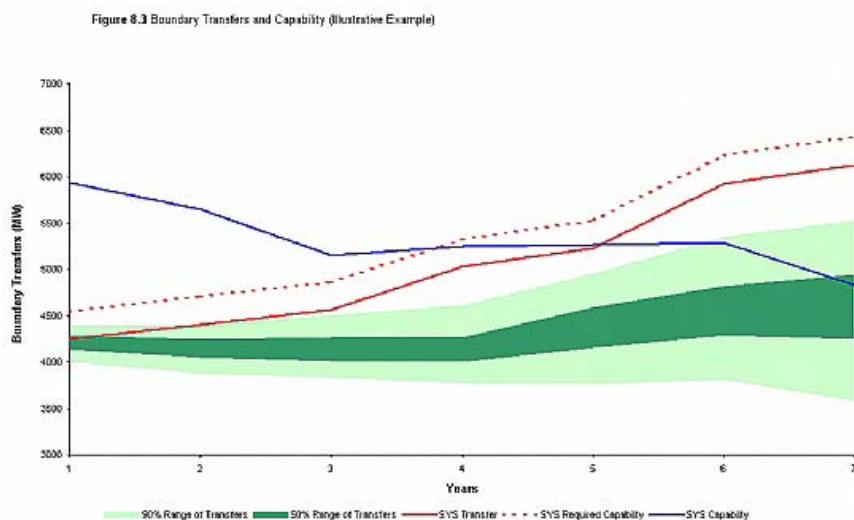
A key output of GUM is the probabilistic range of transfers over a given period for each defined boundary. For each year of the study, GUM calculates probabilistic distributions of power transfers for each boundary under peak load conditions. These distributions could be plotted as separate charts for 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 2008/09 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 2009/10 winter peak, but construction may slip such that it is unable to contribute to the system peak demand until 2010/11. Variations and uncertainties relating to transfers across the External Interconnections with External Systems are included in the probabilistic analyses. This can account for a significant part of the range of uncertainty displayed in the fan diagrams.

Interpretation

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

However, as noted previously, these kinds of conclusions must be qualified by recognition that the boundary capability is dependent on the exact disposition of generation and demand in the background against which it is assessed. For example, interactions of generation openings and closures and changes in demand all on the same side of a boundary, or on opposite sides, can lead to little or no change in the 'Planned'

boundary transfer but, nevertheless could give rise to a need for significant reinforcements in order to maintain system security. Nor would two backgrounds, which, result in similar transfers across a particular boundary necessarily, give rise to the need for the same transmission reinforcement across that boundary since the boundary capability is a function of how the boundary transfer is shared between the boundary circuits, which is in turn a function of the particular background under consideration.

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

Boundary Commentary

Background

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

Please note that the transfers displayed in the series of figures which follow (i.e. [Figure 8.B1](#) to [Figure 8.B17](#)) relate to the time of system peak demand. The capabilities shown are the transfer levels beyond which either thermal or voltage limitations become apparent on the Main Interconnected Transmission System. These SYS capabilities have been evaluated for the spot years 2009/10, 2011/12, 2013/14 and 2015/16 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 2005/06 to 2015/16, [Table 3.10](#) for generation disconnections since 2005/06 and to [Table 3.11](#) for generating units declared unavailable.

Overview

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

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

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

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

After the introduction of BETTA, which brought about the removal of the administered Interconnection arrangements between England and Scotland, an extensive reinforcement programme is required to accommodate the required capabilities determined by the SYS background for boundaries in the border area. The projected commissioning of some 2GW of new transmission contracted generation in Scotland, substantially made up of wind farms, is dependant on the completion of the schemes which make up the planned Beauly/Denny transmission reinforcement. The Beauly/Denny reinforcement is included as part of the SYS background for commissioning by 2013/14. However, elements of this reinforcement are currently the subject of a Public Inquiry and, consequently, the final commissioning date may vary, which would impact on the study results presented in [GB Transmission System Performance](#) and this chapter.

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

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

Southwest in line with present contractual positions.

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

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

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

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

Commentary

Boundary 1: SHETL North West

Figure 8.B1

[Click to load a larger version of Figure8.B1 image](#)

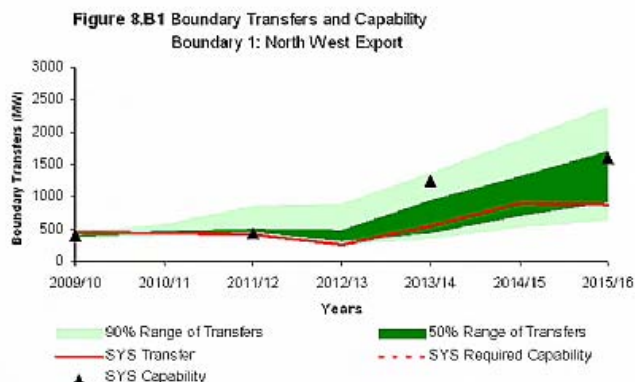


Figure 8.T1

[Click to load a larger version of Figure8.T1 image](#)

Figure 8-T1 - Boundary B1 Demand and Generation [MW]

BOUNDARY		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B1E	SHETL NORTH WEST (EXPORT)							
	Effective Generation	961	954	942	792	1075	1437	1434
	Demand	508	512	516	523	529	536	543
	Planned Transfer	455	442	426	269	546	901	891
B1I	SHETL NORTH WEST (IMPORT)							
	Effective Generation	59393	59092	59797	60643	60812	60953	61412
	Demand	59638	59474	60223	60912	61368	61654	62303
	Planned Transfer	-455	-442	-426	-269	-546	-901	-891

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

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

The 2009/10 required transfer for this boundary just exceeds the boundary capability indicating the need for transmission reinforcement. The required transfers beyond 2009/10 are within the boundary capability.

The first of the proposed reinforcements for this boundary is scheduled for completion by the end of 2010 and comprises the creation of a new 275/132kV substation at Knocknagael. This is located to the south of Inverness at the existing Foyers connection tee point on the Beauly-Blackhillock line. It is proposed to move the existing Inverness demand onto this new substation using new 132kV cable circuits, thus reducing the load on the Beauly-Keith 132kV circuits and thereby increasing the B1 capacity to around 450MW.

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 conducting 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 second proposed reinforcement 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. The Beauly-Denny project was the subject of a public inquiry during 2007 and the outcome of this will determine the extent of the works required and completion date. Currently, the project completion date is predicted to be 2013. The completion of Beauly-Denny will increase this boundary capability from 450MW to 1250MW.

The additional generation connecting to the north of this boundary means that further reinforcement of this boundary will be required. The next proposed reinforcement is strengthening of the transmission infrastructure between Beauly (near Inverness), Keith/Blackhillock and Kintore. The boundary capability can be raised to around 1600MW by reconductoring the existing 275kV transmission line between Beauly, Blackhillock and Kintore.

If the generation volumes warrant it then the transmission capacity can be increased further 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 Beauly-Denny, a new build transmission line between Beauly and Keith/Blackhillock and using existing infrastructure from Keith down the east coast to Kincardine which is already 400kV construction.

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 conducting the spare side of the existing 275kV double circuit line between Beauly and Dounreay, installation of a 275kV busbar and a second 275/132kV transformer at Dounreay. Phase shifting transformers will also be required on the 132kV lines between Beauly and Shin. 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. Current proposals are for the Western Isles to be connected using an HVDC transmission link to Beauly 400kV substation (already proposed as part of the Beauly-Denny infrastructure). It is also proposed to use an HVDC transmission link to connect Shetland to the mainland at a new 400kV busbar at Blackhillock Substation. The growth of renewable generation on Orkney is more gradual and the extent to which reinforcement is required is under consideration.

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

Boundary 2: SHETL North - South

Figure 8.B2

[Click to load a larger version of Figure8.B2 image](#)

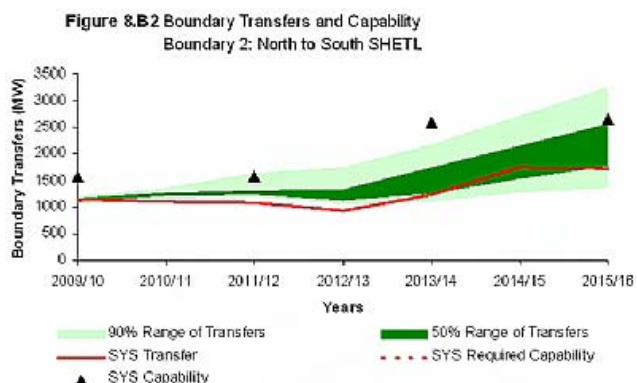


Figure 8.T2

[Click to load a larger version of Figure8.T2 image](#)

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B2E SHETL NORTH - SOUTH (EXPORT)							
Effective Generation	2232	2216	2186	2061	2381	2905	2898
Demand	1089	1105	1116	1128	1139	1161	1165
Planned Transfer	1142	1111	1070	932	1242	1754	1733
B2I SHETL NORTH - SOUTH (IMPORT)							
Effective Generation	57112	57770	58553	58374	58506	59485	58940
Demand	59255	59981	59623	60307	60746	61239	61661
Planned Transfer	-1143	-1111	-1070	-932	-1242	-1754	-1733

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

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

The increase in required transfer capability of this boundary over the seven year period indicates the need to reinforce the transmission system in this location. The proposed Beauly to Denny reinforcement required for the north west boundary also provides the necessary increased capacity for this boundary. The reinforcement comprises the replacement of the existing 132kV double circuit tower line between Beauly, Fort Augustus, Errochty and Bonnybridge, by a new 400kV double circuit tower line terminating at Denny near Bonnybridge. Subject to a successful outcome from the Beauly-Denny public inquiry, this reinforcement could be completed in 2013 and will increase the north south boundary

capability from 1460MW in 2012/13 to 2600MW in 2013/14. Depending on the volume of future renewable generation applications, additional reinforcement of this boundary may be required. This could include a 400kV east coast upgrade from Blackhillock to Kincardine using existing infrastructure that is currently operated at 275kV but which is 400kV construction.

Boundary 3: SHETL Sloy

Figure 8.B3

[Click to load a larger version of Figure8.B3 image](#)

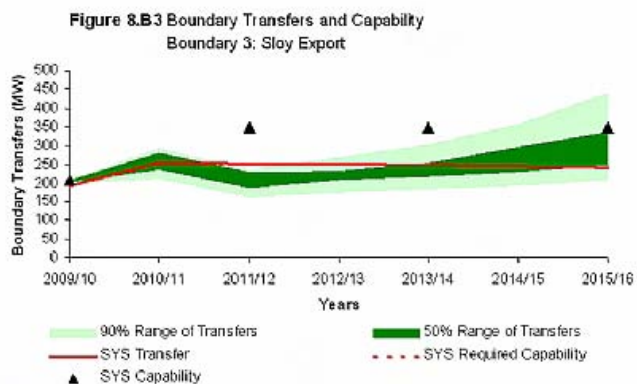


Figure 8.T3

[Click to load a larger version of Figure8.T3 image](#)

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B3E SLOY (EXPORT)							
Effective Generation	258	322	318	317	315	311	311
Demand	66	67	65	66	67	68	69
Planned Transfer	192	255	253	251	248	243	242
B3I SLOY (IMPORT)							
Effective Generation	59086	59864	60421	61118	61572	62078	62535
Demand	59278	59919	60674	61369	61820	62322	62777
Planned Transfer	-192	-255	-253	-251	-248	-243	-242

The 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 transfer 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 transfer capability after 2009/10. A new 275/132kV substation is being created to link the existing Killin to Sloy 132kV line with the existing 275kV line which runs from Windyhill to Dalmally. The substation, to be called Inverarnan and located at a point near to where the lines cross at the north end of Loch Lomond, is under construction and when completed in 2010 will increase the South West boundary capacity to around 3050MW.

Additional generation applications within this boundary have been received which may require additional reinforcement within this area. A number of reinforcement options are being considered to provide additional transmission capacity, including the option of 132kV subsea cables from Carradale to Hunterston on the Ayrshire coast.

Boundary 4: SHETL - SPT

Figure 8.B4

[Click to load a larger version of Figure8.B4 image](#)

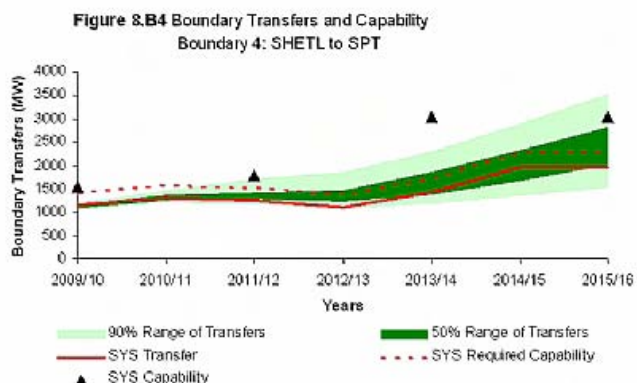


Figure 8.T4

[Click to load a larger version of Figure8.T4 image](#)

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

BOUNDARY		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B4E	SHETL - SPT (EXPORT)							
	Effective Generation	2646	3011	2971	2843	3181	3754	3763
	Demand	1698	1709	1725	1744	1762	1781	1802
	Planned Transfer	1148	1302	1246	1099	1419	1973	1961
B4I	SHETL - SPT (IMPORT)							
	Effective Generation	58498	58975	57768	56592	58706	58636	58083
	Demand	57646	58277	59014	59691	60125	60609	61044
	Planned Transfer	-1148	-1302	-1246	-1099	-1419	-1973	-1961

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.

The 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 transfer capability for the boundary.

The increase in the required transfer capability over the seven year period clearly indicates the need to reinforce the transmission system in this location. The new Inverarnan substation, described under Boundary B3 and due for completion in 2010, provides additional capacity for Boundary B4. The proposed Beauly to Denny reinforcement outlined for the north west boundary, due to be completed in 2013, 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. These reinforcements will increase the boundary capability from 1660MW in 2009/10 to around 1800MW by 2010/11 and to around 3050MW by 2013/14.

The increasing volume of renewable generation in the SHETL area may require further reinforcement of this boundary. This could include a 400kV east coast upgrade from Blackhillock to Kincardine using existing infrastructure that is currently operated at 275kV but which is 400kV construction.

Boundary 5: SPT North - South

Figure 8.B5

[Click to load a larger version of Figure8.B5 image](#)

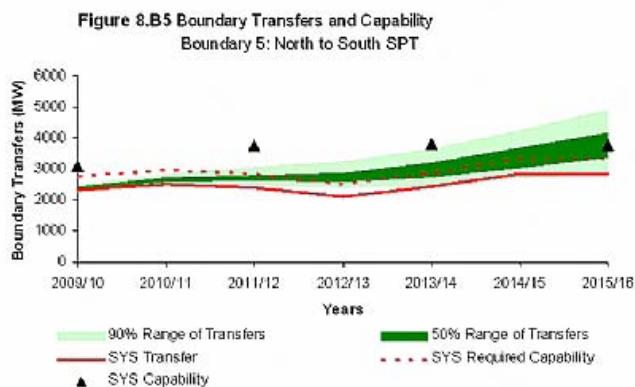


Figure 8.T5

[Click to load a larger version of Figure8.T5 image](#)

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

BOUNDARY		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B5E	SPT NORTH - SOUTH (EXPORT)							
	Effective Generation	5234	5419	5324	5012	5363	5829	5852
	Demand	2886	2899	2900	2991	2920	2867	2985
	Planned Transfer	2348	2520	2424	2112	2443	2962	2867
B5I	SPT NORTH - SOUTH (IMPORT)							
	Effective Generation	54110	54567	55415	56423	56524	56561	56994
	Demand	58456	57067	57850	58534	58967	59423	59861
	Planned Transfer	-2348	-2520	-2424	-2112	-2443	-2962	-2867

The north to south transfer across this boundary in the central belt of Scotland shows a rise through the years of this statement, due to contracted renewable energy developments in the north of Scotland. The required capability rises to a level in excess of the current (winter 2008/09) capability, indicating a strong need for reinforcement. The extent of this rise in later years is reduced as a result of some existing generation becoming non-contributory.

Works to reinforce this boundary are presently in the construction phase. These works will enhance the thermal capability of the Longannet to

Clyde's Mill and Esterhouse to Clyde's Mill 275kV circuits via switchgear replacement at Clyde's Mill 275kV substation. A series reactor will be installed at Windyhill 275kV Substation on the Neilston 275kV circuit.

Together with a second 400/275kV transformer at Strathaven and additional reactive compensation plant, the works described above will deliver a boundary capability approaching 3800MW by 2011/12.

Boundary 6: SPT - NGET

Figure 8.B6

[Click to load a larger version of Figure8.B6 image](#)

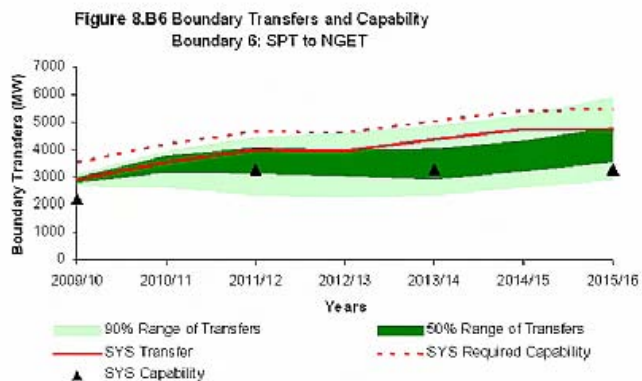


Figure 8.T6

[Click to load a larger version of Figure8.T6 image](#)

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B6E SPT - NGET (EXPORT)							
Effective Generation	8615	9491	9951	9917	10335	10778	10804
Demand	5912	5934	5953	5948	5976	6041	6051
Planned Transfer	2903	3557	-4009	3970	4358	4737	4753
B6I SPT - NGET (IMPORT)							
Effective Generation	50529	50485	50778	51518	51551	51612	52042
Demand	53432	54052	54766	55487	55909	56349	56795
Planned Transfer	-2903	-3557	-4008	-3970	-4358	-4737	-4753

The north to south transfer across the boundary between SPT and NGET shows a significant rise throughout all years of this statement, due to contracted renewable energy developments throughout Scotland. As a consequence, the required capability is significantly in excess of the current capability, indicating a strong 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 by 2010/11 and 3,300MW by 2011/12, SPT and NGET are undertaking an extensive reinforcement programme.

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

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

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

It should be remembered that the planned transfer figures derived from the SYS Background reflect the current contracted generation position (which includes almost 6900MW of Large wind generation in Scotland by 2015/16) 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](#)

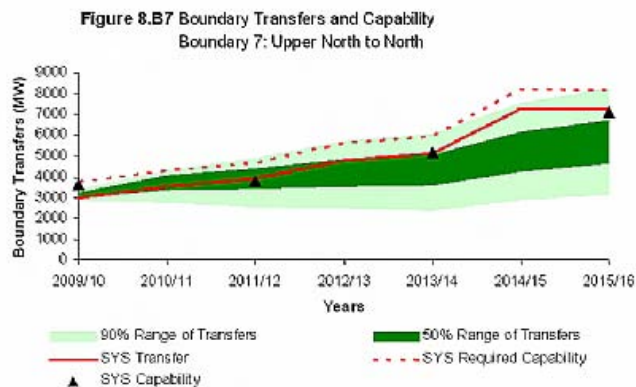


Figure 8.T7

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

BOUNDARY		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B7E	UPPER NORTH (EXPORT)							
	Effective Generation	11682	12317	12734	13718	14115	16501	16528
	Demand	8711	8720	8748	8803	8867	9104	9178
	Planned Transfer	2872	3597	3968	4915	5248	7297	7350
B7I	UPPER NORTH (IMPORT)							
	Effective Generation	47682	47869	48005	47717	47771	45888	46318
	Demand	50634	51265	51901	52632	53020	53286	53669
	Planned Transfer	-2872	-3597	-3968	-4915	-5248	-7297	-7350

New generation openings north of the boundary result in a significant export transfer across this boundary from 2009/10 onwards. This boundary shows insufficient transfer capability and remains below the planned system transfer from 2011/12 throughout the SYS period to 2015/16.

The planned and required transfers lie to the upper part of the probabilistic range of transfers suggesting a possible exaggeration of the planned and required transfers. Thermal circuit limitations do not provide enough capability to cover the full range of probabilistic transfers demonstrating a requirement for network reinforcements. The jump in planned and required transfers in 2014/15 is due to a large generation connection in the North West.

