Office of Gas and Electricity Markets

KEMA Limited

TSORG - Licensee action summary and review

10010662 Rev 1.0

FINAL REPORT

12 May 2008

Table of Contents

Revision history

Rev.	Date	Description	Author	Checker	Approver
1.0	12/05/2008	First draft report	MF	DP	JS

1. Management summary

1.1 Background

Ofgem undertook with the three transmission licensees, National Grid Electricity Transmission ("NGET"), Scottish Hydro Electricity Transmission Limited ("SHETL") and Scottish Power Transmission Limited ("SPTL"), a review of Transmission System Operation through the Transmission System Operation Review Group ("TSORG") which sought to review operational measures to:

- Establish if the capacity and utilisation of the existing transmission system could be increased;
- Consider innovative approaches to network management and operation; and
- Highlight geographical areas where there may be scope to connect additional generation capacity using the existing transmission infrastructure.

This concluded with the publication of the TSORG report, which together with the Short Term Access Governance report and the joint Ofgem and BERR Transmission Access Review initiative led to recommendations for further work which included a number of actions on the transmission licensees.

The actions were split into four main categories:

- Transmission system capability
- Transmission system utilisation
- Limiting factors within the current regulatory framework
- Development

A summary and review of the responses to the actions in each of the four main categories is set out below.

1.2 Transmission system capability

The licensees were required to undertake analysis regarding the potential to introduce or extend techniques to increase the thermal ratings of circuits to maximise the utilisation of the existing infrastructure.

To enable a system operator to fully exploit the capability of a network, it must understand the ratings characteristics of each circuit comprising the network. The most basic ratings are calculated using static assumptions, for example, standard loading profiles and seasonal average ambient temperatures. Improved utilisation of circuits is possible, however, where information is available that enables equipment ratings enhancement, whether this is dynamic information, such as weather forecasts, or the modelled thermal inertia of equipment. Such information can allow greater post-fault power flow based on contingency actions being undertaken within prescribed timescales to reduce circuit loadings.

Three main areas were considered: increased usage of weather informed ratings enhancements, the application of "hot wiring" circuits and the usage of short-term ratings in operational timescales.

1.2.1 Weather related ratings

Weather informed ratings enhancements seek to take advantage of forecast or current weather conditions to modify a circuit rating to reflect actual (or forecast actual) conditions, e.g. ambient temperature or wind speed, that may be markedly different from the seasonal average conditions that are used in calculating a circuit rating.

The licensees responded that there was scope for increasing the capability of the GB network through the wider application of ratings for overhead line circuits based on short term, local weather forecasts. One Scottish TO [SPTL] regarded the current application of the procedure by National Grid Electricity Transmission ("NGET") to be "very conservative", suggesting that the identified improvements in ratings of between 5-11% could be greater if a less conservative approach was adopted. It is clear that the worst case scenario from the MORE process (Meteorological Office Ratings Enhancement) is used for up-rating of lines, e.g. taking the least favourable predicted weather conditions, with the adjustment factors that weight the forecast for historically recorded forecast error.

One Scottish TO [SPTL] outlined that they were in the process of reviewing and developing further their techniques for weather led dynamic ratings for their distribution network that includes the potential for integration with their control system using a state estimation engine to allow real-time ratings to be used on a business as usual basis. The two Scottish TOs saw benefit in moving the technique from a day-ahead prediction process to provide within-day ratings. They regard this as beneficial for the accommodation of more variable generation on the GB transmission system. The licensees suggested that implementation times would be dependent on the time needed to undertake survey work to calibrate and establish the local weather related input information to derive possible enhancements. An indicative timeline of 18 months was suggested by one Scottish TO [SPTL] to prepare the first circuit with five subsequent circuits being added within a further 12 month period. It

was noted that the enhancement possible using the current techniques was lower than that available through hot wiring of circuits. One other development was highlighted by a Scottish TO [SHETL] that is seeking to use tension or sag monitoring equipment to provide better information in real-time to enable enhanced ratings to be accurately established.

KEMA's view

The application of the MORE process by NGET for calculating enhanced ratings, and the view of the Scottish TOs provides some suggestion that greater enhancement may be possible in excess of that which is currently achieved. The absence of action when the advice from the model suggests that the lines should be down-rated (compared to the standard seasonal rating) suggests that the model provides conservative estimates of possible rating enhancements. If this were not the case then the modelled de-ratings would be applied to reflect the same risk factors that apply e.g. public safety (safety distance clearance issues), greasing and fittings performance. This therefore suggests there is a potential opportunity to use higher ratings from this process, when the model suggests that the ratings can be increased, than are currently applied.

KEMA is aware of work that is well advanced in at least one another UK distribution company that will establish a dynamically rated overhead line route within its network to assist in managing loadings, demonstrating that some network operators are further advanced in these areas than others.

It would also appear beneficial to see increased information sharing regarding the potential of these innovative ideas to avoid repeating demonstration projects and duplicating research and development projects, either directly between the licensees or facilitated through a third party.

1.2.2 Hot wiring

Hot wiring is the ability to operate an existing circuit at a higher temperature than its original designed capability. The process exploits the ability to undertake a more precise assessment of the limiting factors, e.g. grease melting points, and safety clearance distances below the line. The development of Aerial Laser Survey (ALS) methods means that information is available to develop a precise understanding between conductor temperature and line sag and discover potential obstructions along the route. In addition, laser survey provides comprehensive information about an overhead line route that is likely to have ongoing value beyond simply hot wiring enhancement, for example it would be expected to assist wider asset management and future re-conductoring.

All of the licensees acknowledge that there are opportunities to increase network capability through hot wiring of circuits and are either continuing their existing programme of assessment of possible improvements or are initiating such a programme. One of the licensees [SHETL] did not include any hot wiring options but identified the potential for reconductoring with high temperature, low sag conductors to improve network capability on constrained circuits. One of the licensees [SPTL] quantified the potential benefit of hot wiring to be in the range 11-15%, and noted that this was a "firm" enhancement which could be utilised during planning assessments as opposed to an operational

enhancement alone, i.e. not dependent on weather conditions. Two licensees [NGET & SHETL] also provided indications that they are currently undertaking research projects to identify new materials or constructions of overhead lines to increase route capacity, however, these projects were in the early stages of development and implementation timescales were not yet established.

KEMA's view

The Scottish TOs have not yet established a programme for hot wiring of circuits and therefore some investment will be required to gather the necessary information, for example, through aerial laser survey work, in order that circuit operating temperatures could be safely increased. NGET responses show that it is well advanced in this area and good progress has already been made to maximise the capability of circuits using this technique.

1.2.3 Short-term ratings

The approach to achieve short-term ratings for equipment requires the pre-fault loading of the limiting asset to be measured so that the magnitude and duration of the post-fault rating can be determined (e.g. a much higher loading is possible for a short-period, however, protection may operate before the theoretical maximum loading restricted by temperature is reached). This approach seeks to take advantage of the thermal inertia of the plant to avoid damage or unacceptable reductions in operating life.

NGET responded that detailed rating schedules are available for all new transmission circuits and all existing transmission circuits in England and Wales and most of the 400kV and 275kV network in Scotland. SPTL responded that the interconnected 400kV and 275kV network in Scotland had detailed rating schedules with work ongoing to extend this to the 132kV interconnected network (where currently generic ratings are more typically used). The collection of data on the specific circuit items, their capability over different loadings and time limits is ongoing and improvements in post-fault ratings may provide scope to improve the utilisation of the interconnected 132kV network in Scotland. Development work is underway by the licensees to improve the accuracy of ratings models across overhead lines and cables to further improve their utilisation and understand the impact of climate change, developments which are understood to be completed before 2011.

Other limitations on the ability to increase the capability of circuits, including stability and voltage constraint considerations can apply under specific circumstances (e.g. stability may be a particular problem for long length overhead lines). In addition to these limitations, one licensee [NGET] noted that its ability to use enhanced ratings is limited due to the warranty provided for new assets by suppliers, i.e. the warranty would be invalidated if the asset was used outside of the manufacturer's specified envelope of operation.

KEMA's view

Consideration should be given to reviewing plant specifications such that suppliers are encouraged to provide products and support arrangements that enable inherent short-term capabilities to be utilised.

Summary

- Weather dependent enhancement to ratings could provide greater increases than currently applied
- Hot wiring techniques continue to provide opportunities for higher route ratings
- Using real-time ratings could better accommodate variable generation and provide confidence in other rating enhancements
- Greater collaboration and sharing of learning between licensees may allow earlier deployment of technologies that increase capacity
- Consideration should be given to reducing the limitations on asset ratings due to supplier warranty restrictions

1.3 Transmission system utilisation

To assist in understanding the use of the transmission network a measure of utilisation is being developed. In its role as System Operator, NGET was asked to bring forward a methodology for measuring the utilisation of capacity across main system boundaries. Utilisation was defined as the anticipated boundary flow at a point in time divided by the corresponding boundary limit. The methodology utilised ex-ante information to establish two measures of utilisation, a purely market action based metric, that excluded all System Operator actions, and a pre-Gate Closure measure that included those actions. There was no ex-post measure considered in the licensee response for the measuring utilisation of transmission boundaries. Such an ex-post measure of utilisation was identified by one Scottish TO [SPTL] suggesting that it could help inform investment decisions.