Boundary 8: NGET North to Midlands

Figure 8.B8

[Click to load a larger version of Figure8.B8 image](#)

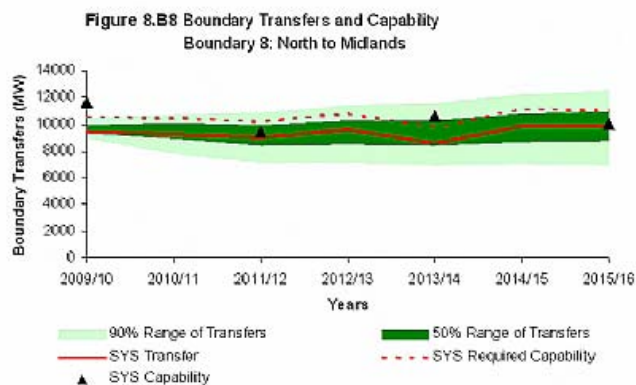


Figure 8.T8

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B8E NORTH TO MIDLANDS (EXPORT)							
Effective Generation	31376	31299	31464	32335	31463	33117	33157
Demand	21884	21784	22433	22651	22790	23168	23243
Planned Transfer	9392	9515	9051	9684	8673	9950	9914
B8I NORTH TO MIDLANDS (IMPORT)							
Effective Generation	27868	28887	29255	29100	30424	29272	28889
Demand	37361	38202	38306	38784	38087	39222	39603
Planned Transfer	-9392	-9515	-9051	-9684	-8673	-9950	-9914

The North to Midlands boundary transfers remain mostly constant throughout the SYS period. Changes to generation and demand on either side of the boundary give rise to fluctuations in the transfers and capabilities. The boundary capability dips below required transfers under some generation conditions needing some additional reinforcements to ensure boundary compliance.

The planned and required transfers lie well within the probabilistic range of transfers.

Boundary 9: NGET Midlands to South

Figure 8.B9

[Click to load a larger version of Figure8.B9 image](#)

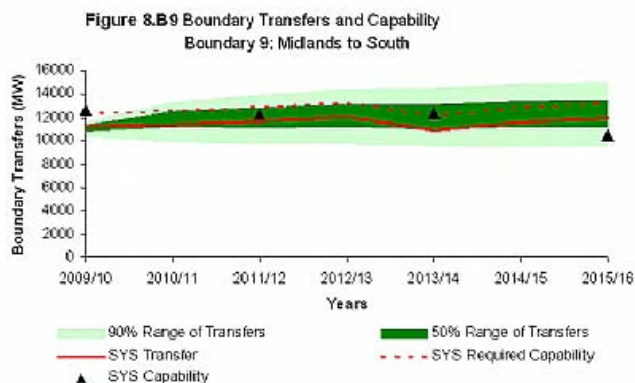


Figure 8.T9

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B9E MIDLANDS - SOUTH (EXPORT)							
Effective Generation	40661	41343	42071	42861	41935	43004	43446
Demand	29710	29678	30393	30683	30853	31310	31426
Planned Transfer	11141	11866	11677	12177	11082	11894	12020
B9I MIDLANDS - SOUTH (IMPORT)							
Effective Generation	18494	18642	18668	18574	18952	19386	19401
Demand	29634	30308	30345	30752	31034	31079	31421
Planned Transfer	-11141	-11866	-11677	-12177	-11082	-11894	-12020

The Midlands to South boundary shows a gentle increase in transfers over the SYS period with a small dip in 2013/14 due to southern connecting generation. The boundary capability decreases to below the required transfer as the gradual increase in boundary transfers pushes the boundary beyond its voltage and thermal limits.

The planned and required transfers lie well within the probabilistic range of transfers.

Boundary 10: NGET South Coast

Figure 8.B10

[Click to load a larger version of Figure8.B10 image](#)

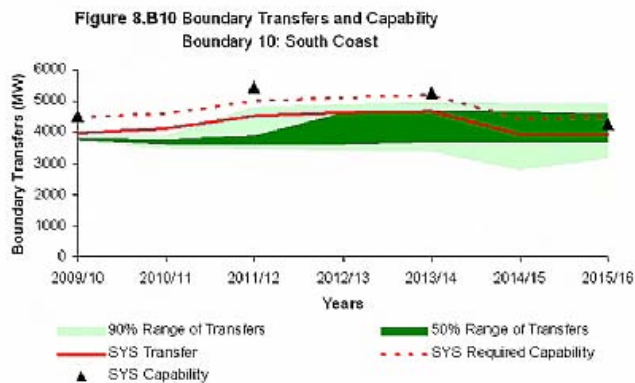


Figure 8.T10

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B10E SOUTH COAST (EXPORT)							
Effective Generation	2983	2940	3552	2537	2524	3307	3309
Demand	6949	7028	6990	7028	7078	7116	7124
Planned Transfer	-3666	-4088	-4439	-4491	-4554	-3809	-3815
B10I SOUTH COAST (IMPORT)							
Effective Generation	58361	57046	58187	58998	59363	59083	59537
Demand	52396	52958	53749	54407	54606	55274	55722
Planned Transfer	3666	4088	4439	4491	4554	3809	3815

The South Coast area is an importing area. The SYS transfer remains fairly constant from 2009/10 to 2013/14, with a marginal increase as the system progresses towards 2013/14, mainly due to steady demand growth in the area.

The system transfer begins to reduce from 2013/14 due to new generation openings in the south coast area. The probabilistic range of transfers sits below planned and required transfers in the early years due to an assumed output from normally non-contributory generation.

Boundary 11: NGET North East and Yorkshire

Figure 8.B11

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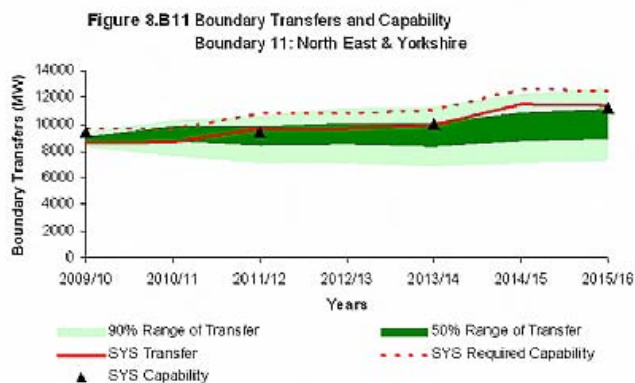


Figure 8.T11

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B11E NORTH EAST & YORKSHIRE (EXPORT)							
Effective Generation	23188	23143	24352	24745	25087	26871	26907
Demand	14614	14364	14617	14875	14982	16294	15385
Planned Transfer	9573	9779	9735	9970	10105	11577	11521
B11I NORTH EAST & YORKSHIRE (IMPORT)							
Effective Generation	38157	38843	36367	36690	38800	35518	35939
Demand	44730	45622	46122	46560	46605	47096	47460
Planned Transfer	-8573	-8779	-8735	-8870	-10105	-11577	-11521

The SYS transfer across the boundary increases year on year for the entire SYS period due to the connection of new generation north of the boundary. The SYS capability is below the SYS required transfer from 2009/10, suggesting that additional reinforcements beyond those currently planned are needed to meet SYS required capability.

Boundary 12: NGET South & South West

Figure 8.B12

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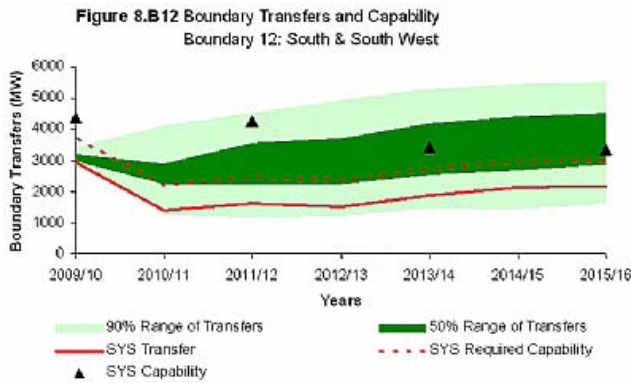


Figure 8.T12

[Click to load a larger version of Figure8.T12 image](#)

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B12E SOUTH & SOUTH WEST (EXPORT)							
Effective Generation	8923	10758	10123	10351	10118	9905	9912
Demand	11856	12948	13006	12080	12180	12234	12260
Planned Transfer	-2933	-1292	-1863	-1729	-2063	-2329	-2348
B12I SOUTH & SOUTH WEST (IMPORT)							
Effective Generation	50421	49230	50816	51084	51770	52485	52933
Demand	47488	47938	48733	49355	49707	50155	50585
Planned Transfer	2933	1292	1863	1729	2063	2329	2348

Being a boundary with north to south power flows the addition of new generation in the south acts to reduce to planned and required transfers. The boundary capability does reduce over the SYS period but it does not go below the required transfer keeping compliance.

With the possibility of the future new generation delaying or withdrawing the probabilistic range of transfers is raised above the planned and required transfers and shows a wide band of possible transfers. The capabilities decrease into the lower part of the probabilistic range suggesting future reinforcements may be necessary.

Boundary 13: NGET South West

Figure 8.B13

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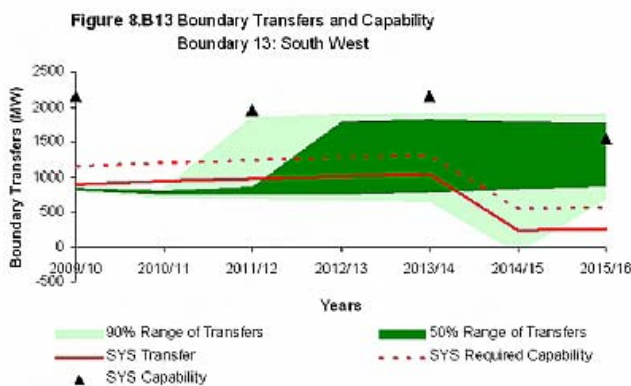


Figure 8.T13

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

BOUNDARY		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B13E SOUTH WEST (EXPORT)	Effective Generation	1773	1747	1714	1784	1695	2495	2497
	Demand	2655	2676	2654	2670	2690	2703	2709
	Planned Transfer	-882	-929	-939	-886	-994	-208	-211
B13I SOUTH WEST (IMPORT)	Effective Generation	57572	58238	58024	59731	60191	59894	60349
	Demand	56689	57310	56865	56765	59197	59686	60137
	Planned Transfer	882	929	939	886	994	208	211

SYS transfer remains relatively unchanged until 2013/14 when it decreases for the remainder of the SYS period due to significant new generation. The spread of likely transfers between 09/10 and 11/12 is narrow, which is representative of the lack of proposed generation in the boundary for that period. The probabilistic transfer then widens out reflecting uncertainties associated with possible new generation and station closures within the boundary.

SYS capability exceeds the SYS transfer and SYS required capability for the whole SYS period but given the boundary transfer is not very large a single large connection could change that situation.

Boundary 14: NGET London

Figure 8.B14

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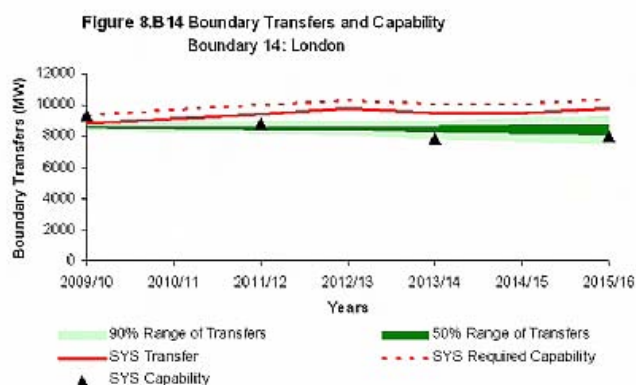


Figure 8.T14

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

BOUNDARY		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B14E LONDON (EXPORT)	Effective Generation	1242	1224	1201	1195	1557	1525	1526
	Demand	10029	10331	10482	10738	10833	10756	11062
	Planned Transfer	-9797	-9107	-9261	-8542	-9275	-9232	-9536
B14I LONDON (IMPORT)	Effective Generation	58103	58761	58538	60240	60330	60865	61320
	Demand	49316	49655	50257	50698	51054	51633	51784
	Planned Transfer	8787	9107	9261	8542	9275	9232	9536

London imports a significant proportion of its demand with very little local generation. The spread of likely transfers for B14 is narrow due to the high level of demand and the relatively low volatility and volume of generation in the boundary. The planned and required transfers increase slightly over the SYS period as a result of demand growth in the London region.

The SYS capability looks particularly poor against the planned and required transfers however the SYS background is particularly onerous with exporting power to the continent drawing power through London overloading the northern London circuits and depressing voltages. The probabilistic transfers are somewhat less onerous however the capabilities are still below the required capability indicating a requirement for additional reinforcements.

Boundary 15: NGET Thames Estuary

Figure 8.B15

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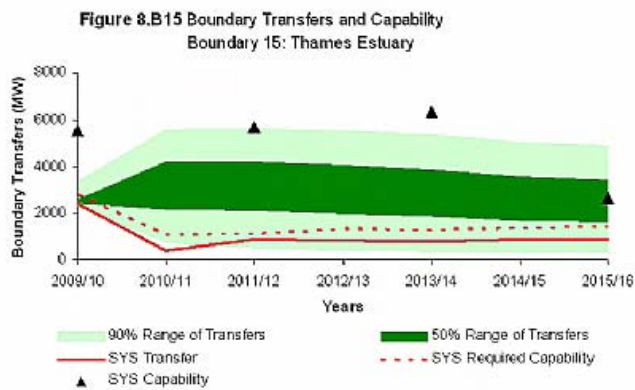


Figure 8.T15

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B16E THAMES ESTUARY (EXPORT)							
Effective Generation	4425	2483	2960	2937	2905	3003	3006
Demand	2021	2107	2108	2139	2160	2172	2140
Planned Transfer	2404	378	851	798	745	822	888
B15I THAMES ESTUARY (IMPORT)							
Effective Generation	54820	57502	57779	58488	58982	59388	59040
Demand	57524	57879	58630	59296	59727	60218	60706
Planned Transfer	-2404	-378	-851	-798	-745	-822	-888

The Thames Estuary transfers are heavily dependant on the assumed flows on the continental interconnectors. With the high plant margin in the SYS background the interconnectors are expected to mostly export to the continent which massively reduces the exports from the Thames Estuary towards London. The boundary has to manage when the interconnectors wish to import from the continent so the boundary transfer can increase to more than 6GW.

The probabilistic range demonstrates the wide variation that can be seen across this boundary.

Boundary 16: NGET North East, Trent & Yorkshire

Figure 8.B16

[Click to load a larger version of Figure8.B16 image](#)

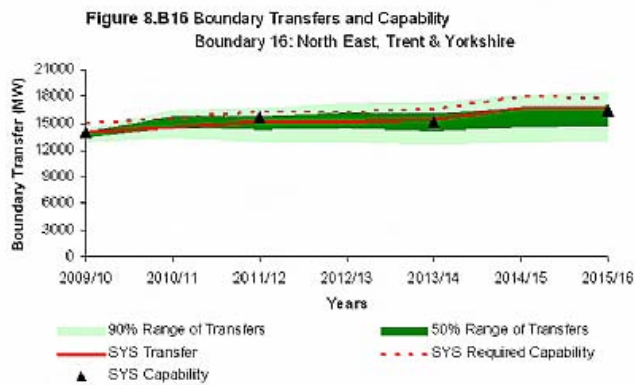


Figure 8.T16

[Click to load a larger version of Figure8.T16 image](#)

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B16E NORTH EAST, TRENT & YORKSHIRE (EXPORT)							
Effective Generation	29235	29908	30579	30936	31245	32903	32944
Demand	16333	16126	15376	15644	15738	16072	16170
Planned Transfer	13602	14892	15202	15292	15507	16831	16774
B16I NORTH EAST, TRENT & YORKSHIRE (IMPORT)							
Effective Generation	30108	30178	30180	30488	30642	29486	29802
Demand	44011	44868	45362	45791	46148	46317	46676
Planned Transfer	-13602	-14892	-15202	-15292	-15507	-16831	-16774

New generation openings and a steady demand growth typify this boundary. The boundary shows insufficient transmission capability and remains below the planned system transfer from 2011/12 throughout the SYS period to 2015/16. The probabilistic range and SYS transfer for this boundary increases progressively over the SYS period.

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

Boundary 17: NGET West Midlands

Figure 8.B17

[Click to load a larger version of Figure8.B17 image](#)

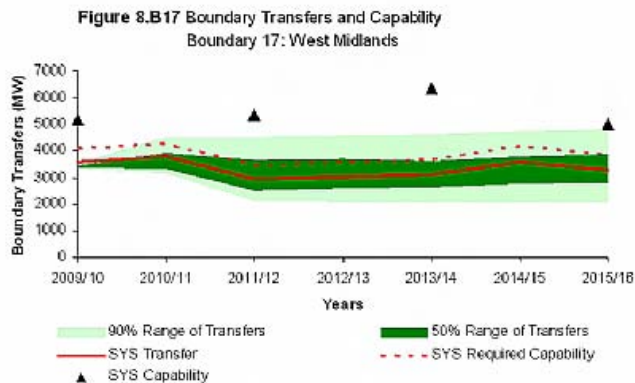


Figure 8.T17

[Click to load a larger version of Figure8.T17 image](#)

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

BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B17E WEST MIDLANDS (EXPORT)							
Effective Generation	3427	3379	4360	4334	4313	3654	4250
Demand	7008	7132	7201	7263	7306	7364	7388
Planned Transfer	-3580	-3752	-2841	-2928	-2993	-3510	-3147
B17I WEST MIDLANDS (IMPORT)							
Effective Generation	55917	56806	56379	57101	57574	58535	58596
Demand	52937	52854	53632	54172	54581	55026	55448
Planned Transfer	3580	3752	2841	2928	2993	3510	3147

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 a little in 2011/12 from new generation connections in this importing area. The transfer then increases gradually until 2014/15, 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.

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.

Indicative Reinforcements required to meet Environmental Targets

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

- Develop electricity generation and demand scenarios consistent with the EU target for 15% of the UK's energy to be produced from renewable

sources by 2020; and

- Identify and evaluate a range of potential electricity transmission network solutions that would be required to accommodate these scenarios.

In March 2009, ENSG published a report 'Our Electricity Transmission Network: A Vision For 2020':

http://www.ensg.gov.uk/assets/1696-01-ensg_vision2020.pdf

which discharged the action placed on the Transmission Licensees. The reinforcements identified in this report are based on a range of scenarios that take account the significant changes anticipated in the generation mix between now and 2020. In particular, the scenarios examined the potential transmission investments with the connection of large volumes of onshore and offshore wind generation required to meet the 2020 renewables target, whilst, at the same time, facilitating the connection of other essential new generation, such as new nuclear that will be needed to reduce carbon emissions and maintain continued security of supply.

The study concluded that, provided the identified reinforcements are taken forward in a timely manner, they can be delivered to required timescales. It should also be noted that the reinforcements identified in this report are designed to facilitate connection of a large volume of different types of generation in a given area, not dependent on a single generation project proceeding, and where the lead time for the combined transmission reinforcements in a given area would exceed the time taken to construct the generation, i.e. lack of transmission capacity would have a potential negative impact in meeting renewable targets and/or accommodating generation required to maintain continued security of supply.

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

Following Ofgem initial consultation phase on Strategic investments, funds have been made available to undertake the 2009/10 pre-construction engineering for reinforcements identified by the study and these are being developed without requirements for User commitment. It is anticipated that Ofgem will undertake further consultation with regard establishing a regulatory framework which will facilitate taking forward the reinforcements identified by the report and any additional anticipatory reinforcement which may be required to facilitate the objectives identified in the report.