KEMA's view

An ex-post measure could provide additional information that would complement the two measures identified. It could provide insight into the effectiveness of the market and the System Operator at maximising the use of the transmission system, within the limits of maintaining system security. An ex-post measure would appear to be a simpler measure to calculate (although does not necessarily capture itself any shortage of capacity), comprising metered data (extractable from operational systems) divided by the boundary limit calculated as part of normal operational planning process. There are clearly complexities in implementing the measures of utilisation, however, there appears the potential to take a first step based on information currently gathered by the System Operator, i.e. at cardinal points and for varying boundaries, to provide an indication of boundary and to test to the usefulness of this data.

1.3.1 Generation connection dependencies on boundary utilisation

The concept of measuring utilisation enables assessment of the degree to which a generator that is dependent on the reinforcement of a boundary before it is allowed to connect could be accommodated within the existing capacity. The licensees provided information on the generation projects that have dependencies on transmission reinforcements and any external dependencies, e.g. consents. The licensees outlined that the majority of generation projects in the GB queue are subject to one or more transmission reinforcements. The key risk to reinforcement programmes, highlighted by the licensees, is planning consents for new infrastructure. This issue is under consideration in the forthcoming Planning Bill. One licensee [SHETL] also suggested that uncertainty in which generation projects will actual come to fruition, the consequential need to undertake wide ranging design reviews (as upgrades are typically sequential) and the potential requirement to restart consents processes (to minimise stranded asset risk) are factors that introduce delays into the connections process. The percentage of projects that are dependent on transmission reinforcements ranges across the licensees from 70-90% (in MW capacity terms). Across GB approximately 12% of the MW capacity (15% by number of projects) seeking connection are not dependent on deeper transmission infrastructure upgrades.

Summary

- A transmission system utilisation indicator based on the information currently used operationally could be considered in the short-term to enable evaluation of the usefulness of such measures and the need for greater precisions
- An ex-post measure of utilisation may be simpler to achieve (but may not provide sufficient information to assess capacity shortages)
- Most connections are subject to transmission reinforcements and those projects

1.4 Limiting factors in the current regulatory framework

The licensees were required to identify any factors in the current regulatory framework that had the potential to limit assessments or connections of new generation.

1.4.1 Limitations placed on licensees by GBSQSS

The Security and Quality of Supply Standard that applies in Great Britain, ("GBSQSS") places specific limits on the discretion of the transmission owners in sizing the transmission network in response to changes in generation and demand. The standards within the GBSQSS require the transmission system to be secure for a set of prescribed circumstances, e.g. a double-circuit overhead line fault, against a series of requirements, such as, no unacceptable overloading of equipment, staying within prescribed voltage limits, and maintaining stability of the system.

The licensees suggested a programme for review of the standards to review whether the limitations placed upon them by the GBSQSS should be changed. The review programme considered issues including: removing regional differences; probabilistic approaches to security; different (lower) standards of security e.g. "N-1"; and allowing the use of intertrips in planning timescales.

In addition, consideration was given to reducing the most onerous fault condition that should be catered for in the assessment of security. It was shown through a simplified example that this could increase the capacity of a transmission boundary by something of the order of 8-17%, however, the potential consequences of a higher impact fault was also considered and was regarded as outweighing the benefits of moving to a lower standard. The exact quantities considered in determining the impact was referenced to the cost of a total system shutdown, with the US Eastern Seaboard being used as an example where the cost to the regional economy was comparable to half the annual energy bill for the region. In conclusion the licensees all suggested that the most onerous fault conditions against which security should be assessed should remain unchanged at this time, pending the outcome of the review programme.

KEMA's view

There would appear to be merit in considering short duration reductions in the standard e.g. extending the potential for time limited derogations to a lower security level, where there is a cost benefit of allowing the new generation to connect earlier. Reliability analysis would be required to quantify the merits and risks of such an approach.