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Figure 8.1 - Limiting factors on Boundary Transfer
(Example for Illustration Only)

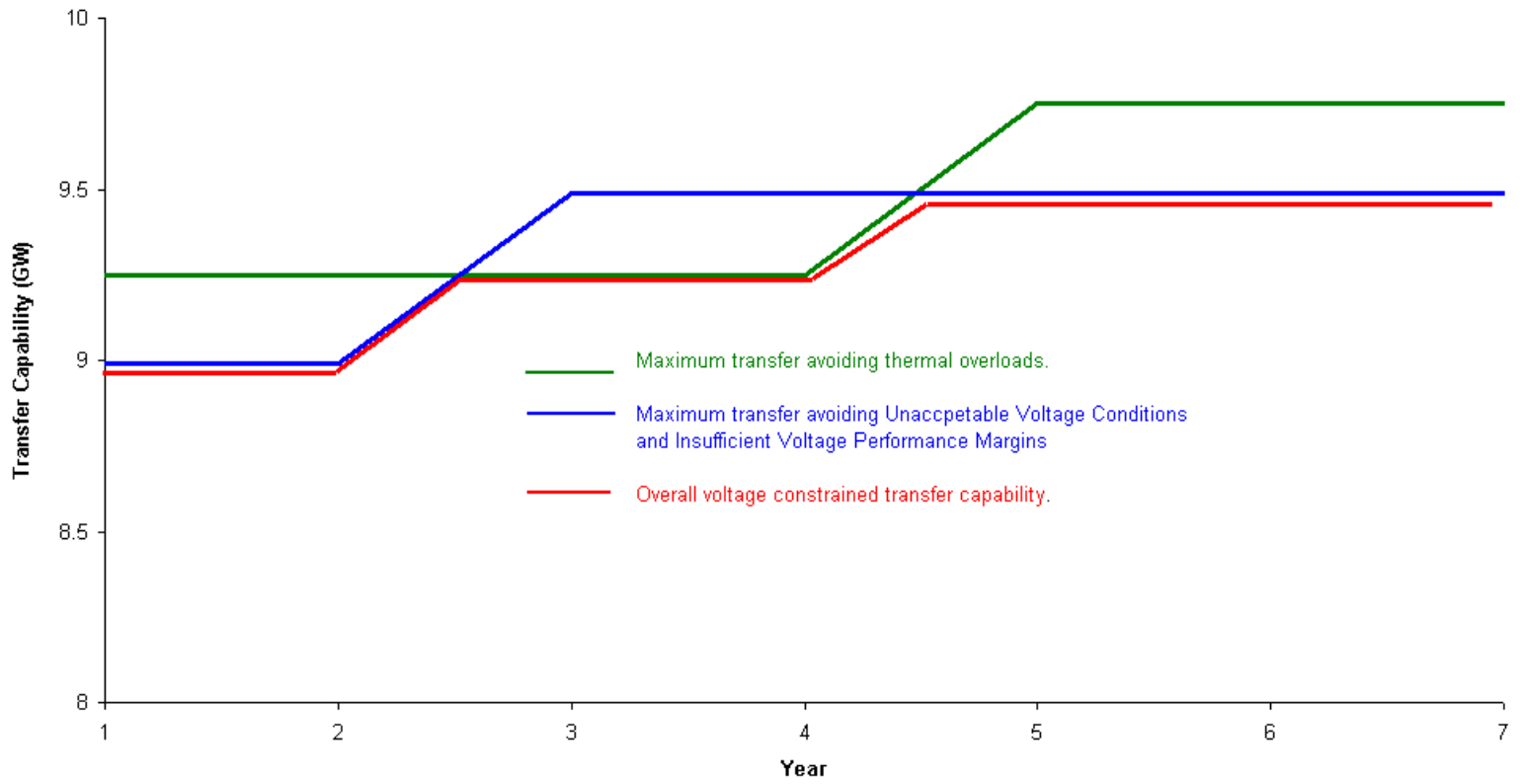


Figure 8.2 - Constraints on Boundary Transfer
(Example for Illustration Only)

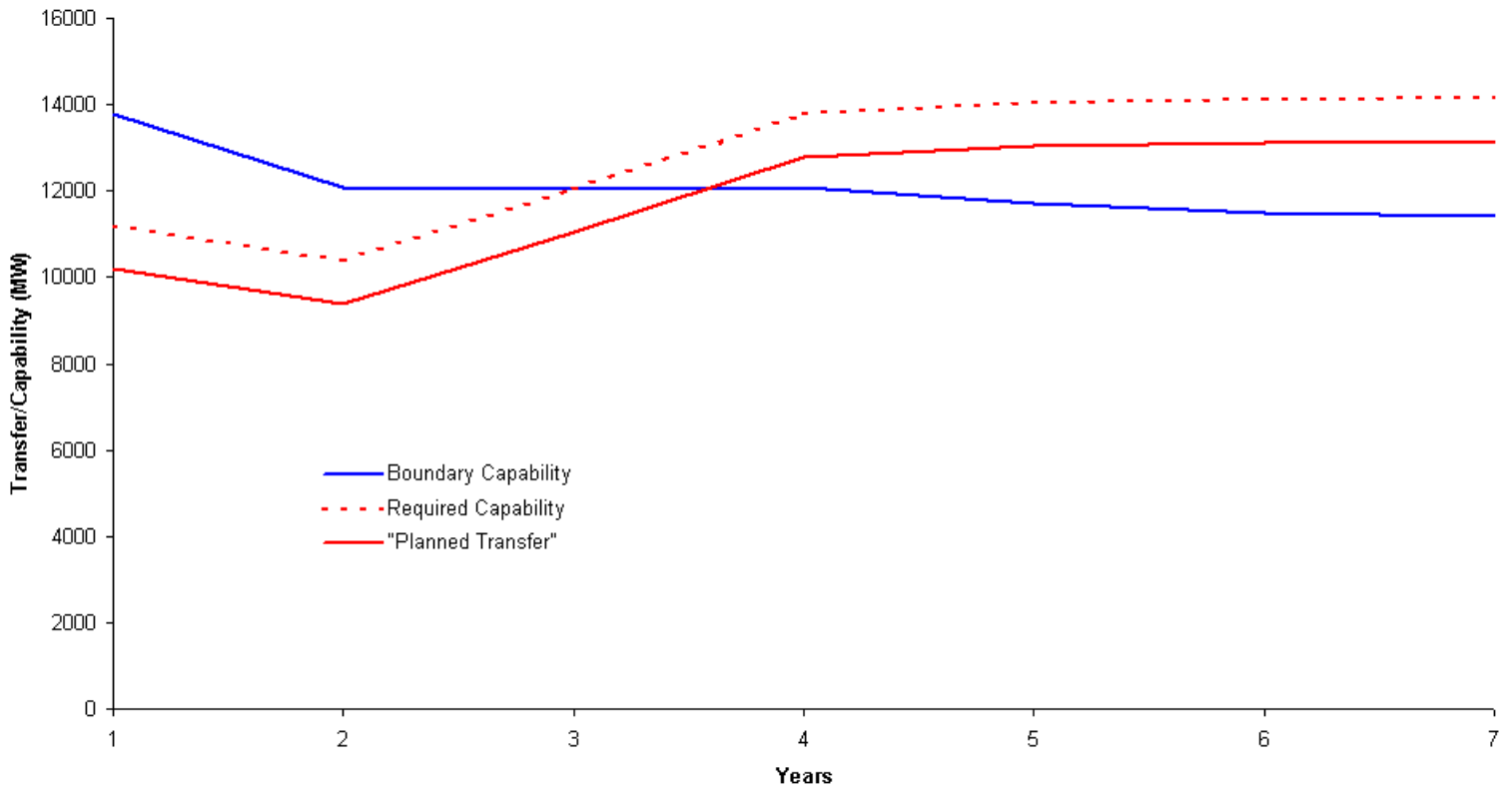


Figure 8.3 Boundary Transfers and Capability (Illustrative Example)