Furthermore, the number, location and character of double circuit fault events (N-D) might advantageously be re-examined to enable a more permanent but targeted relaxation to N-1 operation. It may be possible to extend this to consider a standard that maintains a bad weather arrangement of generation (including distributed generation) and network arrangements that would enable the system to operate at N-2 for bad weather circumstances (recognising that this would bring additional costs to operations at times). All of the above require a more probabilistic or risk based approach to setting the standards that would maintain the level of security to demand points to, with redundancy in transmission being one element that enables that security.

In addition, a strategic assessment with the aim of reducing the incidence of double circuit events would clearly be helpful and might for example address tower lightning vulnerability and performance, and protection stability.

1.4.2 Limitations that drive investment for current generation projects

The licensee responses showed that thermal limitations i.e. avoidance of unacceptably overloaded equipment, drove nearly 70% of all system reinforcements and these potential overloads most often occurred under the N-2 secured event. Having to secure against N-2 or N-D (worst double overhead line fault outage) events drove nearly 90% of all transmission reinforcements.

KEMA's view

This suggests that there is a benefit of moving to an N-1 security standard, at least on a selective basis, as it would significantly reduce the need for investment in the transmission system to accommodate additional generation. Consideration must be given to the potential impact of such a reduction on

demand security and the risks associated with high impact, low probability events should be quantified. Such work should be incorporated into the reviews of the security standard and are included in the proposed work plan for the development of the current GBSQSS.

1.4.3 Exchange of information

To enable the most efficient and secure utilisation of the whole GB transmission system consistent standards must be adopted for the running and development of the system. This requires information to be exchanged between those who have the responsibility of meeting those standards, especially in areas where the actions in one network has implications on its neighbours.

The efficient development of the transmission system requires data collection, analysis and modelling for the array of elements that comprise the interconnected system. Included within this is data submitted by Users of the transmission systems that enables the system security to be assessed and reinforcement requirements to be identified. Under the British Electricity Transmission and Trading Arrangements the SO-TO Code ("STC") was established that determined the information exchange requirements from the System Operator ("GBSO") and the Transmission Owners (TO). The STC prescribes by inclusion the data items that can be provided by the GBSO. Within the arrangements a concept of the Boundary of Influence was established, whereby it was accepted (as a simplification) that outside of that boundary, there would only be minimal impact from one TO area to another. This allowed a limited dataset to be exchanged between the GBSO and the Scottish TOs for investment planning purposes. The licensees suggested that this original simplifying assumption appears to be inadequate, with modelling of the transmission system showing deviations that are outside of acceptable tolerances and noted that this could lead to inefficient investment decisions. The licensees have proposed changes to the STC that would seek to alleviate these issues by ensuring a single GB-wide dataset is used for all of TOs for reinforcement investment planning purposes.

KEMA's view

The moves to increases the sharing of information between the licensees would appear to be a helpful development, particularly noting that longer term trends indicate continued high network loading which is likely to result in greater sensitivity to system variables (as voltage and stability limits are approached) and underscores the importance of accurate modelling. It is important that impact of any increased sharing of information is considered to ensure that there are no unintended consequences whereby any party is materially disadvantaged.

Summary

- Moving to an N-1 security standard could remove the need for many identified reinforcements to support new generation, however, the risk to demand security has to be investigated
- Further consideration should be given to relaxing security standards, whether universally, selectively or through probabilistic reliability analysis
- Where the transmission system is operated closer to its limits, the importance of system modelling rises and requires increasingly precise and accurate data
- The STC is relatively new and refinements to its principles and processes, based on operating experience, can be expected to assist overall system optimisation

1.5 Developments

The licensees were requested to provide information on their current initiatives and research and development programmes that could facilitate the release of additional capacity or allow the connection of new generation.

The licensees are carrying out work in three main areas that would allow greater capacity to be released from the existing transmission system. These relate to improving the thermal ratings of overhead lines, which are discussed in paragraph 1.2 above. In addition, the licensees have been working on new monitoring and protection solutions that would allow faster disconnection of faults and predictive systems that seek to prevent a wider area system collapse, which would lead to significant loss of supply events. If proven these developments would allow the transmission system to be operated closer to the limit of its capability potentially without significant increased risk to security of supply because contingency actions would be undertaken automatically by fast acting or predictive protection systems. There is a risk that the transmission system becomes increasingly brittle as operational margins approach their working minimum levels, whereby disruptive events remain rare, but are increasingly catastrophic in their consequences, e.g. a high impact system incident is likely to spread more quickly with less chance of a successful intervention by operators (or automatic systems) to intercept cascade failure. It will be important for a strategic risk assessment process to be undertaken if the incentives on network operators increasingly address maximum utilisation of capacity in the short-term. This should include the deployment of leading practices in network modelling and development of suitable predictive tools, together with the appropriate skills and training and simulation and if necessary revised operational management practices.