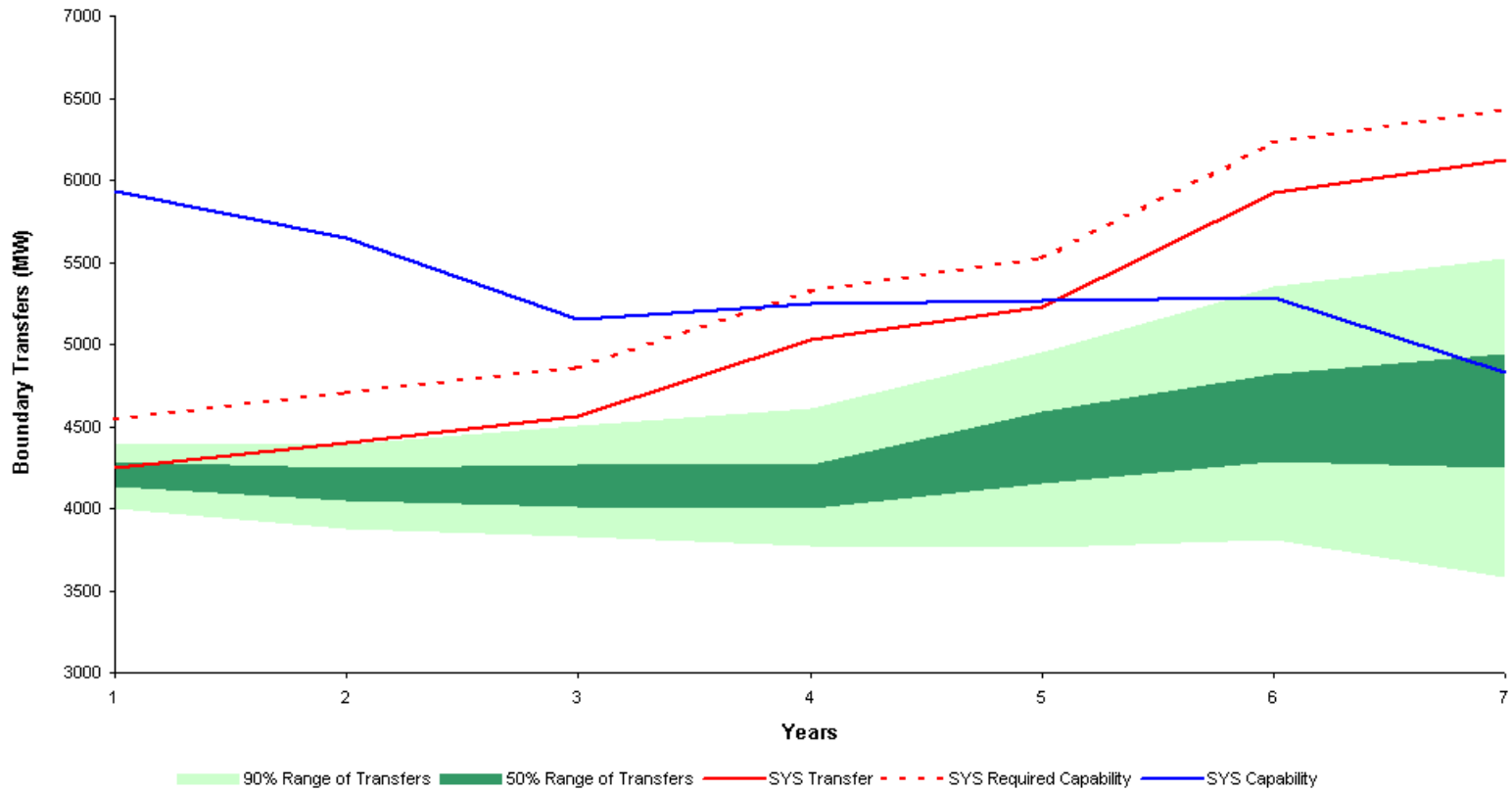


Figure 8.B1 Boundary Transfers and Capability
Boundary 1: North West Export

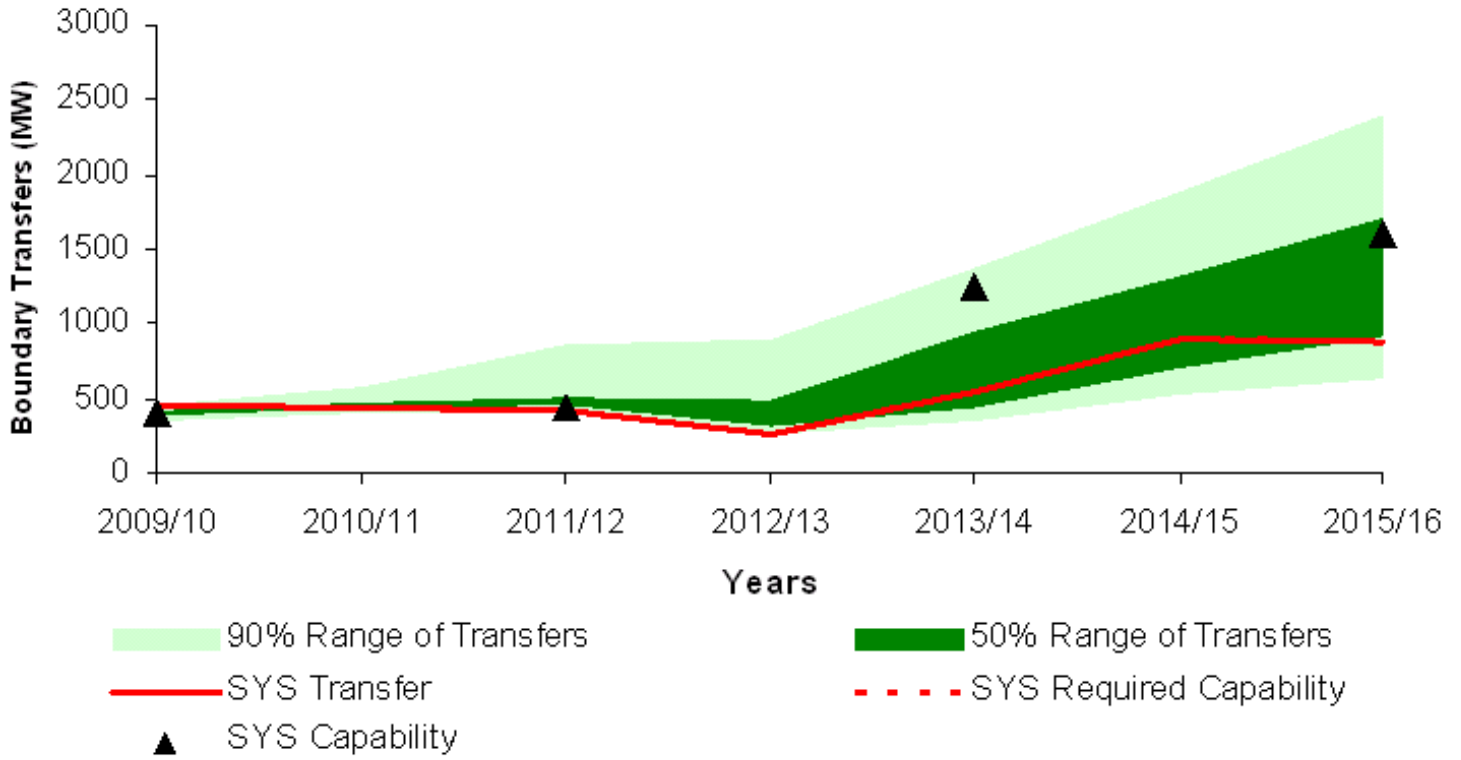


Figure 8.B2 Boundary Transfers and Capability
Boundary 2: North to South SHETL

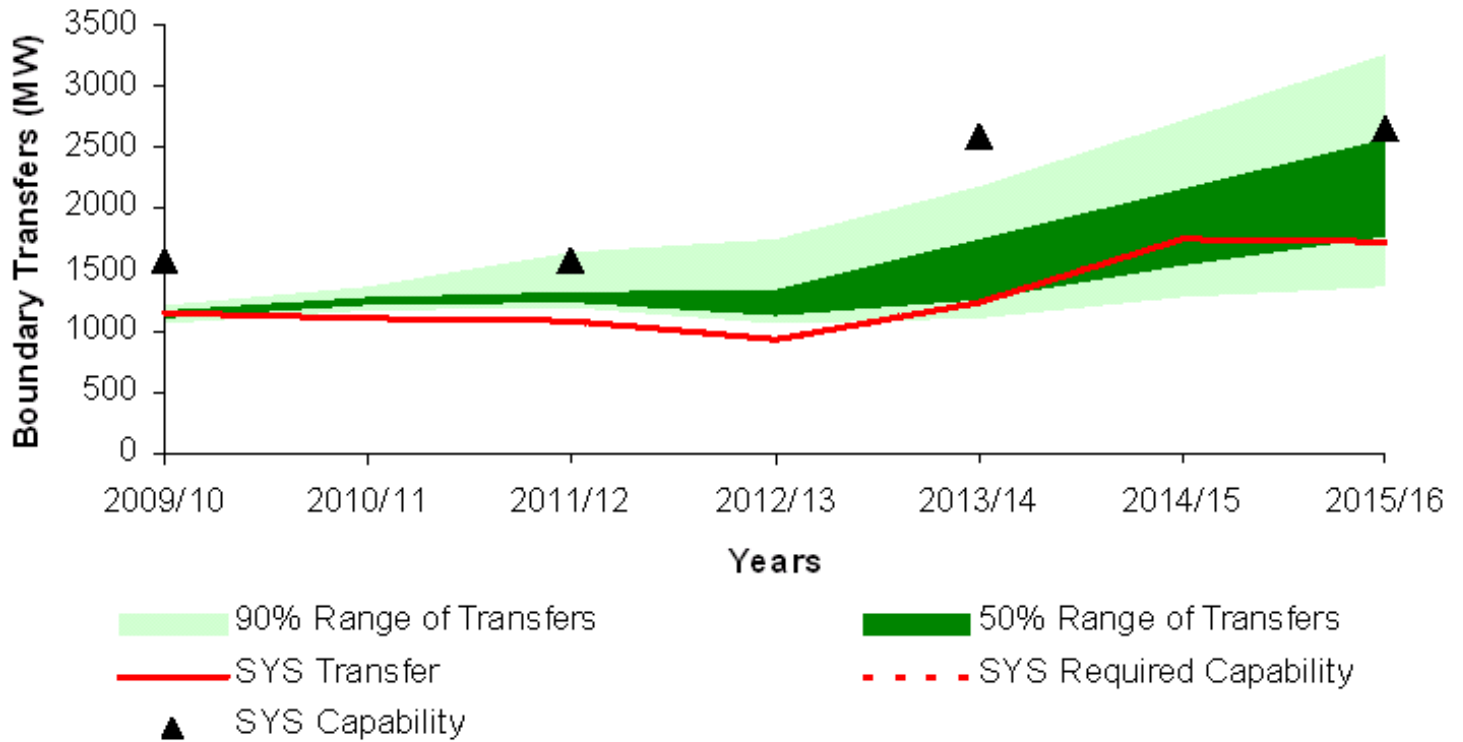


Figure 8.B3 Boundary Transfers and Capability Boundary 3: Sloy Export

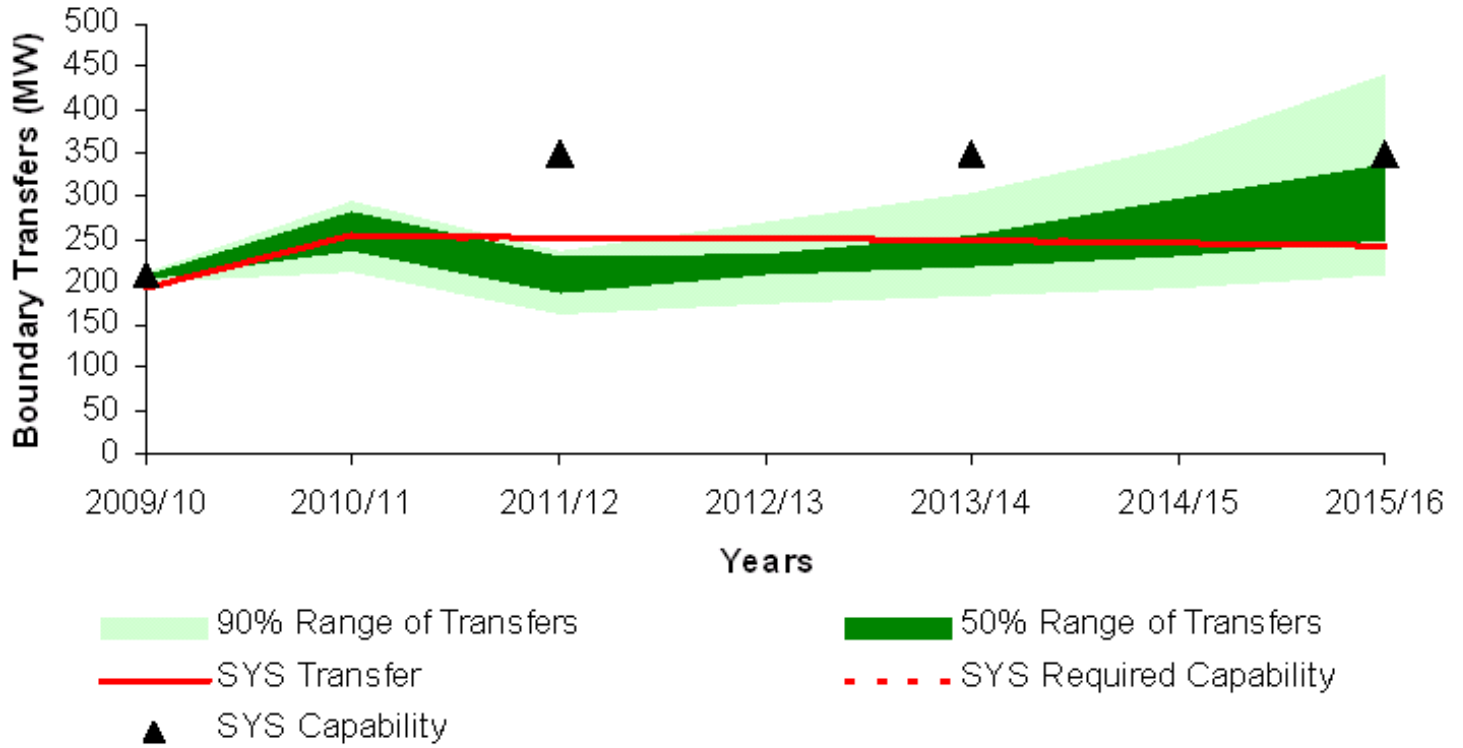


Figure 8.B4 Boundary Transfers and Capability
Boundary 4: SHETL to SPT

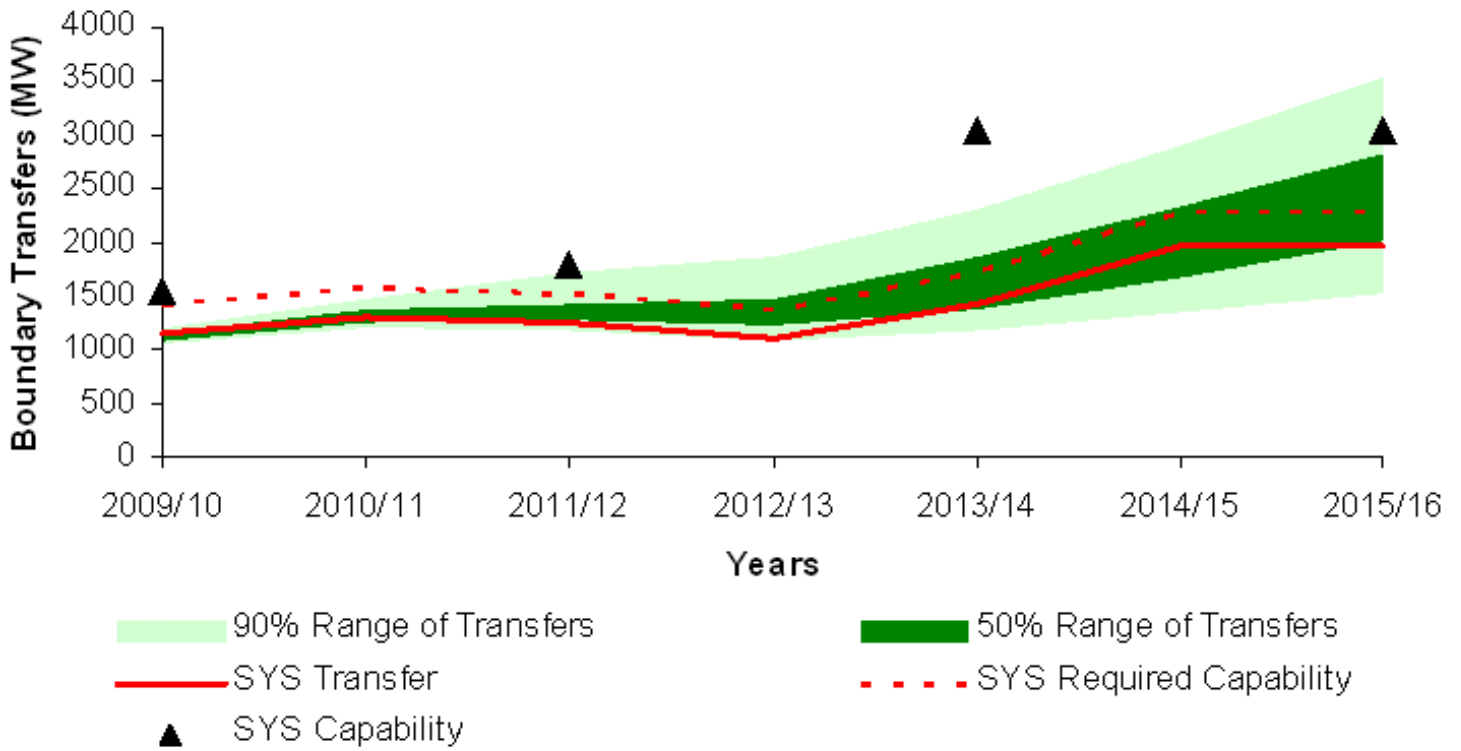


Figure 8.B5 Boundary Transfers and Capability
Boundary 5: North to South SPT

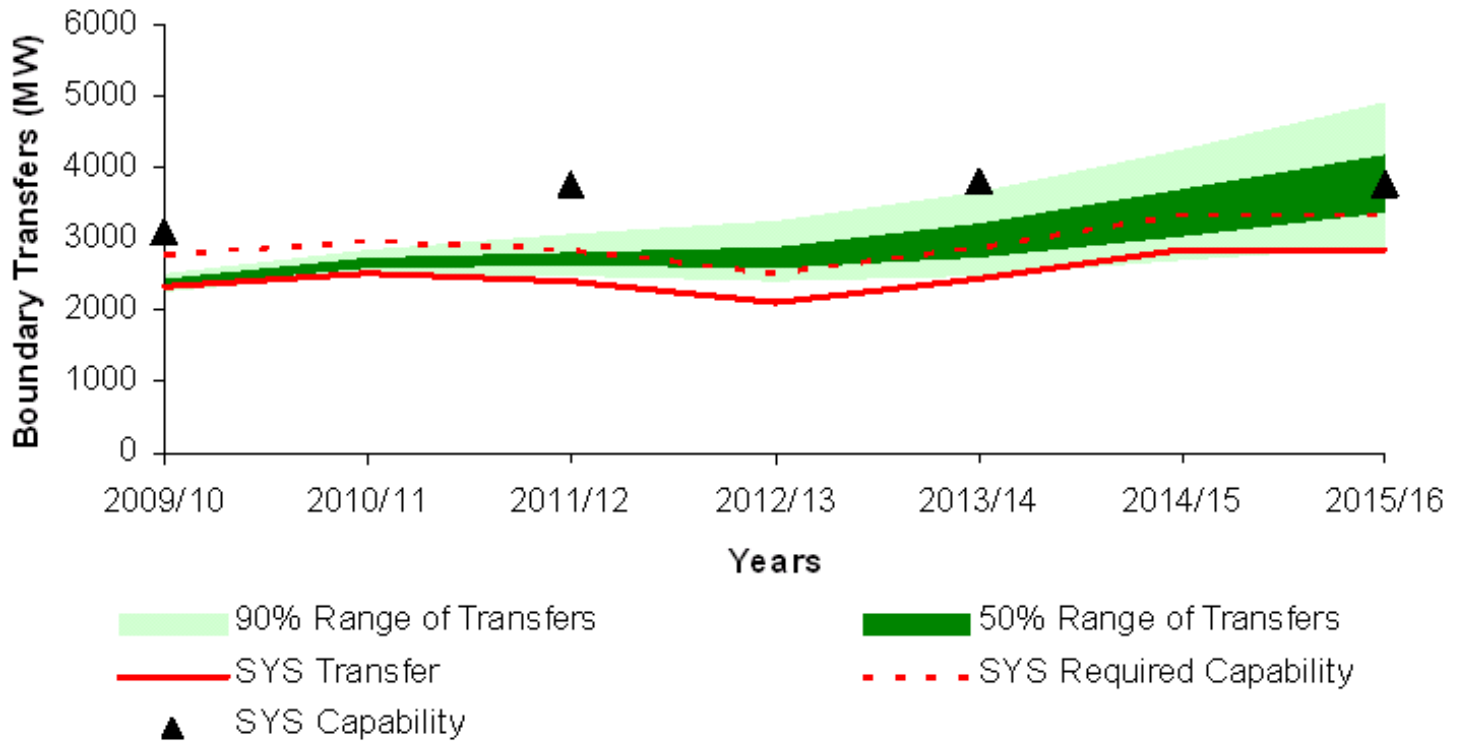


Figure 8.B6 Boundary Transfers and Capability
Boundary 6: SPT to NGET

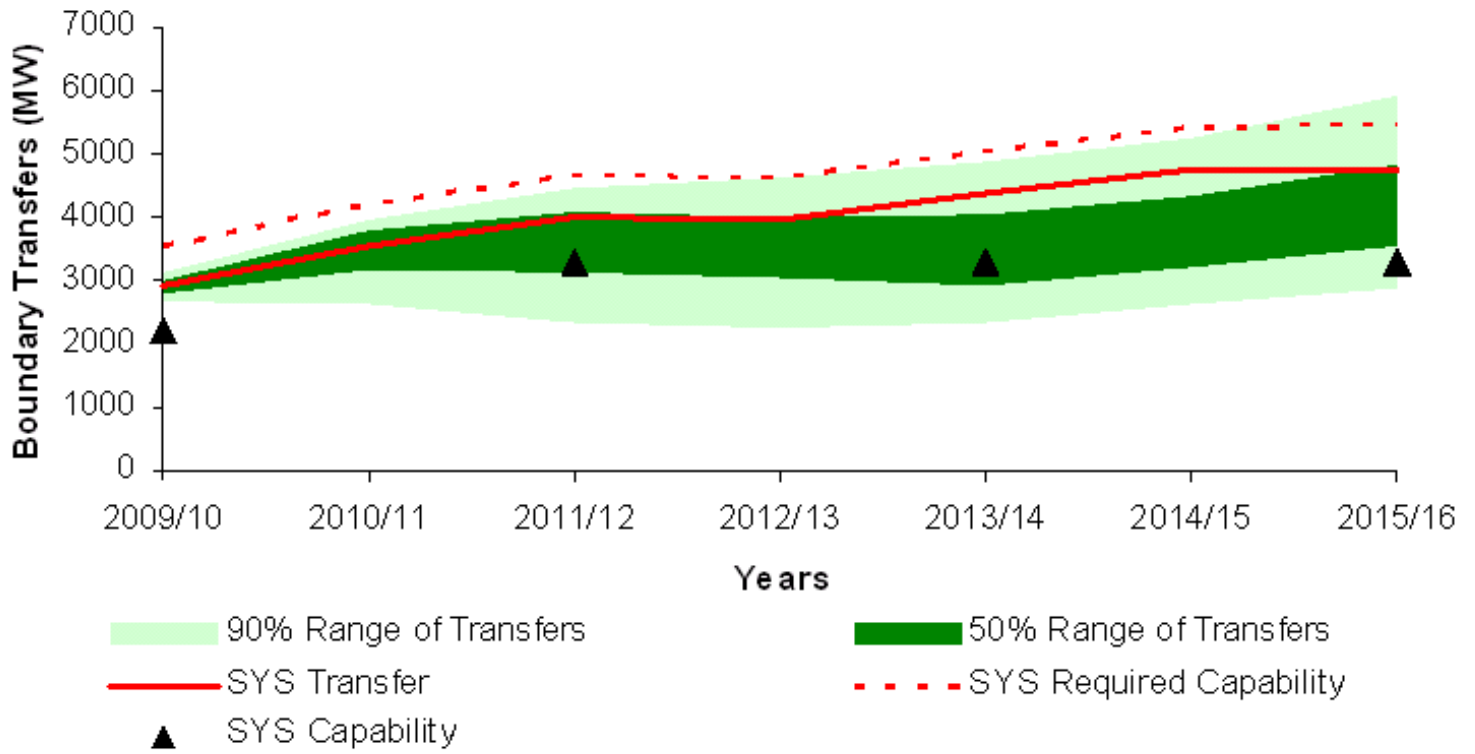


Figure 8.B7 Boundary Transfers and Capability
Boundary 7: Upper North to North

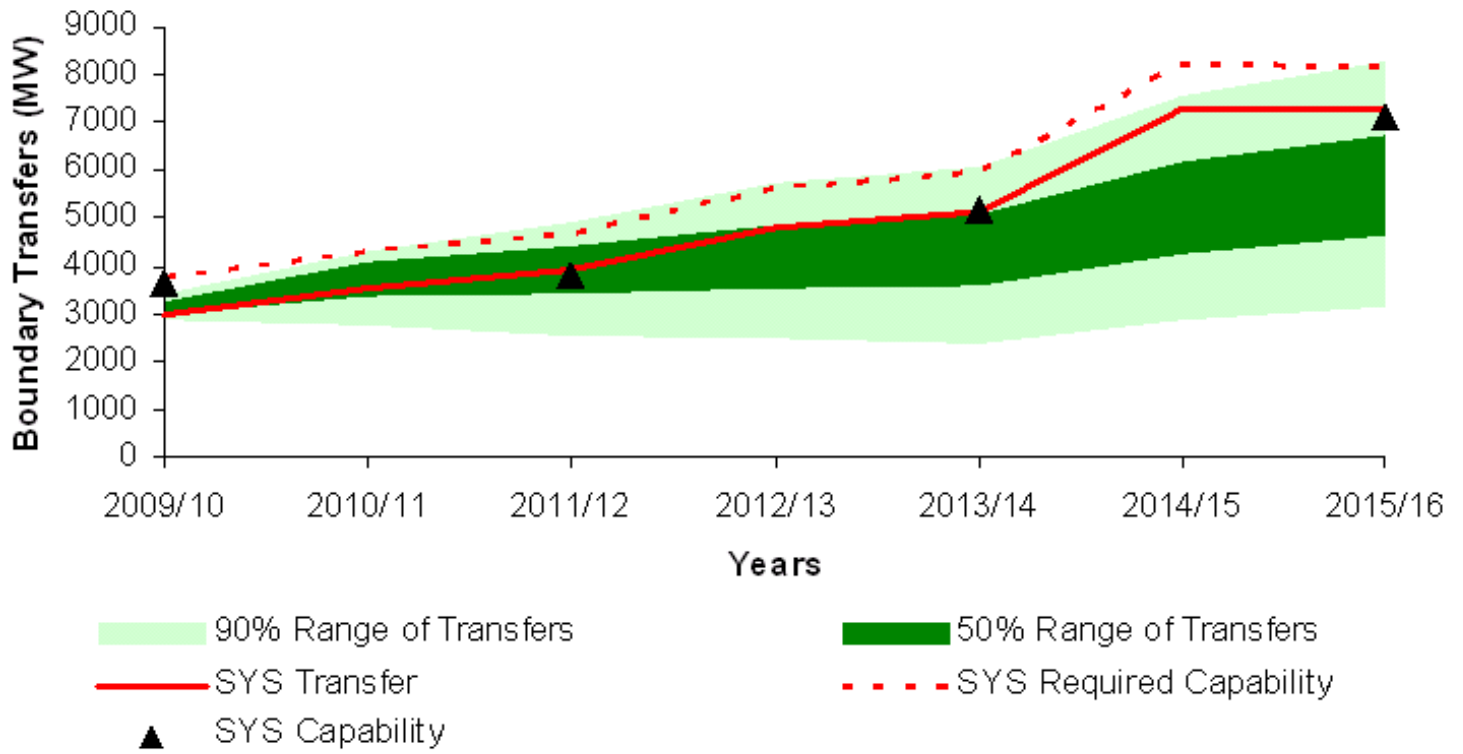


Figure 8.B8 Boundary Transfers and Capability
Boundary 8: North to Midlands

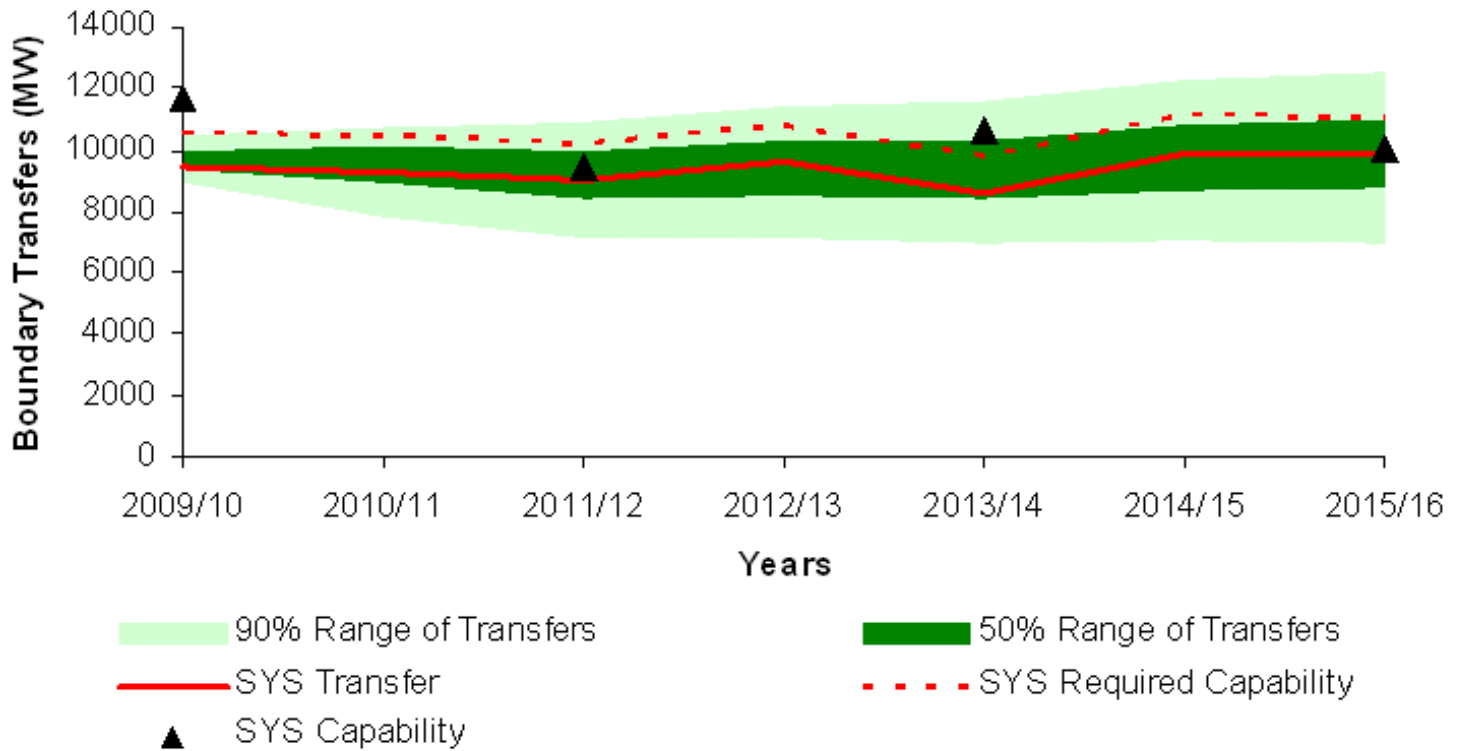


Figure 8.B9 Boundary Transfers and Capability
Boundary 9: Midlands to South

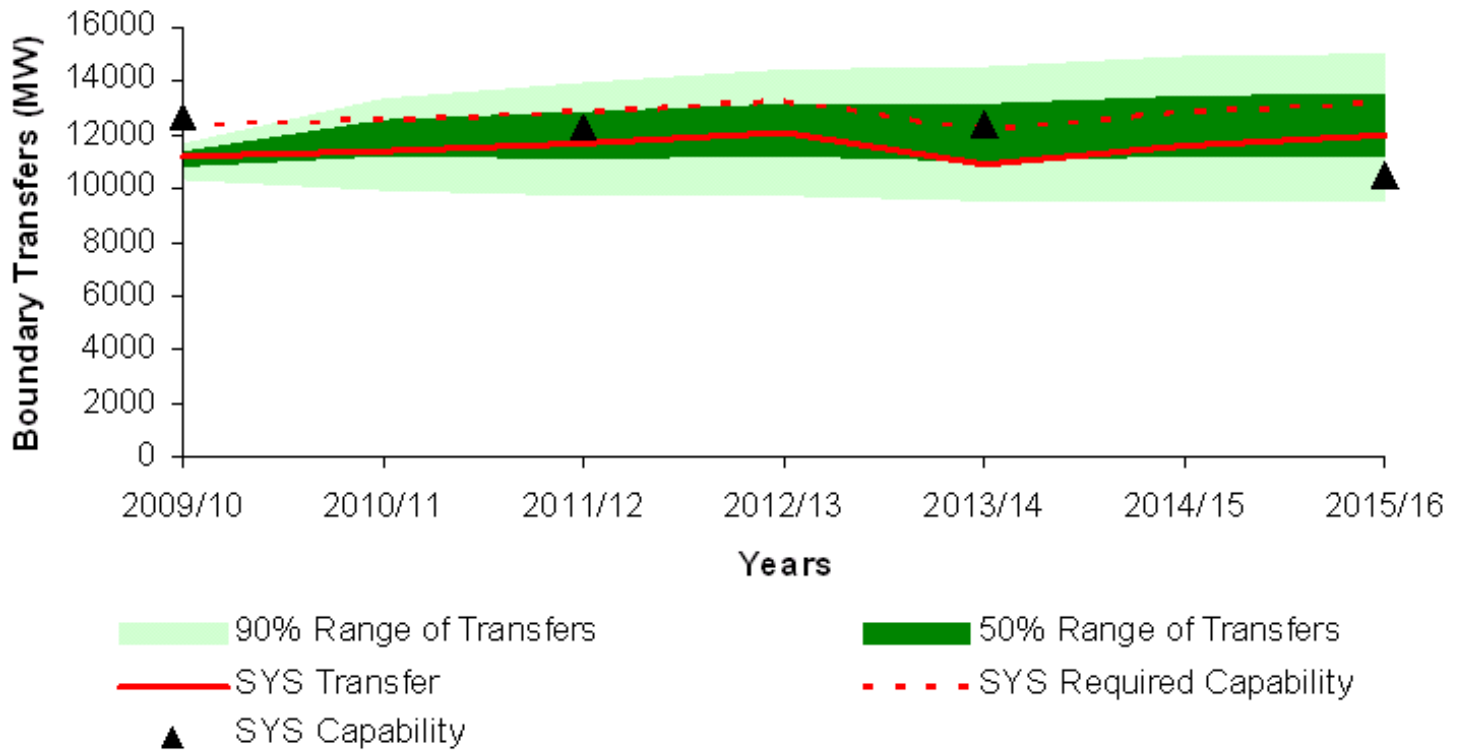


Figure 8.B10 Boundary Transfers and Capability
Boundary 10: South Coast

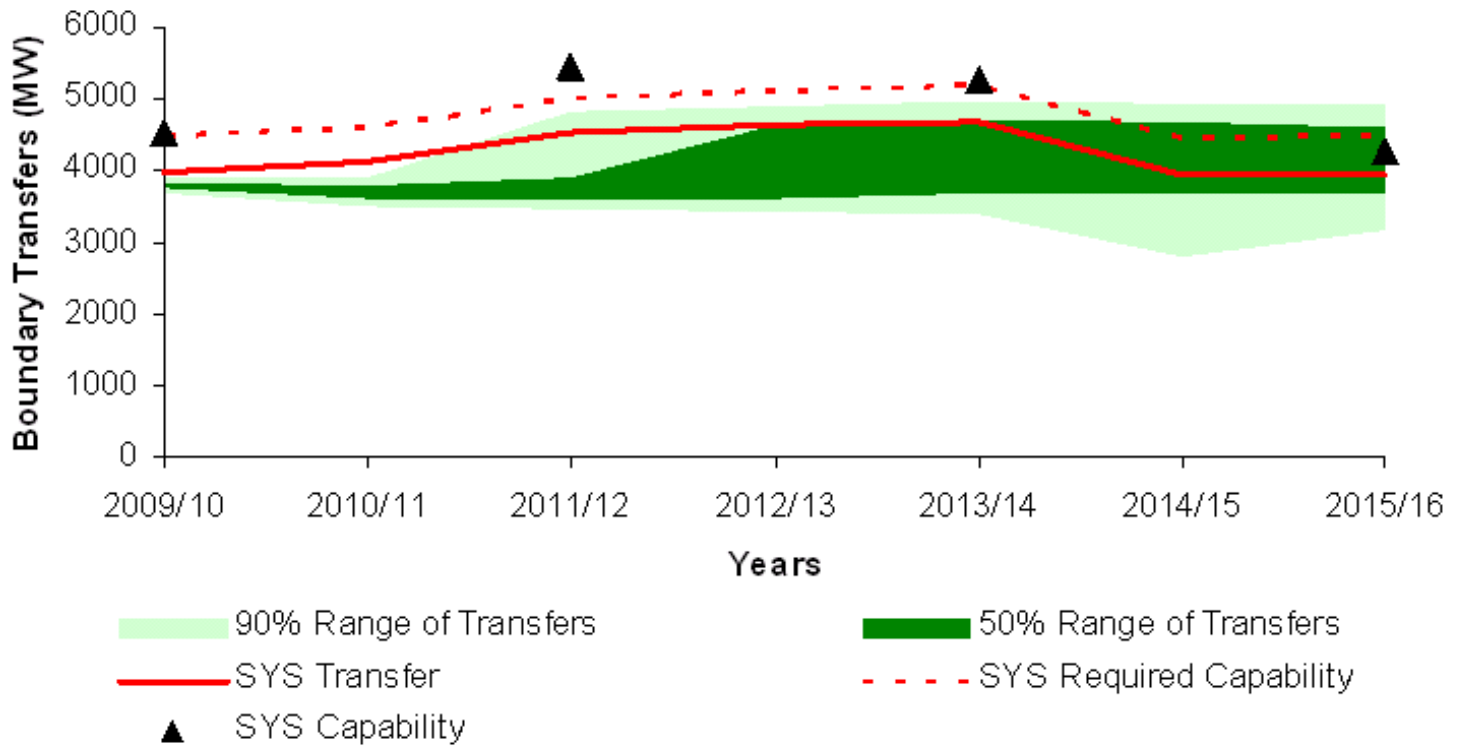


Figure 8.B11 Boundary Transfers and Capability Boundary 11: North East & Yorkshire

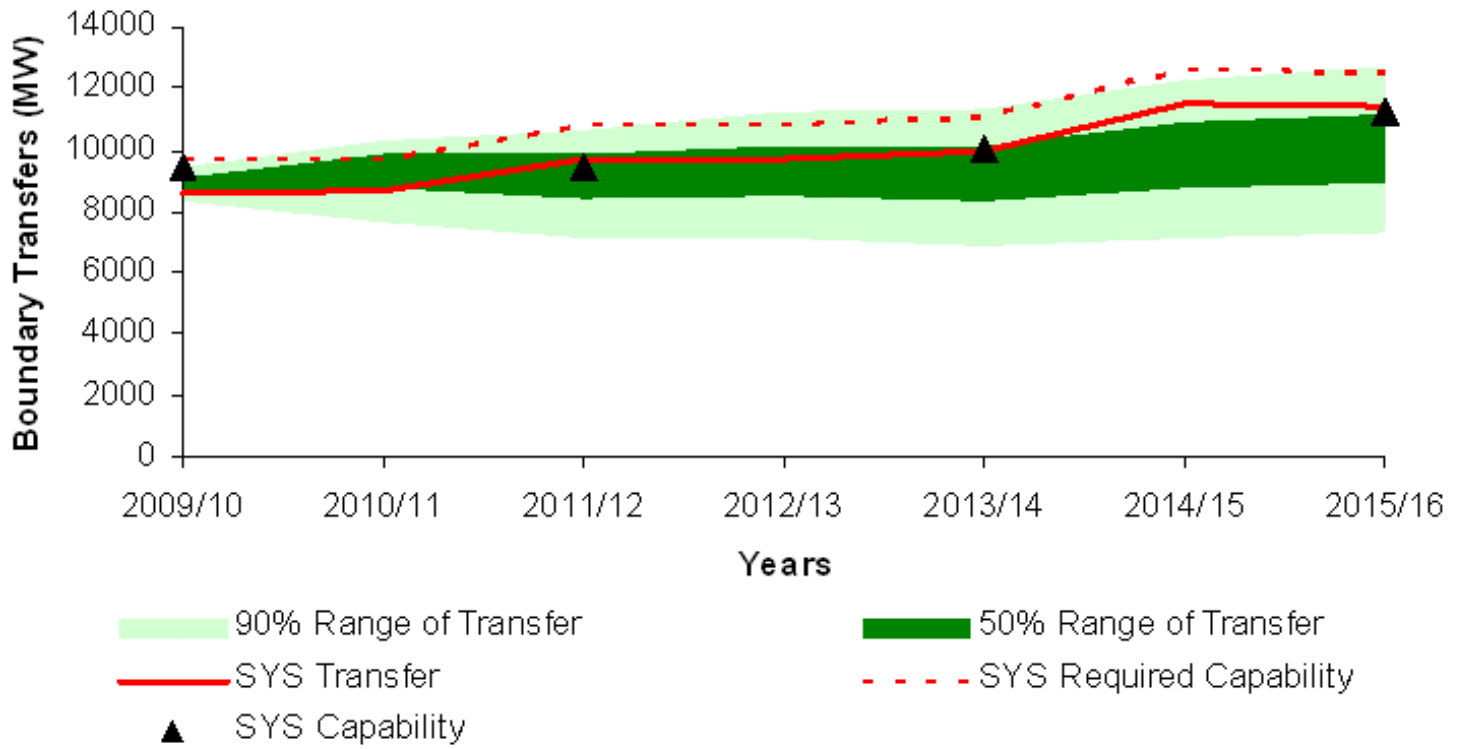


Figure 8.B12 Boundary Transfers and Capability
Boundary 12: South & South West

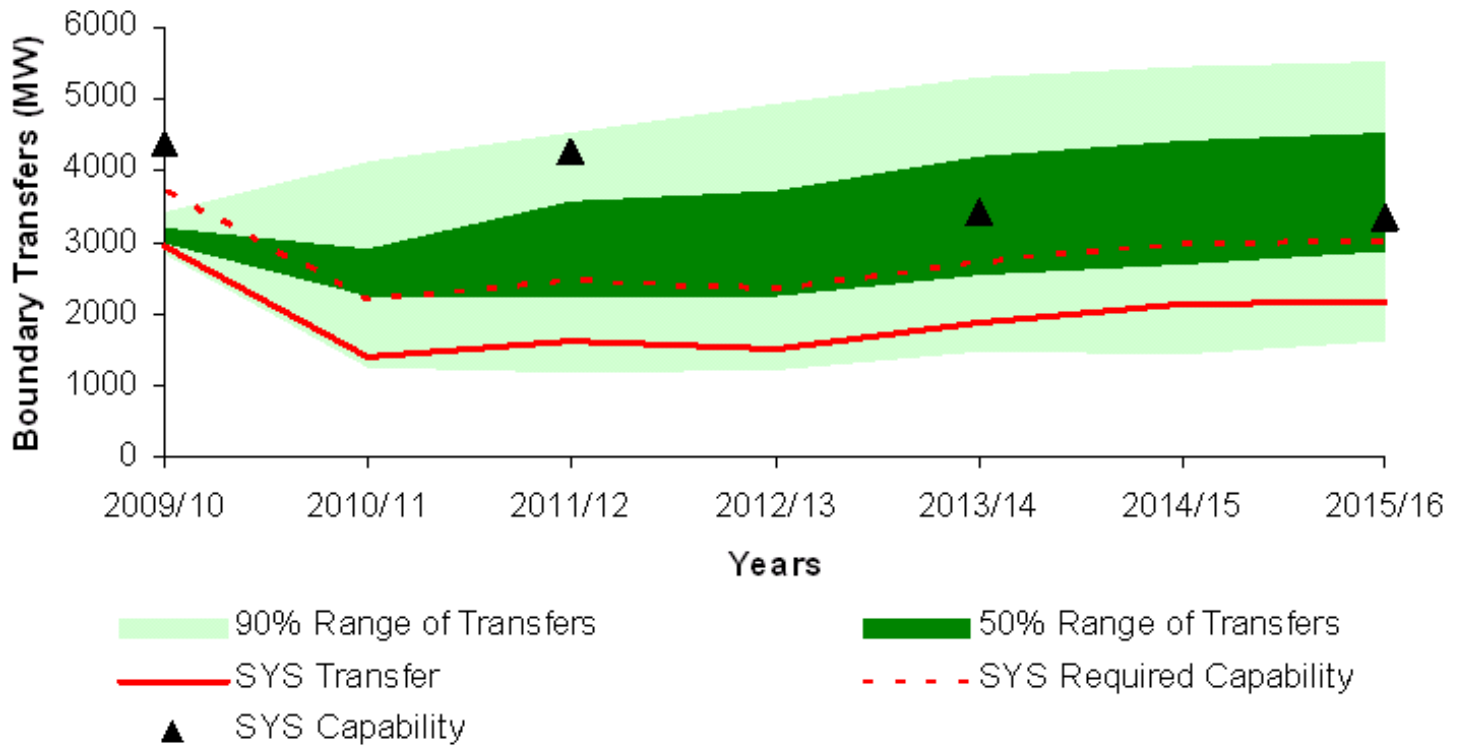


Figure 8.B13 Boundary Transfers and Capability
Boundary 13: South West

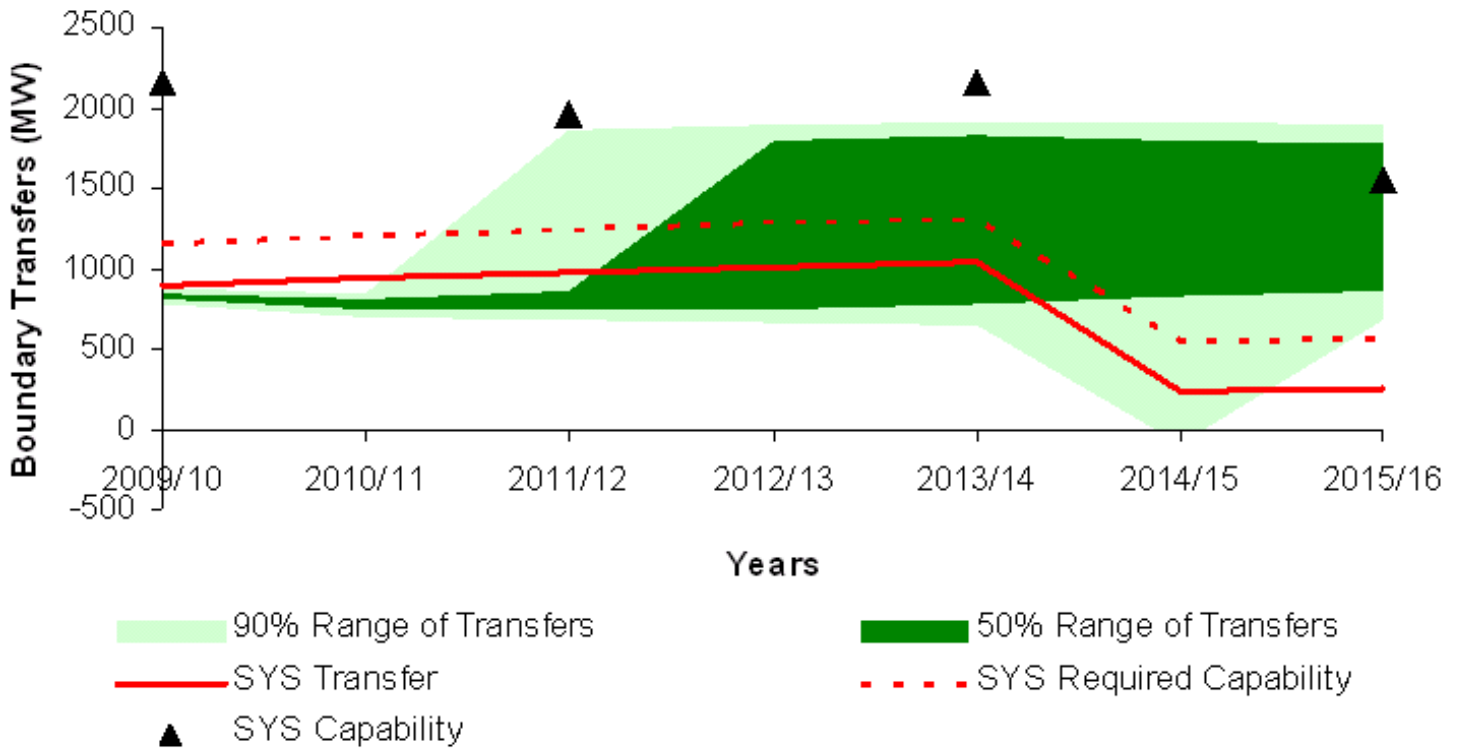


Figure 8.B 14 Boundary Transfers and Capability
Boundary 14: London

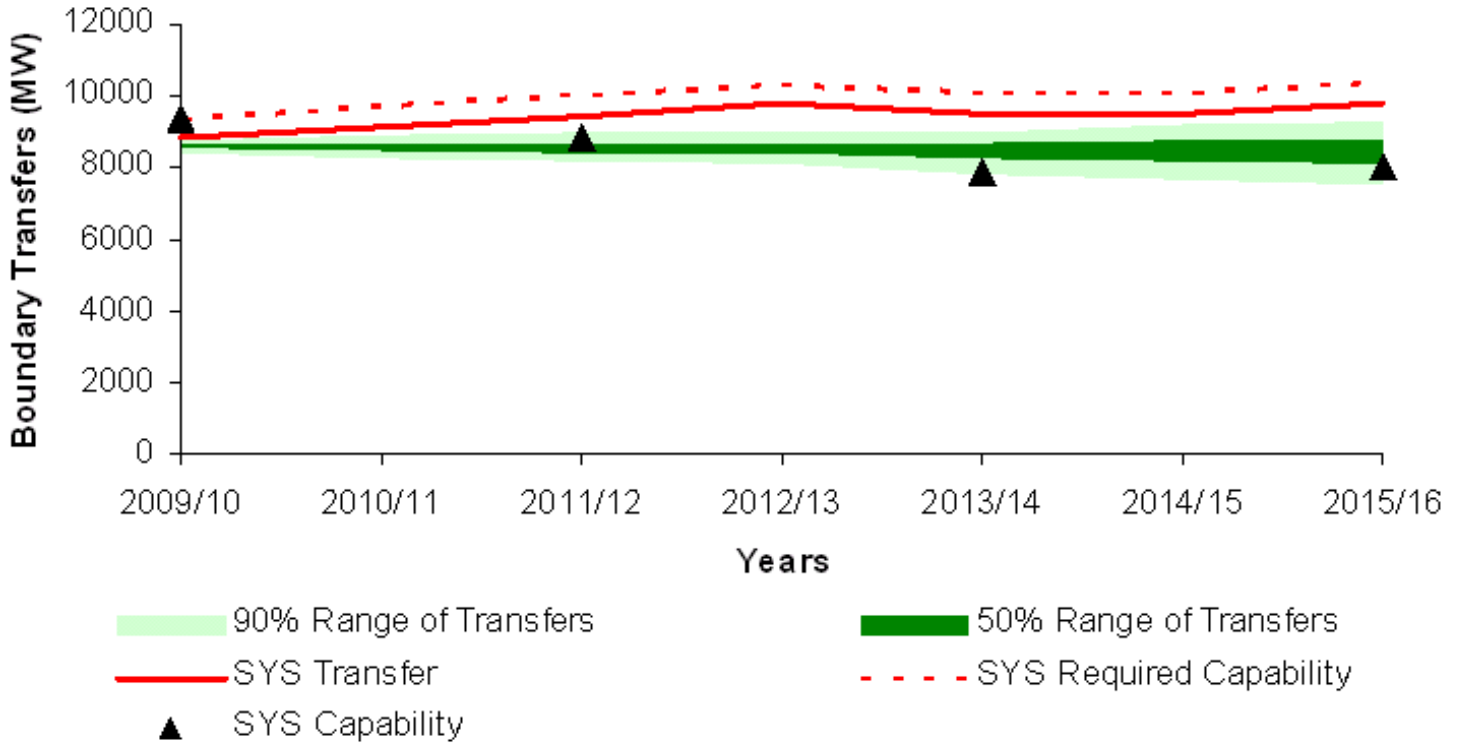


Figure 8.B15 Boundary Transfers and Capability Boundary 15: Thames Estuary

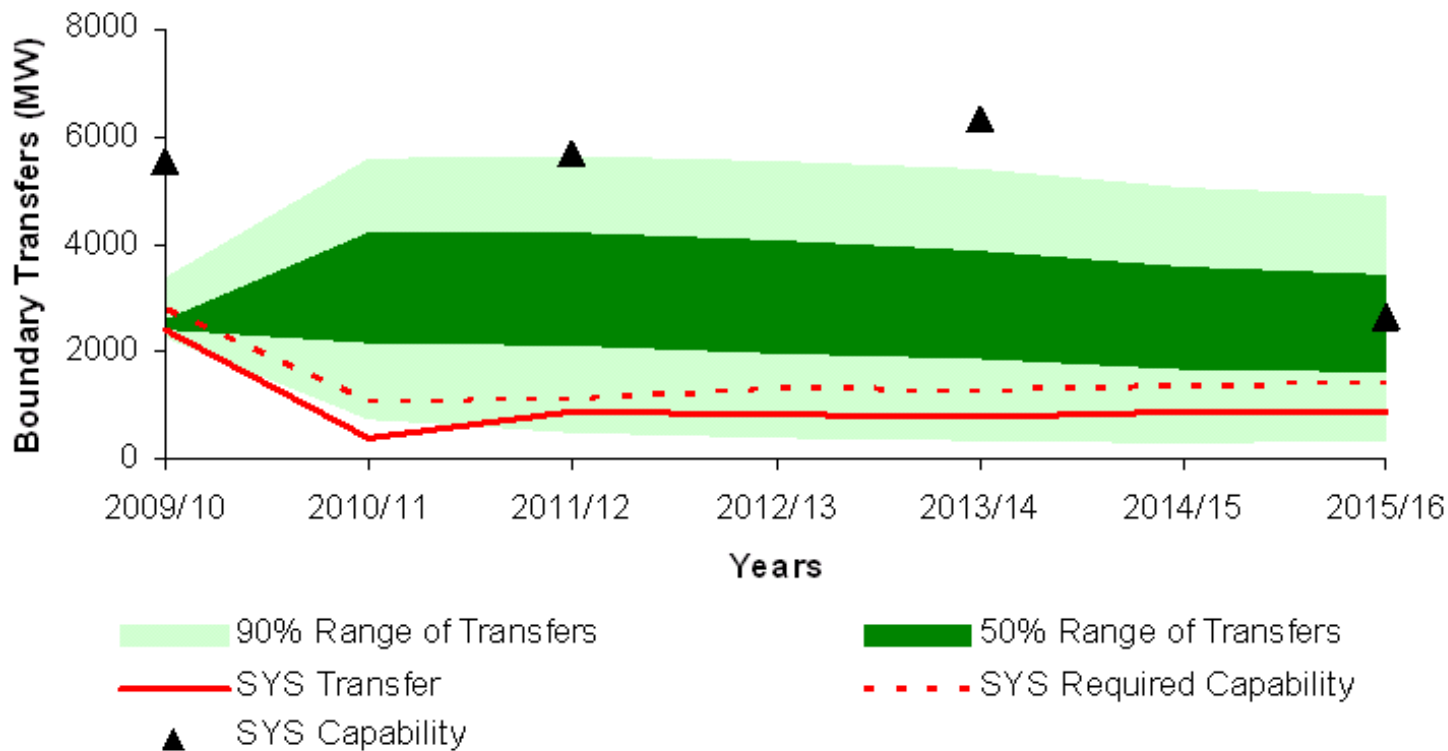


Figure 8.B16 Boundary Transfers and Capability
Boundary 16: North East, Trent & Yorkshire