The licensees are also embarking on a benchmarking exercise to assess the security standards used in countries with similar societal, political and economic backgrounds to the UK and that reflect other similar characteristics, e.g. island networks with limited interconnections. The questionnaire based benchmarking study aims to complete by 31 March 2009 and provide insight in to the satisfaction of the utilities of the balance of risk, cost and security of supply.

Summary

- Developments in more sophisticated predictive and wider view protection systems are likely to be needed before the transmission system utilisation can be maximised
- Developments in technical systems should be matched by corresponding developments in system operator facilities and training
- International experience should be used to inform the security standards to move towards confirming the maximum utilisation of the existing infrastructure

1.6 Summary remarks

In summary, it is clear that the projects and actions outlined by the licensees would deliver enhancements that could allow greater connection of new generation. It is also clear, however, that many of the responses do not include new thinking and may not consider the strategic considerations of a different future, one perhaps with large numbers of small generators embedded in lower voltage systems or greater demand response from smart metering or direct load control.

For these actions and approaches to succeed there is a need to address not only the core issues but ensure the commercial and regulatory arrangements and the necessary resources are in place to drive timely resolutions to best meet TSORG objectives.

2. Background

The Transmission System Operation Review Group (TSORG) was established to review transmission system operational measures to:

- Establish if the capacity and utilisation of existing transmission system infrastructure can be increased;
- Consider innovative approaches to network management and operation; and
- Highlight geographical areas where there may be scope to connect additional generation capacity using existing transmission system infrastructure.

The output from the TSORG review work to date has been presented in the following four categories:

- Assessment of whether capacity and utilisation of existing transmission system infrastructure can be increased;
- Review of opportunities (that have been taken and are being considered) for more innovative approaches to network management and operation;
- Use made of existing transmission system and opportunities to connect additional generation capacity; and
- Barriers to the connection of new generation within current frameworks.

The objective of this short report by KEMA Consulting is to provide a summary and review of the responses from the British electricity transmission licensees outlining methods to accommodate additional power generation within existing network infrastructure.

2.1 Scope and study inputs

The relevant input materials to be provided by Ofgem include:

- The Transmission System Operation Review Group (TSORG) report published in October 2007;
- Ofgem post-TSORG letters to transmission licensees setting out action lists with deadlines (staggered between end of Feb 2008 and end of March 2008) for them to submit report on progress or planned work to Ofgem; and
- Reports from the three transmission licensees.

2.2 Report outline

The report provides a summary of the licensees' submissions regarding the actions taken or planned, together with an independent review, considering as appropriate:

- the effectiveness of the measures planned/taken by the licensees, to make best use of existing transmission infrastructure to accommodate additional generation;
- the appropriateness of the balance between increasing capacity/utilisation and costs/risks; and
- additional measures which could be implemented.

3. Transmission System Capability

Three actions were placed on the licensees in this category, primarily relating to relieving thermal constraints. The actions sought to share information on the use of weather related rating enhancement, uncover the potential for greater 'hot-wiring' of circuits and to review the use of short-term rating information in operational timescales.

3.1 Consideration of weather enhancement techniques to enhance the capability of the transmission systems (Action A1)

3.1.1 Actions and outputs required of the licensees

The Scottish licensees were asked to consider how the techniques currently employed by NGET (or other techniques) could be applied to the Scottish networks to provide enhanced capability. The licensees were required to report on the scope for potential enhancements, the works that would be needed to achieve those enhancements, the timetable for such works and the implications of implementation. NGET was required to respond to requests from the Scottish licensees for information on the techniques used.

3.1.2 Summary of licensee responses

NGET provided a summary of the techniques used in achieving enhanced ratings based on the prevailing weather conditions. Four separate techniques were identified,

- Met Office Rating Enhancement ("MORE");
- Circuit Thermal Monitor (transformer/cable circuits);
- Ad hoc cable enhancement requests; and
- Ad hoc transformer enhancement requests.

In addition NGET provided a technical report that supported the introduction of ratings based on meteorological data (Technical Report TR(T)273, Issue 1). In its response on the techniques used, NGET noted that for new cable installations restrictions within the warranty terms from suppliers restricted its ability to operate new cable assets in the same way as cables not subject to warranty agreements. Similar restrictions were not mentioned with respect to new transformer assets.