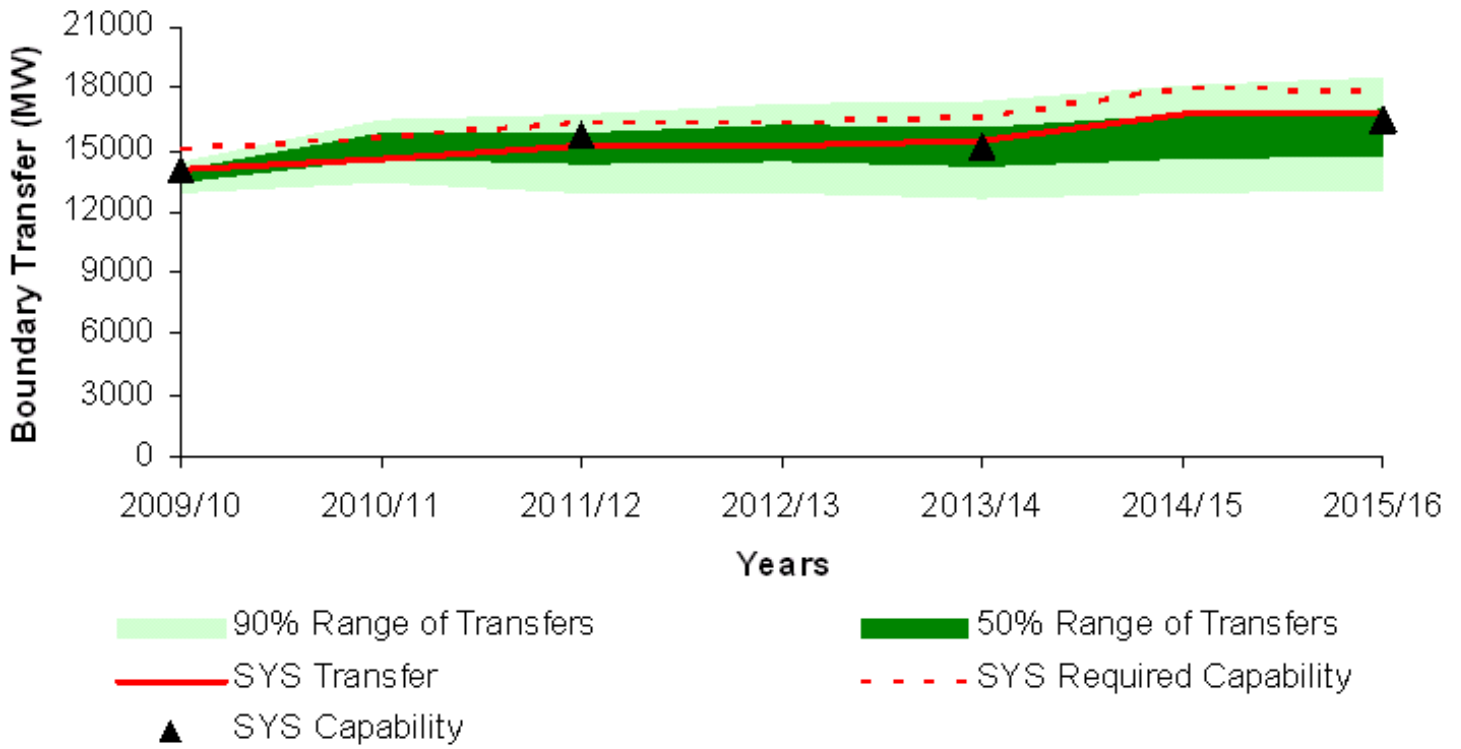


Figure 8.B17 Boundary Transfers and Capability Boundary 17: West Midlands

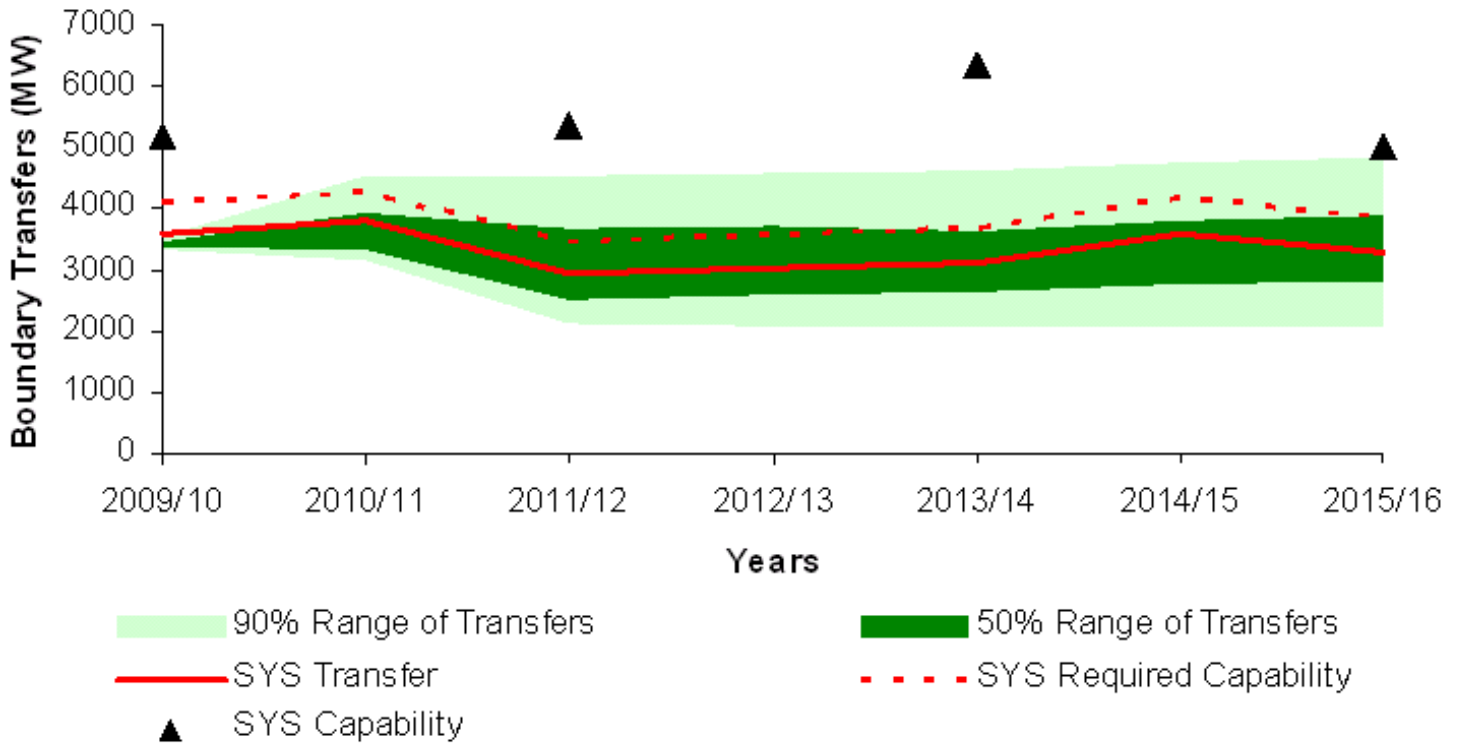


Figure 8-T1 - Boundary B1 Demand and Generation (MW)

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B1E	SHETL NORTH WEST (EXPORT)							
	Effective Generation	961	954	942	792	1075	1437	1434
	Demand	506	512	516	523	529	536	543
	Planned Transfer	455	442	426	269	546	901	891
B1I	SHETL NORTH WEST (IMPORT)							
	Effective Generation	58383	59032	59797	60643	60812	60953	61412
	Demand	58838	59474	60223	60912	61358	61854	62303
	Planned Transfer	-455	-442	-426	-269	-546	-901	-891

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B2E	SHETL NORTH - SOUTH (EXPORT)							
	Effective Generation	2232	2216	2186	2061	2381	2905	2898
	Demand	1089	1105	1116	1128	1139	1151	1165
	Planned Transfer	1143	1111	1070	933	1242	1754	1733
B2I	SHETL NORTH - SOUTH (IMPORT)							
	Effective Generation	57112	57770	58553	59374	59506	59485	59948
	Demand	58255	58881	59623	60307	60748	61239	61681
	Planned Transfer	-1143	-1111	-1070	-933	-1242	-1754	-1733

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B3E	SLOY (EXPORT)							
	Effective Generation	258	322	318	317	315	311	311
	Demand	66	67	65	66	67	68	69
	Planned Transfer	192	255	253	251	248	243	242
B3I	SLOY (IMPORT)							
	Effective Generation	59086	59664	60421	61118	61572	62079	62535
	Demand	59278	59919	60674	61369	61820	62322	62777
	Planned Transfer	-192	-255	-253	-251	-248	-243	-242

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B4E	SHETL - SPT (EXPORT)							
	Effective Generation	2846	3011	2971	2843	3181	3754	3763
	Demand	1698	1709	1725	1744	1762	1781	1802
	Planned Transfer	1148	1302	1246	1099	1419	1973	1961
B4I	SHETL - SPT (IMPORT)							
	Effective Generation	56498	56975	57768	58592	58706	58636	59083
	Demand	57646	58277	59014	59691	60125	60609	61044
	Planned Transfer	-1148	-1302	-1246	-1099	-1419	-1973	-1961

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B5E	SPT NORTH - SOUTH (EXPORT)							
	Effective Generation	5234	5419	5324	5012	5363	5829	5852
	Demand	2886	2899	2900	2901	2920	2967	2985
	Planned Transfer	2348	2520	2424	2112	2443	2862	2867
B5I	SPT NORTH - SOUTH (IMPORT)							
	Effective Generation	54110	54567	55415	56423	58524	58561	58994
	Demand	56458	57087	57839	58534	58967	59423	59861
	Planned Transfer	-2348	-2520	-2424	-2112	-2443	-2862	-2867

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B6E	SPT - NGET (EXPORT)							
	Effective Generation	8815	9491	9961	9917	10336	10778	10804
	Demand	5912	5934	5953	5948	5978	6041	6051
	Planned Transfer	2903	3557	4008	3970	4358	4737	4753
B6I	SPT - NGET (IMPORT)							
	Effective Generation	50529	50495	50778	51518	51551	51612	52042
	Demand	53432	54052	54786	55487	55909	56349	56795
	Planned Transfer	-2903	-3557	-4008	-3970	-4358	-4737	-4753

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B7E	UPPER NORTH (EXPORT)							
	Effective Generation	11682	12317	12734	13718	14116	16501	16528
	Demand	8711	8720	8748	8803	8867	9104	9178
	Planned Transfer	2972	3597	3986	4915	5248	7397	7350
B7I	UPPER NORTH (IMPORT)							
	Effective Generation	47662	47669	48005	47717	47771	45889	46318
	Demand	50634	51265	51991	52632	53020	53286	53668
	Planned Transfer	-2972	-3597	-3986	-4915	-5248	-7397	-7350

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B8E	NORTH TO MIDLANDS (EXPORT)							
	Effective Generation	31376	31299	31484	32335	31463	33117	33157
	Demand	21984	21784	22433	22651	22790	23168	23243
	Planned Transfer	9392	9515	9051	9684	8673	9950	9914
B8I	NORTH TO MIDLANDS (IMPORT)							
	Effective Generation	27969	28687	29255	29100	30424	29272	29689
	Demand	37361	38202	38306	38784	39097	39222	39603
	Planned Transfer	-9392	-9515	-9051	-9684	-8673	-9950	-9914

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B9E	MIDLANDS - SOUTH (EXPORT)							
	Effective Generation	40851	41343	42071	42861	41935	43004	43445
	Demand	29710	29678	30393	30683	30853	31310	31425
	Planned Transfer	11141	11666	11677	12177	11082	11694	12020
B9I	MIDLANDS - SOUTH (IMPORT)							
	Effective Generation	18494	18642	18668	18574	19952	19386	19401
	Demand	29634	30308	30345	30752	31034	31079	31421
	Planned Transfer	-11141	-11666	-11677	-12177	-11082	-11694	-12020

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B10E	SOUTH COAST (EXPORT)							
	Effective Generation	2983	2940	2552	2537	2524	3307	3309
	Demand	6949	7028	6990	7028	7078	7116	7124
	Planned Transfer	-3966	-4088	-4439	-4491	-4554	-3809	-3815
B10I	SOUTH COAST (IMPORT)							
	Effective Generation	56361	57046	58187	58898	59363	59083	59537
	Demand	52396	52958	53749	54407	54808	55274	55722
	Planned Transfer	3966	4088	4439	4491	4554	3809	3815

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B11E	NORTH EAST & YORKSHIRE (EXPORT)							
	Effective Generation	23188	23143	24352	24745	25087	26871	26907
	Demand	14614	14364	14617	14875	14982	15294	15385
	Planned Transfer	8573	8779	9735	9870	10105	11577	11521
B11I	NORTH EAST & YORKSHIRE (IMPORT)							
	Effective Generation	36157	36843	36387	36690	36800	35518	35939
	Demand	44730	45622	46122	46560	46905	47096	47460
	Planned Transfer	-8573	-8779	-9735	-9870	-10105	-11577	-11521

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B12E	SOUTH & SOUTH WEST (EXPORT)							
	Effective Generation	8923	10756	10123	10351	10116	9905	9912
	Demand	11856	12048	12006	12080	12180	12234	12260
	Planned Transfer	-2933	-1292	-1883	-1729	-2063	-2329	-2348
B12I	SOUTH & SOUTH WEST (IMPORT)							
	Effective Generation	50421	49230	50616	51084	51770	52485	52933
	Demand	47488	47938	48733	49355	49707	50155	50585
	Planned Transfer	2933	1292	1883	1729	2063	2329	2348

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B13E	SOUTH WEST (EXPORT)							
	Effective Generation	1773	1747	1714	1704	1696	2496	2497
	Demand	2655	2676	2654	2670	2690	2703	2709
	Planned Transfer	-882	-929	-939	-966	-994	-208	-211
B13I	SOUTH WEST (IMPORT)							
	Effective Generation	57572	58238	59024	59731	60191	59894	60349
	Demand	56689	57310	58085	58765	59197	59686	60137
	Planned Transfer	882	929	939	966	994	208	211

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B14E	LONDON (EXPORT)							
	Effective Generation	1242	1224	1201	1195	1557	1525	1526
	Demand	10029	10331	10482	10738	10833	10756	11062
	Planned Transfer	-8787	-9107	-9281	-9542	-9275	-9232	-9536
B14I	LONDON (IMPORT)							
	Effective Generation	58103	58761	59538	60240	60330	60865	61320
	Demand	49316	49655	50257	50698	51054	51633	51784
	Planned Transfer	8787	9107	9281	9542	9275	9232	9536

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B15E	THAMES ESTUARY (EXPORT)							
	Effective Generation	4425	2483	2960	2937	2905	3003	3006
	Demand	2021	2107	2108	2139	2160	2172	2140
	Planned Transfer	2404	376	851	798	745	832	866
B15I	THAMES ESTUARY (IMPORT)							
	Effective Generation	54920	57502	57779	58498	58982	59386	59840
	Demand	57324	57879	58630	59296	59727	60218	60706
	Planned Transfer	-2404	-376	-851	-798	-745	-832	-866

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B16E	NORTH EAST, TRENT & YORKSHIRE (EXPORT)							
	Effective Generation	29235	29808	30579	30936	31245	32903	32944
	Demand	15333	15126	15376	15644	15738	16072	16170
	Planned Transfer	13902	14682	15202	15292	15507	16831	16774
B16I	NORTH EAST, TRENT & YORKSHIRE (IMPORT)							
	Effective Generation	30109	30178	30160	30499	30642	29486	29902
	Demand	44011	44860	45362	45791	46149	46317	46676
	Planned Transfer	-13902	-14682	-15202	-15292	-15507	-16831	-16774

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

	BOUNDARY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
B17E	WEST MIDLANDS (EXPORT)							
	Effective Generation	3427	3379	4360	4334	4313	3854	4250
	Demand	7008	7132	7201	7263	7306	7364	7398
	Planned Transfer	-3580	-3752	-2841	-2928	-2993	-3510	-3147
B17I	WEST MIDLANDS (IMPORT)							
	Effective Generation	55917	56606	56379	57101	57574	58535	58596
	Demand	52337	52854	53537	54172	54581	55026	55448
	Planned Transfer	3580	3752	2841	2928	2993	3510	3147

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
Strathaven - Smeaton	Uprate the existing Strathaven-Wishaw-Kaimes-Smeaton 275kV circuits to 400kV operation and reconfigure.	SPT - NGET
Torness - Eccles	Install a second 400kV cable per phase on both Torness-Eccles 400kV circuits.	SPT - NGET
Strathaven - Harker and Eccles - Stella West	Install reactive series compensation.	SPT - NGET
Hunterston - Deeside	Establish a new offshore transmission route from Hunterston to Deeside	SPT - NGET
Elstree - Sundon	Increase the rating of the Elstree to Sundon circuits	NGET
Elstree - St Johns Wood	Install second cable	NGET
High Marnham - Ratcliffe	Increase the rating on the High Marnham to Ratcliffe circuits	NGET
Ratcliffe - Staythorpe	Increase the rating of the Ratcliffe to Staythorpe circuit	NGET
Grendon - West Burton	Increase the rating of the Grendon to West Burton circuit	NGET
Hutton	Install reactive compensation (1 MSC)	NGET
Stella West	Install reactive compensation (2 MSCs)	NGET
Harker	Install reactive compensation (3 MSCs)	NGET
Cottam	Install reactive compensation (1 MSC)	NGET
Staythorpe	Install reactive compensation (4 MSCs)	NGET
Ratcliffe on Soar	Install reactive compensation (1 MSC)	NGET
Eaton Socon	Install reactive compensation (1 MSC)	NGET
High Marnham	Install reactive compensation (1 MSC)	NGET
Stoke Bardolph	Install reactive compensation (2 MSCs)	NGET
Burwell	Install reactive compensation (2 MSCs)	NGET

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GB Seven Year Statement 2009

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.

Eire Link

Eirgrid is developing an 500MW HVDC interconnector to join Eire to the GB network at Deeside. A second 375MW HVC link to Eire is being developed by East West Cable One Ltd connecting at Pentir. Both interconnectors are proposed for 2011 connection.

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.

It 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 83.6GW in 2009/10 to 109.8GW by 2015/16. The largest change is due to a 10.3GW increase in CCGT plant capacity, which constitutes a 12.3% increase in overall capacity over the period. On this basis, the capacity of CCGT plant will overtake that of coal by 2010/11. By 2015/16, CCGT capacity will exceed coal capacity by 6.5GW and account for 30.2% of the total transmission contracted installed generation capacity.

The next largest increases are due to the growth in Wind generation, with onshore wind accounting for a 6.9% increase and offshore wind accounting for a 6.3% increase in overall capacity. Wind generation capacity (both onshore and offshore) is set to rise to 11.1GW by 2015/16.

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

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

The disposition of the 30.2GW of projected increase in generating capacity is described in [Generation Disposition](#). In particular, [Table 3.13](#) details the capacity changes on a zonal basis. A key message arising from the analyses of boundary power transfers is that, with this 26.2GW increase in new generation planned over the next seven years, the resultant power flows through the Scottish and English grid systems to the Midlands would require significant reinforcement. The future is uncertain and it may be that not all projects may proceed to completion. In addition some existing fossil fuel stations may close for either technical or commercial reasons e.g. following the introduction of the Large Combustion Plant Directive in 2008.

Generation Opportunities

As in previous years, Figure E.12 provides an indication of the opportunities for new generation across the 17 SYS Study Zones. The 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 caused by the need for planning consent and possible Public Inquiry. The red areas on the diagram would imply limited opportunity for connection in those zones given the level of transmission reinforcement required. Whilst the diagram correctly represents the opportunity for connection to a compliant network, it should be noted that Ofgem's open letter dated 8th May provides the opportunity for new generation projects to connect under a derogation in advance of the wider system reinforcements being delivered. This interim measure is intended to be in operation until the implementation of the enduring transmission access arrangements which are currently being consulted upon with the industry. We therefore advise customers to contact National Grid if they are interested in making a connection to the transmission system so that the likely lead times for connection can be properly assessed against the background commercial and regulatory framework.

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 SPT - NGET boundary (Boundary B6), where there is insufficient transmission capacity to accommodate the level of contracted generation in Scotland.

The SYS background power flows across major boundaries within Scotland have increased over the period of the SYS. This has resulted in a number of transmission reinforcements being required to achieve the necessary boundary capacities. The proposed connection of a significant volume of new transmission contracted generation in the SHETL area, substantially made up of wind farms, is dependant on the completion of transmission reinforcement schemes which include the planned Beauty/Denny transmission reinforcement. The Beauty/Denny reinforcement is included as part of the SYS background for commissioning by 2013/14. However, elements of this reinforcement are currently the subject of a Public Inquiry and, consequently, the final commissioning date may vary, which would impact on the study results presented in [GB Transmission System Performance](#) and [GB Transmission System Capability](#) and on opportunities.

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

These circumstances could lead to significant operational constraints and, depending on location, connection dates may be subject to delays until major system reinforcements are completed. The system reinforcements concerned are mainly within Scotland, around the SPT-NGET

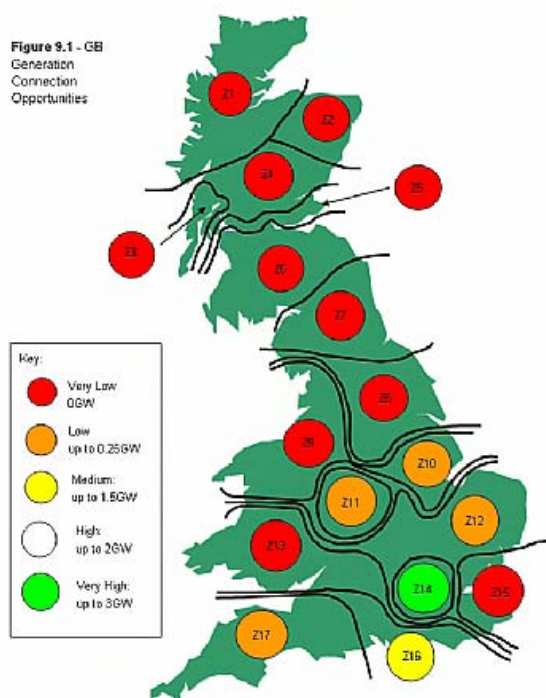
boundary and in the North East of England. A significant proportion of these reinforcement works are unlikely to be completed much before 2010/11. On this basis it would be unlikely that there would be any opportunity for new applicants to connect generation at any point to the north of the North - Midlands boundary (Boundary B8) within the seven year period covered by this Statement. However, the proposed new transmission access rules (see below) are expected to change the emphasis by providing an opportunity for earlier transmission access for new generation projects.

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

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

Figure 9.1

[Click to load a larger version of Figure9.1 image](#)



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

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

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

Transmission Access Review

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

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

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

The review includes the consideration of different models of transmission access, and to support this part of the review, National Grid has raised

a suite of CUSC amendments and charging methodology modifications which could be used as building blocks to implement a number of different access models. Each of these models could be expected to provide an opportunity for earlier transmission access to new generation projects.

The framework changes that support each of the models currently being discussed are available on the National Grid CUSC and Charging amendments proposal areas:

<http://www.nationalgrid.com/uk/Electricity/Codes/systemcode/access/>

<http://www.nationalgrid.com/uk/Electricity/Codes/systemcode/amendments/currentamendmentproposals/>

<http://www.nationalgrid.com/uk/Electricity/Charges/modifications/uscmc/>

GB Queue

For information on GB Queue Management, please refer to our publication "Transmission Network Quarterly Connections Update – April 2009", available at:

www.nationalgrid.com/uk/Electricity/GettingConnected/gb_agreements/

Strategic Investment

The information contained in this year's SYS does not reflect the recent work undertaken for the Energy Networks Strategy Group (ENSG) – Our Electricity Network – A Vision for 2020. Whilst the work carried out for ENSG identifies a set of transmission reinforcements that would facilitate the connection of renewable generation to help meet the Government's 2020 climate change targets, there is still further work required to agree a revised regulatory regime to deal with this anticipated investment. It is expected that a new regulatory regime will be developed during 2009 and these reinforcements may then form part of the SYS background in 2010.

Zonal Power Losses

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

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

For comparison, the main tables from Schedule 1 of our 2009/10 'Statement of Use of System Charges', are 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.

Generators are also subject to local circuit and substation tariffs. Details of these can be found at:

<http://www.nationalgrid.com/uk/Electricity/Charges/usefulinfo/>

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 2009/10 to 2015/16 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 2009/10 to 2015/16 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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
21 NORTH WEST (SHETL)							
Effective Generation	981	954	942	792	1075	1437	1434
Demand	506	512	516	523	528	536	543
Planned Transfer	455	442	426	269	546	991	891

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
22 NORTH (SHETL)							
Effective Generation	1271	1262	1244	1269	1306	1468	1464
Demand	583	593	600	605	610	615	622
Planned Transfer	688	669	644	664	696	853	842

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
23 SLOY							
Effective Generation	258	322	318	317	315	311	311
Demand	66	67	65	66	67	68	68
Planned Transfer	192	255	253	251	248	243	242

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
24 SOUTH (SHETL)							
Effective Generation	356	473	467	465	485	538	554
Demand	543	537	544	550	558	562	568
Planned Transfer	+187	+64	-77	+85	-71	-24	+14

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

Zone 5: North (SPT)

Figure 9.Z5

[Click to load a larger version of Figure9.Z5 image](#)

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

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
25 NORTH (SPT)							
Effective Generation	2388	2408	2353	2169	2182	2075	2089
Demand	1188	1180	1175	1157	1158	1188	1183
Planned Transfer	1200	1218	1178	1013	1024	889	906

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

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
26 SOUTH (SPT)							
Effective Generation	3581	4072	4637	4905	4973	4948	4952
Demand	3026	3035	3053	3047	3058	3074	3088
Planned Transfer	555	1037	1584	1858	1915	1875	1888

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

Zone 7: North & North-East England

Figure 9.Z7

[Click to load a larger version of Figure9.Z7 image](#)

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

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
27 NORTH & NE ENGLAND							
Effective Generation	2687	2826	2773	2801	2788	2723	2724
Demand	2788	2788	2785	2855	2880	3083	3127
Planned Transfer	68	40	-22	945	889	2680	2587

Zone 7 is located between the SPT 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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
28 YORKSHIRE							
Effective Generation	11595	10825	11818	11027	10971	10371	10378
Demand	5804	5843	5888	6072	6114	6180	6207
Planned Transfer	5602	5182	5749	4955	4857	4180	4171

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

Zone 9: North West England & North Wales

Figure 9.Z9

[Click to load a larger version of Figure9.Z9 image](#)

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

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z9							
NW ENGLAND & N WALES							
Effective Generation	8188	8156	7192	7591	6376	6246	6250
Demand	7370	7420	7818	7776	7809	7874	7858
Planned Transfer	619	736	-684	-185	-1432	-1628	-1607

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

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

Zone 10: Trent

Figure 9.Z10

[Click to load a larger version of Figure9.Z10 image](#)

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

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z10							
TRENT							
Effective Generation	6048	6665	6227	6191	6158	6032	6038
Demand	719	762	758	769	767	778	784
Planned Transfer	5329	5903	5467	5422	5402	5254	5253

This zone is enclosed by the North to Midlands boundary towards the North and the North East, the 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 the later 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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z11							
MIDLANDS							
Effective Generation	3427	3379	4360	4334	4313	3854	4250
Demand	7088	7132	7201	7263	7306	7384	7398
Planned Transfer	-3580	-3752	-2841	-2926	-2993	-3510	-3147

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

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

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

Zone 12: Anglia & Bucks

Figure 9.Z12

[Click to load a larger version of Figure9.Z12 image](#)

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

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z12							
ANGLIA & BUCKS							
Effective Generation	3904	4179	4385	4081	5373	4953	4957
Demand	8729	8822	8748	8785	8682	8917	8958
Planned Transfer	-1825	-1643	-1365	-1704	-488	-964	-1002

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

north of London. The opportunity for new projects within the zone is considered as 'low'.

Zone 13: South Wales & Central England

Figure 9.Z13

[Click to load a larger version of Figure9.Z13 image](#)

Figure 9.Z13 - SYS Study Zone Z13, Studied Zonal Demand and Generation [MW]

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z13 S WALES & CENTRAL ENGLAND							
Effective Generation	5940	7816	7571	7814	7592	6598	6803
Demand	4807	5020	5015	5052	5101	5118	5138
Planned Transfer	1033	2786	2556	2762	2491	1480	1467

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z14 LONDON							
Effective Generation	1242	1224	1201	1195	1557	1525	1528
Demand	10029	10331	10482	10738	10833	10758	11062
Planned Transfer	-8787	-9107	-9281	-8542	-9275	-8232	-9538

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z15 THAMES ESTUARY							
Effective Generation	4425	2463	2660	2937	2805	3003	3008
Demand	2021	2107	2108	2138	2160	2172	2140
Planned Transfer	2404	376	651	788	745	832	858

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

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

Zone 16: Central South Coast

Figure 9.Z16

[Click to load a larger version of Figure9.Z16 image](#)

Figure 9.Z16 - SYS Study Zone Z16, Studied Zonal Demand and Generation [MW]

ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z16 CENTRAL S COAST							
Effective Generation	1210	1192	837	833	828	811	812
Demand	4284	4352	4337	4357	4388	4412	4415
Planned Transfer	-3084	-3180	-3500	-3525	-3560	-3601	-3804

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	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
217 SOUTH WEST ENGLAND							
Effective Generation	1773	1747	1714	1704	1696	2406	2407
Demand	2655	2676	2654	2670	2680	2703	2709
Planned Transfer	-882	-929	-939	-966	-984	-208	-211

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

Voltage Support Services

Introduction

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

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

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

The terms 'Reactive Power Default Mechanism', 'Obligatory Reactive Power Service', 'Enhanced Reactive Power Service' and 'Market Agreement' are defined in Schedule 3 of the CUSC. The CUSC Schedule 3 also sets out payment rules and qualifications and evaluation criteria. The payment rate under the Reactive Power Default Mechanism is now indexed against RPI and Power Prices, and has varied between £2.93/Mvarh and £5.92/Mvarh during 2008/09.

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 March 2009 and is the latest information available at the time of writing. Data for Scotland has only been available since 1 April 2005. Accordingly prior to that time information is restricted to the three geographical areas in England and Wales, namely: North, Midlands and South.

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

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Figure 9.1 - GB
Generation
Connection
Opportunities

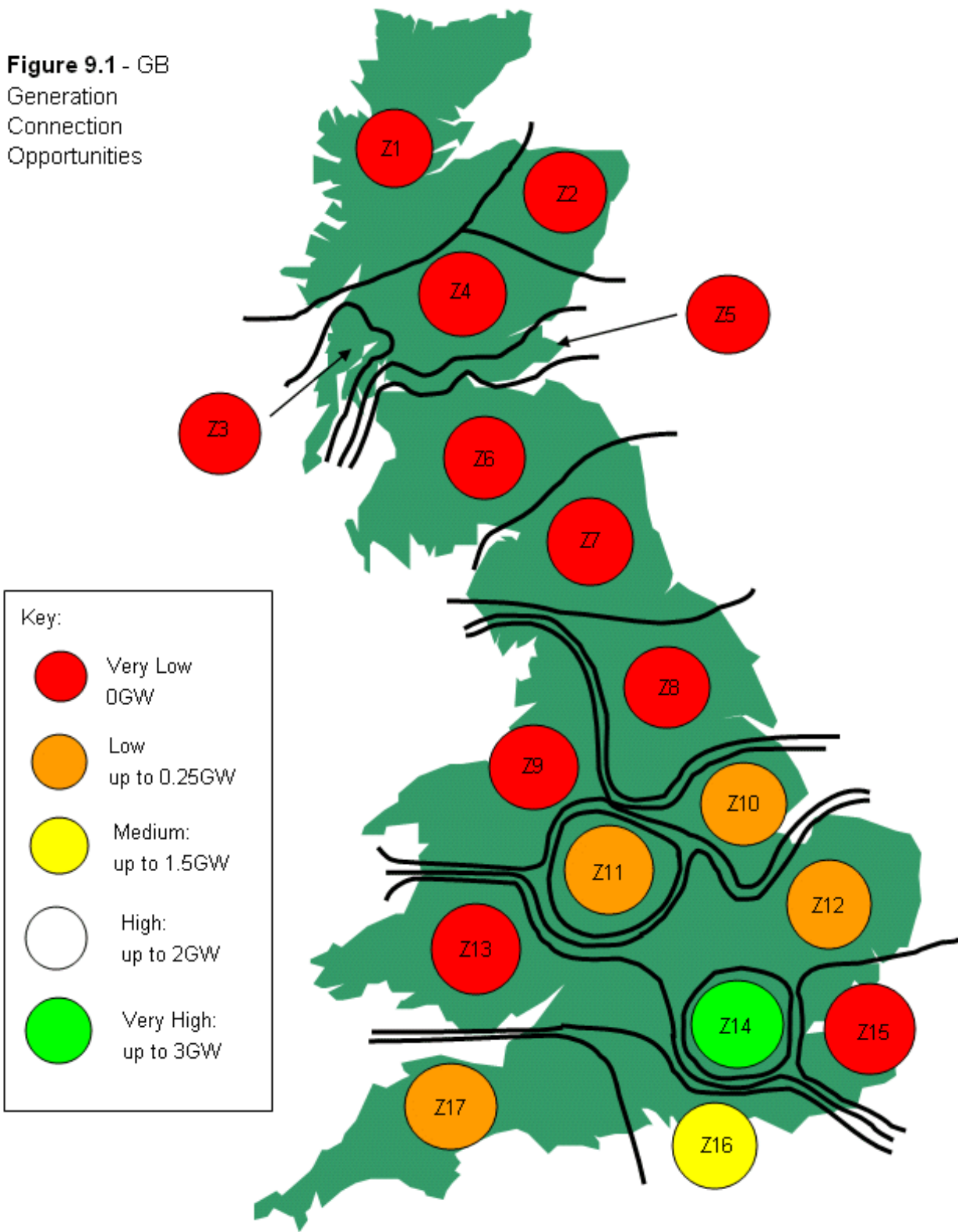


Figure 9.Z1 - SYS Study Zone Z1, Studied Zonal Demand and Generation (MW)

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z1	NORTH WEST (SHETL)							
	Effective Generation	961	954	942	792	1075	1437	1434
	Demand	506	512	516	523	529	536	543
	Planned Transfer	455	442	426	269	546	901	891

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z2	NORTH (SHETL)							
	Effective Generation	1271	1262	1244	1269	1306	1468	1464
	Demand	583	593	600	605	610	615	622
	Planned Transfer	688	669	644	664	696	853	842

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z3	SLOY							
	Effective Generation	258	322	318	317	315	311	311
	Demand	66	67	65	66	67	68	69
	Planned Transfer	192	255	253	251	248	243	242

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z4	SOUTH (SHETL)							
	Effective Generation	356	473	467	465	485	538	554
	Demand	543	537	544	550	556	562	568
	Planned Transfer	-187	-64	-77	-85	-71	-24	-14

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z5	NORTH (SPT)							
	Effective Generation	2388	2408	2353	2169	2182	2075	2089
	Demand	1188	1190	1175	1157	1158	1186	1183
	Planned Transfer	1200	1218	1178	1013	1024	889	906

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z6	SOUTH (SPT)							
	Effective Generation	3581	4072	4637	4905	4973	4949	4952
	Demand	3026	3035	3053	3047	3058	3074	3066
	Planned Transfer	555	1037	1584	1858	1915	1875	1886

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z7	NORTH & NE ENGLAND							
	Effective Generation	2867	2826	2773	3801	3780	5723	5724
	Demand	2798	2786	2795	2855	2890	3063	3127
	Planned Transfer	68	40	-22	945	890	2660	2597

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z8	YORKSHIRE							
	Effective Generation	11505	10825	11618	11027	10971	10371	10378
	Demand	5904	5643	5869	6072	6114	6190	6207
	Planned Transfer	5602	5182	5749	4955	4857	4180	4171

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z9	NW ENGLAND & N WALES							
	Effective Generation	8188	8156	7132	7591	6376	6246	6250
	Demand	7370	7420	7816	7776	7809	7874	7858
	Planned Transfer	819	736	-684	-186	-1432	-1628	-1607

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z10	TRENT							
	Effective Generation	6048	6665	6227	6191	6158	6032	6038
	Demand	719	762	759	769	757	778	784
	Planned Transfer	5329	5903	5467	5422	5402	5254	5253

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z11	MIDLANDS							
	Effective Generation	3427	3379	4360	4334	4313	3854	4250
	Demand	7008	7132	7201	7263	7306	7364	7398
	Planned Transfer	-3580	-3752	-2841	-2928	-2993	-3510	-3147

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z12	ANGLIA & BUCKS							
	Effective Generation	3904	4179	4385	4091	5373	4953	4957
	Demand	5729	5822	5749	5795	5862	5917	5959
	Planned Transfer	-1825	-1643	-1365	-1704	-488	-964	-1002

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z13	S WALES & CENTRAL ENGLAND							
	Effective Generation	5940	7816	7571	7814	7592	6598	6603
	Demand	4907	5020	5015	5052	5101	5119	5136
	Planned Transfer	1033	2796	2556	2762	2491	1480	1467

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z14	LONDON							
	Effective Generation	1242	1224	1201	1195	1557	1525	1526
	Demand	10029	10331	10482	10738	10833	10756	11062
	Planned Transfer	-8787	-9107	-9281	-9542	-9275	-9232	-9536

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z15	THAMES ESTUARY							
	Effective Generation	4425	2483	2960	2937	2905	3003	3006
	Demand	2021	2107	2108	2139	2160	2172	2140
	Planned Transfer	2404	376	851	798	745	832	866

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z16	CENTRAL S COAST							
	Effective Generation	1210	1192	837	833	828	811	812
	Demand	4294	4352	4337	4357	4388	4412	4415
	Planned Transfer	-3084	-3160	-3500	-3525	-3560	-3601	-3604

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

	ZONE	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Z17	SOUTH WEST ENGLAND							
	Effective Generation	1773	1747	1714	1704	1696	2496	2497
	Demand	2655	2676	2654	2670	2690	2703	2709
	Planned Transfer	-882	-929	-939	-966	-994	-208	-211

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Table 9.1 - Transmission Network Generation Use of System Charges - 2009/10

Generation Zone	Zone Name	Wider Zonal Tariff
1	North Scotland	21.588654
2	Peterhead	20.318087
3	Western Highland & Skye	21.104228
4	Central Highlands	16.871037
5	Argyll	13.993686
6	Stirlingshire	14.479695
7	South Scotland	13.601728
8	Auchencrosh	11.243738
9	Humber & Lancashire	6.14232
10	North East England	9.853652
11	Anglesey	6.872452
12	Dinorwig	6.189823
13	South Yorks & North Wales	4.197861
14	Midlands	2.110543
15	South Wales & Gloucester	-1.603175
16	Central London	-6.977964
17	South East	0.254498
18	Oxon & South Coast	-1.386678
19	Wessex	-3.282014
20	Peninsula	-6.683832
	Small Generators Discount	5.184279

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Table 9.2 - Transmission Network Demand Use of System Charges - 2009/10

Demand Zone	Zone Name	HH Zonal Tariff (£/kW)	NHH Zonal Tariff (p/kWh)
1	Northern Scotland	3.379238	0.459137
2	Southern Scotland	9.066432	1.138085
3	Northern	12.059398	1.598288
4	North West	16.542926	2.095188
5	Yorkshire	16.29794	2.12668
6	N Wales & Mersey	16.888703	2.028429
7	East Midlands	19.130238	2.469531
8	Midlands	20.526611	2.705483
9	Eastern	20.005702	2.526505
10	South Wales	23.683651	2.938924
11	South East	23.844075	3.061244
12	London	25.904688	3.033868
13	Southern	24.471461	3.016744
14	South Western	25.631634	3.200032
	Small Generators Adjustment	0.0893	0.011304

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Table 9.3 - Reactive Utilisation (metered output) April 1995 to March 2009 (TVArh)

StartDate	EndDate	Scotland Lead	Scotland Lag	NORTH LEAD	NORTH LAG	MIDLANDS LEAD	MIDLANDS LAG	SOUTH LEAD	SOUTH LAG	TOTAL LEAD	TOTAL LAG
01/04/1995	31/03/1996			5.26	22.23	0.71	6.19	2.69	5.33	8.67	33.75
01/04/1996	31/03/1997			5.58	22.5	0.73	5.01	3.23	5.01	9.54	32.52
01/04/1997	31/03/1998			5.67	19.32	0.72	4.67	3.41	3.78	9.8	27.77
01/04/1998	31/03/1999			4.06	17.55	0.8	4.12	3.28	3.05	8.15	24.72
01/04/1999	31/03/2000			3.75	17.7	0.64	3.65	2.62	3.59	7	24.97
01/04/2000	31/03/2001			2.96	13.71	0.88	4.41	3.07	3.05	6.91	21.17
01/04/2001	31/03/2002			3.5	10.38	1.08	4.83	3.44	2.96	8.03	18.18
01/04/2002	31/03/2003			3.3	10.43	0.99	3.46	3.29	2.98	7.58	16.87
01/04/2003	31/03/2004			3.68	9.44	0.9	3.48	3.61	3.65	8.19	16.57
01/04/2004	31/03/2005			4.15	9.23	1.15	2.92	4.01	3.28	9.67	15.43
01/04/2005	31/03/2006	2.38	1.19	4.17	7.84	1.59	2.95	3.95	2.51	12.09	14.49
01/04/2006	31/03/2007	1.83	1.52	4.78	7.27	1.31	1.84	3.58	2.05	11.5	12.68
01/04/2007	31/03/2008	2.21	0.84	4.58	6.61	1.28	1.43	3.12	1.82	11.19	10.72
01/04/2008	31/03/2009	2.88	0.86	3.69	4.04	1.19	1.08	2.42	1.39	10.19	7.35

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GB Seven Year Statement 2009

Introduction to Chapter 10

The Energy Act (2004) received Royal Assent 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, and for the first time, touches on the development of offshore generation and the timetable for implementation of the new offshore regime.