Both of the Scottish licensees focused their responses to this action on the MORE technique, with no reference to the other techniques used by NGET. The MORE technique utilises forecasting of local weather on a day-ahead basis to adjust the rating of a line away from the seasonal norm. This is based upon the local ambient temperature, solar radiation and wind velocity.

The Scottish licensees both stated that there is potential for enhancing the capability of specific circuits within their networks. Scottish Power Transmission ("SPTL") suggests that the MORE procedure produces "very conservative" increases in ratings, in the range 5-11%. SPTL identified a set of six circuits that may have scope for increased rating utilising this procedure. One circuit is ruled out in the short-term on the basis that it is currently not thermally constrained, but limited by stability. However, it would become relevant once future works are completed. Scottish Hydro Electric Transmission ("SHETL") identified that there is little doubt that additional capacity is available at times, but noted that stability issues at times limit transfers rather than thermal, weather-related, factors.

Both Scottish licensees' responses identify the need to carry out detailed line surveys to reveal the limiting section of the overhead lines for which local weather information would be required. That local weather information would need to come from the Met Office and be calibrated via local weather stations which would need to be purchased and installed.

SPTL proposed a timetable of 18 months for implementation of MORE on the first circuit, with a further five completed within 30 months. SHETL suggested the timeframe was dependent on the time to complete line survey work.

The two Scottish licensees had differing views on the implementation of the processes to facilitate the use of MORE. SHETL was of the view that the calculations should be undertaken by NGET and approved by them, whereas SPTL suggested that it would implement MORE and provide day-ahead ratings to NGET through the existing SO-TO Code processes for temporary changes to capability. One licensee was concerned regarding the liabilities for damage or degraded condition due to the use of enhanced ratings.

Both Scottish licensees put forward the view that the MORE approach to enhancing rating could be further improved through more dynamic ratings "on-the-day". This would be expected to enable better accommodation of the varying nature of wind-powered generation, requiring the SO to utilise the full thermal capacity of the system in short timescales.

3.1.3 Review of licensee responses

The MORE technique that forms the majority of the licensees approach is over 10 years old and the procedure that was developed by NGET based on empirical data incorporating several factors, which seeks to account for possible errors in forecasting. There appears to be little feedback through monitoring actual conductor performance over time (SHETL is investigating this through a research development project), with only snapshots being available through aerial laser surveys. The continued application of multiple correction factors would appear to be systematically underestimating the capability of circuits and should be reviewed. In support of this, it is clear that Met Office forecasting tools and services have improved significantly with highly localised short-term forecasting that is available commercially. This also suggests that the need for localised weather forecasting to calibrate the Met Office forecasts may have less relevance. It is also notable that recommendations from the model to down-rate conductors are apparently ignored. This suggests that there are safety margins built

in that suggests that the model provides low estimates of conductor capability and therefore it would be reasonable to suggest that the enhanced ratings that could be safely used are higher than those currently applied.

Whilst rating enhancements based upon day-ahead weather forecasting may yield increased network capacity, one licensee commented that hot wiring initiatives usually delivered greater (firm) capacity enhancements. There are examples of projects within the UK being implemented that utilise real-time dynamic ratings. It is notable that the licensees are developing techniques that others are already trialling to better manage and optimise their networks. It seems that the monitoring of actual conditions, e.g. temperature or sag, are not a high priority for the transmission licensees despite the obvious gains that could be achieved in terms of confidence in modelled ratings and the consequential ability to exploit further enhanced and short-term ratings. A change in the incentives to operate the system may be required to generate a mind shift to accept greater risk in the planning timeframe.

The Scottish Licensees were silent on the other techniques used for enhancement in the responses. An area worth further exploration is the apparent rating limitation due to warranty restrictions that apply to new cable installations, but not transformers. It would be useful to consider how the rating assessment differs between the cable suppliers, how enhanced ratings could be incorporated within such agreements and ensure clarity on the aspects that allow greater ratings for cables outside of warranty agreement.

3.2 Consider the scope for additional "hot wiring" (Action A2)

3.2.1 Actions and outputs required of the licensees

The licensees were required to provide a report that identified the circuits that should be considered for hot wiring, the timetable and implications of implementation.