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

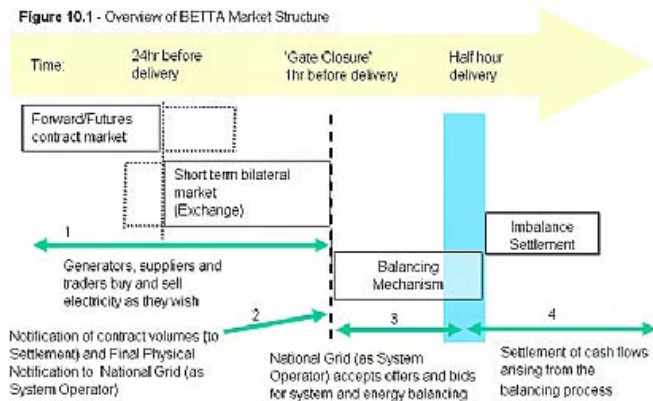
The Market Structure

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.

Forwards and Futures Contract Market

The bilateral contracts markets for firm delivery of electricity operate from a year or more ahead of real time (i.e. the actual point in time at which electricity is generated and consumed) and typically up to 24 hours ahead of real time. The markets provide the opportunity for a seller

(generator) and buyer (supplier) to enter into contracts to deliver/take delivery, on a specified date, of a given quantity of electricity at an agreed price.

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

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

Short-term Bilateral Markets (Power Exchanges)

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

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

Balancing Mechanism

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

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

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

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

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

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

Imbalances and Settlements

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

Previous Imbalance Pricing Arrangements

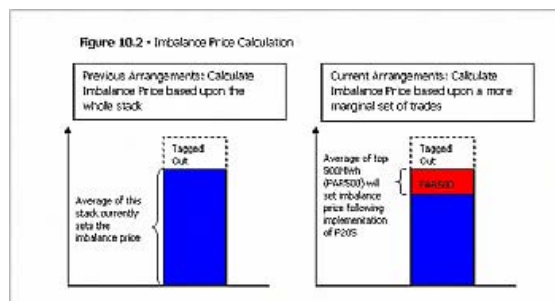
SBP was the price at which deficits were charged and, when the system was short, reflected the average price at which the system had to buy in order to make good the deficit on behalf of the party (i.e. the average of accepted offers). SSP was the price at which surpluses were charged and, when the system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

Figure 10.3 - Energy Imbalance



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

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

Balancing Mechanism Reporting Service (BMRS)

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

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

Forecast information is primarily made available for the day ahead and on the day. Submitted BM data is made available shortly after Gate Closure. Accepted bids and offers and initial imbalance prices are published shortly after real time. LogicaCMG operates the systems for this process under contract to Exelon, 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 licence exempt, are also likely to be required to sign on to the Connection and Use of System Code (CUSC).

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

The Grid Code (GC)

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

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

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

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

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

The Connection and Use of System Code (CUSC)

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

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

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

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

The SO-TO Code (STC)

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

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

National Grid's Role and Obligations

Licence Obligations

Section C of the Transmission Licence (System Operator Standard Conditions) 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 Licences 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 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>

Offshore Generation

A significant volume of offshore generation will be required to connect to the transmission system to contribute to the UK's 2020 renewable energy targets. The Crown Estate has already run three processes (Round 1, Round 2 and Scottish Territorial Waters) to lease areas of the sea bed for the development of offshore wind farms.

A further leasing round (Round 3) is currently in progress (bids closed on 3 March 2009) to lease larger sites, further away from the mainland. A Strategic Environmental Assessment is also underway relating to these developments.

The potential volume of offshore capacity from these processes is as follows:

Round 1 and 2	7 – 8 GW
Scottish Territorial Waters	6.5GW
Round 3	up to 25GW
Total	up to 39.5GW

The Crown Estate process will award exclusive licences to developers to develop within each of Round 3 zone, and each developer will put forward a Zonal Development Plan detailing its intentions in respect of the volume of generation to be delivered and when it is likely to be delivered. **Figure 10.6** shows the location of the Round 3 zones.

National Grid is expecting to work closely with The Crown Estate and developers of the Round 3 zones regarding their plans from the summer of 2009 onwards when preferred bidders for the Round 3 zones are likely to be announced.

Other forms of offshore generation are expected to come forward (wave/tidal) and these will be included in the SYS as more detail emerges. In particular developments are already underway within the Pentland Firth, north of the Scottish mainland.

National Grid is currently working with Ofgem to determine what specific information could be published to assist interested offshore stakeholders.

Offshore Electricity Transmission

The arrangements described in this chapter are subject to continual change and review either via legislative processes or through normal electricity industry governance. In addition to this, Ofgem and DECC are currently working together to implement a new regulatory regime for electricity transmission networks offshore. This is intended to enable significant volumes of offshore renewable generation to connect from UK offshore waters.

The Energy Act 2004 provides powers for the Secretary of State to make changes to electricity codes, agreements and transmission and distribution licences for purposes connected with offshore transmission or distribution. A final consultation on the regulatory framework for the offshore regime was issued by Ofgem and DECC in March 2009. This consultation contains the changes that the Secretary of State is expected to designate in June 2009.

From June 2009 (Go-active), it is expected that a 12 month transitional period will commence prior to full Go-live of the regime in June 2010. From Go-live onwards it will be a prohibited activity to own transmission equipment in offshore waters (which is deemed to be equipment operating at greater than or equal to 132kV) without holding a transmission licence.

From Go-live, National Grid's role as GBSO will extend to cover offshore areas (the Renewable Energy Zone). This means that National Grid will take responsibility for operating any offshore transmission assets.

The main feature of the new regime is the proposal to allocate offshore transmission licences (and hence the ownership of offshore transmission equipment) via a competitive tender process.

During the transitional period from Go-active to Go-live, Ofgem will run transitional tenders to identify the Offshore Transmission Owners (OFTOs) for offshore generators who are either already operational or have satisfied certain criteria and are progressing with the design and construction of their connections to shore. In parallel with this activity, National Grid will be revising the contractual arrangements with these sites to reflect the fact that, from Go-live, these sites will connect to the transmission system at the offshore platform rather than at the onshore point of connection. This will result in these offshore users entering into Bilateral Connection Agreements with National Grid, in the same way as onshore transmission connected generation.

Looking further forward, offshore users will apply to National Grid for connection to the transmission system in the same way as any other user. National Grid has transmission licence obligations to respond to an application to connect with an offer within three months of such an application. This Initial Connection Offer will detail the onshore works required to connect up the offshore developer. It will also take account of any information provided by the offshore developer in terms of likely offshore cable routes, landing points etc, but in the absence of such information will contain high level assumptions about the likely offshore transmission requirements. Ultimately, National Grid will ensure that any offer provided to an offshore user will be in accordance with its transmission licence obligations to act in an economic and efficient manner.

Once signed, the offer will trigger a tender process, to be run by Ofgem, to identify an OFTO for that connection. National Grid expects to provide information from the offer to inform the tender process. Once an OFTO has been identified, a Transmission Licence will be granted and the OFTO will accede to the SO-TO Code. Once the OFTO has acceded to the STC, then National Grid will interface with the OFTO in a similar way to the way in which it interfaces with the Scottish Transmission Companies. The OFTO will provide National Grid with a Transmission Owner Construction Agreement (TOCA) which describes the offshore works to be undertaken.

National Grid will then incorporate these works into the offer to the offshore user via an Agreement to Vary. Once this is signed, the construction activities will begin.

Some of the expected key milestones are given below:

March 2009: Final consultation on the Offshore Transmission Regime issued by OFGEM and DECC

March 2009: Crown Estate receives bids for Round 3 exclusive licenses

May 2009: Commencement of section 92 of the Energy Act 2004 and section 44(1) and (2) of the Energy Act 2008 to enable the Authority to make regulations to enable the first round of tenders to begin shortly after Go-active

24 June 2009: Go-active commencement of sections 90 and 91 of the Energy Act 2004

Summer 2009: First tenders commence

From summer 2009: The Crown Estate announces preferred bidders for Round 3 zones

June 2010: commencement of sections 89 and 180 of the Energy Act 2004 and section 44(3) of the Energy Act 2008

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 review 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

Generators are charged a zonal charge dependent on which tariff zone their power station is connected, together with a specific local charge dependent on the type of connection. There are currently 20 generation TNUoS tariff zones (see [Figure A.1.3](#) and [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 local charge is dependent on whether the connecting substation has redundancy ie is single or double busbar, and the type and length of connecting circuits to that substation.

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 [Use of System Tariff Zones](#)). 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 Section 6 (1) (d) of 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 Section 6 (1) (c) 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](#) lists power stations under construction, for which Section 36 and Section 14 consent has been given, and [Table 3.3](#) lists power stations, not yet under construction, for which Section 36 and Section 14 consent has been given. The output capacities (MW) given in the tables are intended to 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

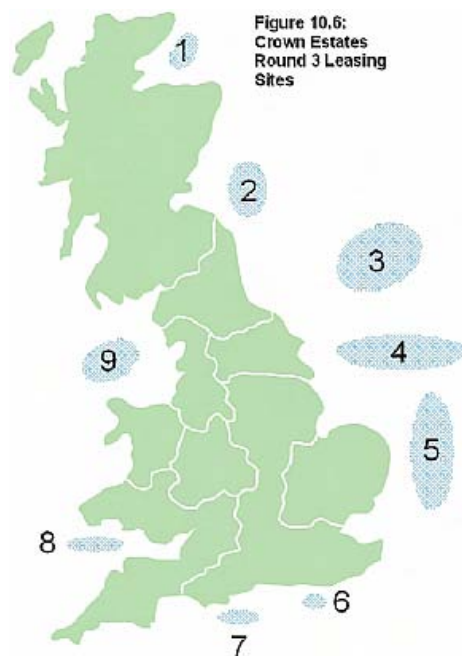
Type of Bilateral Agreement	Type of Power Station	Generation Licence	Connection		Power Station Output Terminology			Charges Applicable		
			Embedded	Direct	TEC	CEC	Size	Connection	TNUoS	BSUoS
BCA	All	yes	yes	yes	yes	yes		yes	yes	yes
BEGA	All	yes	yes	yes	yes			yes	yes	yes
BELLA	Large	no	yes			yes		if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

Figure 10.6

[Click to load a larger version of Figure 10.6 image](#)



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Figure 10.1 - Overview of BETTA Market Structure

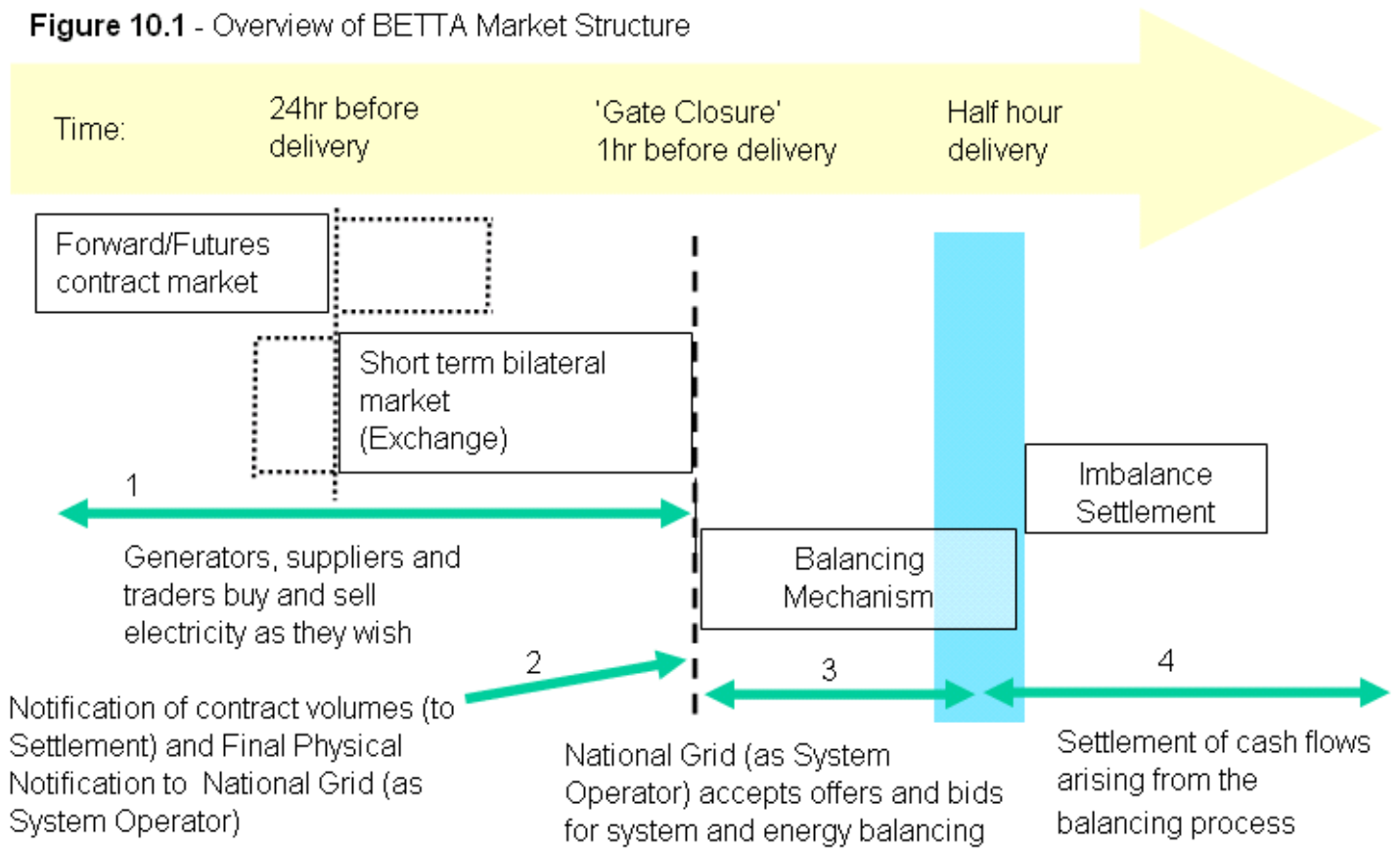


Figure 10.2 - Imbalance Price Calculation

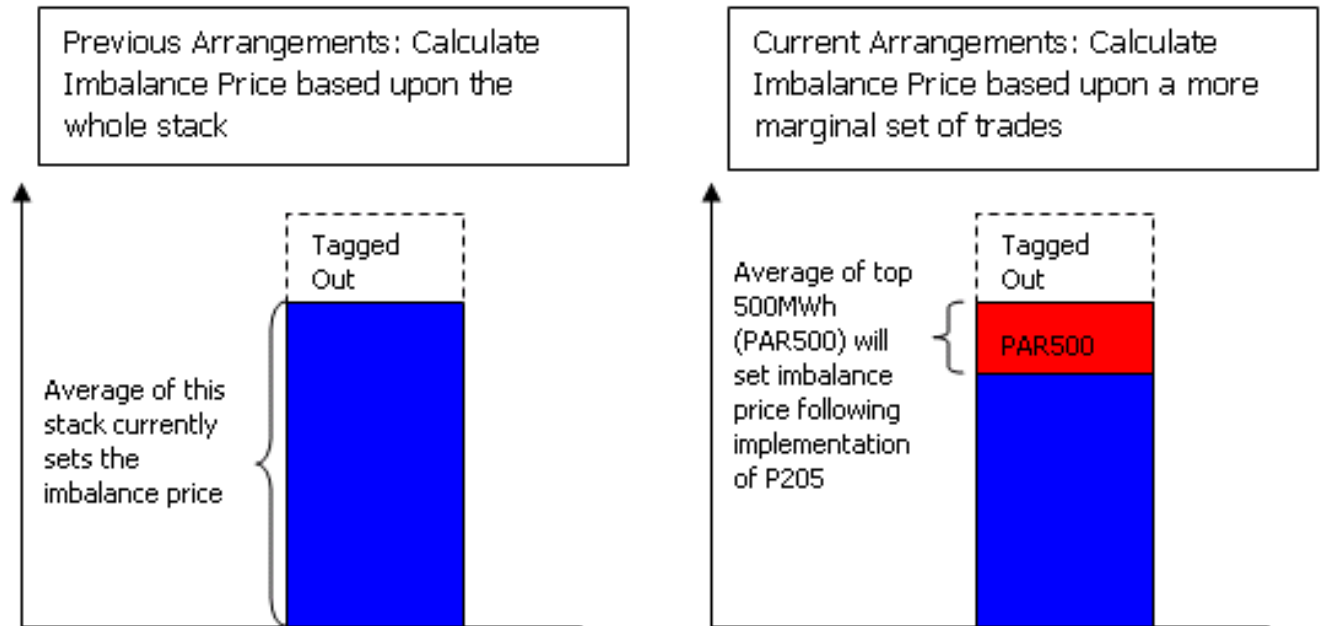


Figure 10.3 - Energy Imbalance

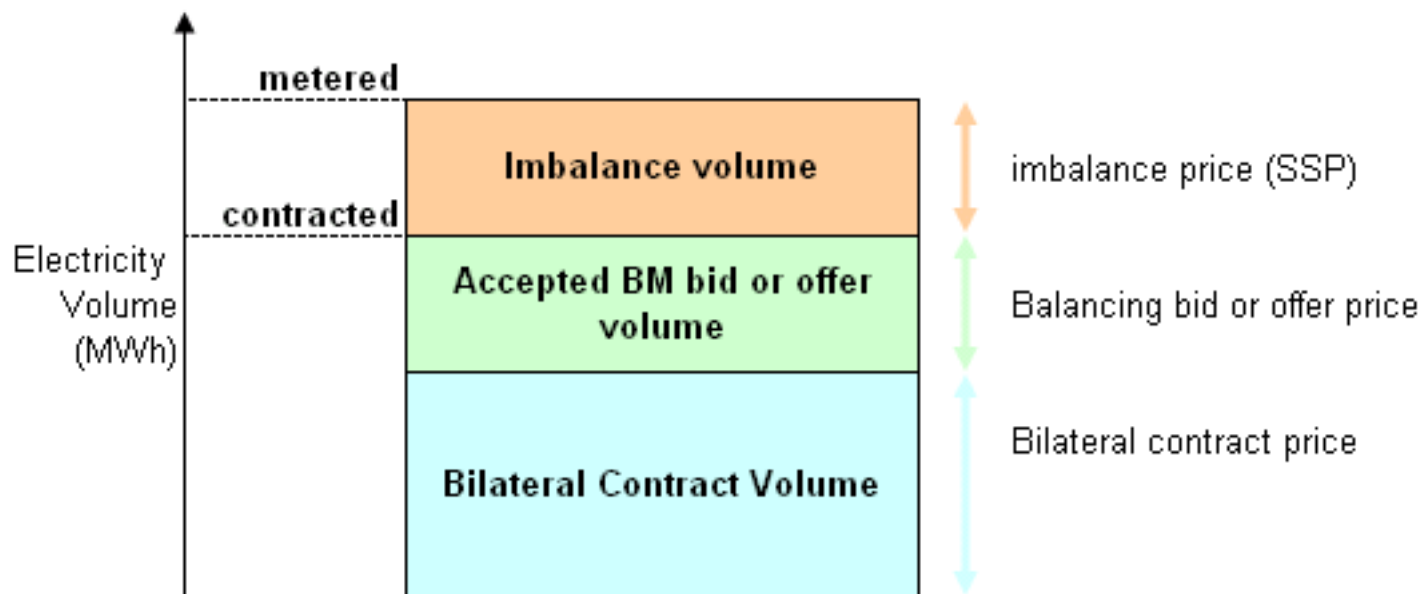


Figure 10.4 - Generalised Summary of Main Requirements Placed on Generators, Suppliers and Distributors

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

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

**Figure 10.6:
Crown Estates
Round 3 Leasing
Sites**