3.2.2 Summary of licensee responses

The licensees identified circuits that have the potential to be hot wired. NGET responded with a description of its approach to identifying priority circuits for assessment and the assessment process. This is initiated by a desktop study to identify limiting factors from route records, e.g. suitability of conductor grease and joints for higher temperature operation. Ground surveys are used to confirm this initial analysis. Circuits are assessed for other limiting factors e.g. protection, before aerial survey information is analysed or (in the absence of data) aerial surveys commissioned. The outcomes of the process can range from no work being required, through to heavy engineering works including addressing reduced clearance spans where obstacles or other issues are found in the survey. NGET provided its current programme of assessment including notes suggesting the likely opportunities for hot wiring. These showed that there were seven circuits for which upgrade was possible and at least a marginal increase in circuit capability would be achieved, four for which there was unlikely to be any benefit with seven circuits remaining to be assessed. SPTL provided a list of six circuits, of which three were already progressing with reconductoring programmes. One circuit was identified for a higher

operating temperature subject to the ability to resolve six clearance issues and two other reconductoring projects to provide enhanced ratings. SPTL also responded saying that they believe that there may be significant merit in undertaking an Aerial Laser Survey programme and are in early discussion with Aerial Laser Survey service providers. SHETL identified two circuits where it is considering reconductoring with high temperature, low sag conductors and said that it is considering the application of innovative conductors on its 132kV network.

3.2.3 Review of licensee response

The licensees confirmed their willingness to undertake hot wiring activities although a specific timetable for implementation or consideration as to the practicalities for implementation was omitted. In addition, the licensees have differing views on the hot wiring process. It is clear that re-conductoring is the primary tool considered by the Scottish licensees, perhaps on the basis of a avoiding the need to collect detailed information on clearances (which is borne out in Scottish Power's intent to undertake a full aerial laser survey) and/or the absence of detailed data on the existing conductor construction.

It is also noted that SHETL are seeking to undertake a demonstration project for the introduction of GAP type conductor before applying it widely. However, this is now being extensively employed on NGET's network, which places into question the need for the demonstration of such a conductor type, however, it is important to recognise that investment is required for training in the maintenance techniques etc, (if done in-house) in order to support such installations.

There appears to be relatively little co-operation beyond the formal investments through University led projects between the licensees that could deliver more shared learning. This is evidenced by examples such as the lack of use of techniques such as MORE, the lack of advanced approaches to calculating short-term ratings and the lack of immediate translation of new conductor types across the border.

3.3 Review the use made in operational planning and control timescales of short term rating information (Action A3)

3.3.1 Actions and outputs required of the licensees

This action was only placed upon NGET. The licensee was required to report on the categories of information available across the GB transmission system, the extent to which the information is complete and what is currently specified when new assets are installed. Comment was sought on the quality of the available information.

3.3.2 Summary of licensee response

NGET responded that there are composite ratings (each component is separately identified and the limiting element identified) which have both pre-fault continuous and post-fault continuous for each transmission circuit in England and Wales. Similar information is available for Scotland made available through the SO-TO Code. These ratings are established when new assets are commissioned or revised when assets are replaced on the system.

Additional short-term rating information is available for each transmission circuit in England and Wales and for the interconnected 400kV and 275kV network circuits in Scotland. The short-term ratings typically provide 6 hour, 20 minute, 10 minute 5 minute, and 3 minute ratings against a range of pre-fault loading conditions (typically 30%, 60%, 75%, 84% and 95%). NGET stated that it is continuing to work with the Scottish licensees to complete the short term ratings information for the 275kV and 132kV circuits in Scotland. SPTL also stated that it was working with NGET to complete this work for its 132kV interconnected network.

NGET also outline how that additional detailed rating information can be requested in specific circumstances, e.g. for specific outage or generation patterns. This processes allows a detailed assessment of the rating for a circuit, for example by references to a specific supply point's load profile, that would allow pre-fault conditions to be determined and enable special ratings to apply for a limited period for a specific purpose e.g. to enable the release of an asset for maintenance.

Short-term rating information are reportedly used in operational timescales to ensure the efficient and economic optimisation of the transmission system, allowing post-fault flows to meet the short term ratings depending on whether the contingency actions are automatic or manual. Where manual interventions are required to secure the network post-fault, only 10 minute or longer time ratings are used.

3.3.3 Review of licensee response

It is not yet clear from the licensees' responses whether the use of such ratings is sufficiently embedded in the systems and processes in order to utilise them on a business-as-usual and GB basis. The increased complexity of monitoring and calculating ratings may not provide maximum value until wider market developments are implemented e.g. smart meters that could allow demand side management to be undertaken to maintain post-fault ratings, and dynamic ratings can be incorporated into control systems with the necessary state estimation engines etc.

4. Transmission System Utilisation

4.1 Develop a methodology for illustrating utilisation of transmission boundaries to take account of pre-gate closure actions to manage constraints (Action B1)

4.1.1 Actions and outputs required of the licensees

NGET was required to provide a report illustrating how such a methodology would work with two active constraint boundaries.

4.1.2 Summary of licensee response

NGET provided a definition and methodology for calculating the utilisation of the constrained boundaries. It defined utilisation as the ratio of the anticipated constraint boundary flow at any point in time, divided by the corresponding constraint boundary limit at that time. NGET defines two different utilisations, described as "market" and "gate closure". The market utilisation unpicks the system operator actions to provide a utilisation figure, net of those actions, i.e. an unconstrained utilisation figure against a constraint limit equally unmodified by system operator actions.

NGET noted limitations of the utilisation methodology and concept. These being primarily that the constraint limits are only currently produced for "active" constraints at cardinal points in the day (normally four) and that the boundaries change over time, depending the patterns of generation and demand that occur.

4.1.3 Review of licensee response

The response puts forward a comprehensive approach to developing an ex-ante view of boundary utilisation but overlooks any form of ex-post review of boundary usage. This appears on the surface to the easiest approach to calculating an 'all-in' utilisation factor. Together with NGET's ex-ante approach would provide insight into the effect of market and System Operator actions that increase or decrease the utilisation of key boundaries.

It is clear that an enduring solution would take a significant effort on the part of the licensee, however, some limited information on constraint boundaries (as they appear) should be able to provide in a first step based on the information that is currently collected. This provides a step forward that can then be built on if the information proves itself valuable and if it is felt that greater precision or accuracy is required for particular purposes.

There is no quantification of the potential costs for implementation other than it is perceived as difficult to provide the metrics at the enhanced frequencies (i.e. beyond the current cardinal points) and across the number of potential constraints (that change daily).

It is notable that one of the Scottish TOs [SPTL] suggested that ex-post operational data regarding the utilisation of the boundaries and the costs incurred in managing constraint could also form a useful data exchange to be better able to assess the cost/benefit of potential upgrades

4.2 Provide information about the dependencies between planned transmission reinforcement works and new generation connections (Action B5)

4.2.1 Actions and outputs required of the licensees

The licensees are required to provide information regarding the number of new generation connections that will be accommodated by each transmission upgrade, together with the timetable for the works, dependencies on other works and any external constraints on that timetable.

4.2.2 Summary of licensee responses

The licensees identified the transmission works on which new generation connections were dependent and the interdependencies between transmission works. The consistently identified external factor, across all of the licensees, on which reinforcements are dependent, is consents. Other issues identified included the uncertainty of requirements for TEC by projects in the queue. Changes in project requirements necessarily lead to a design review (to avoid stranding assets) that can require the consenting process to restart causing a significant delay.

The percentage of MW that are dependent on wider system reinforcements varies according to the TO region from the least effected of around 30% that will connect without requiring reinforcement to only approximately 10% that are able to connect. Across GB approximately 12% of the MW capacity (15% by number of projects) seeking connection are not dependent on deeper transmission infrastructure upgrades.

5. Limiting factors in the current regulatory framework

5.1 Identify any data exchange restrictions in the current regulatory framework that hinders transmission system development (Action C1)

5.1.1 Actions and outputs required of the licensees

The licensees are required to identify relevant data exchange restrictions in the transmission licence and industry codes and propose reviews of the restrictions and identify additional data considered necessary for transmission system planning.

5.1.2 Summary of licensee responses

The licensees considered that the SO-TO Code ("STC") places restrictions on information exchange that could hinder transmission system development. The STC limits the data flow between NGET (as the GBSO) and the Scottish TOs ("Transmission Owners") and the GB Grid Code also places restrictions on the sharing of data submitted by Users. The restrictions prevent the Scottish TOs from running a full GB transmission system model except for the specific case of stability studies (under STC amendment CAA021 approved in August 2006). The current process only allows for information to be exchanged with the Scottish TOs to the limit of the defined "Boundary of Influence" between the respective TO areas and hence forces the use of "Hybrid" models that have the NGET best view generation background within the boundary of influence, but is restricted to the contracted background outside of that region. This means that the TOs use differing models to assess reinforcement of the networks. The licensees suggest that these hybrid models have increasingly diverged to a point of unacceptability. In summary the licensees identified four areas where fewer restrictions on data exchange would be beneficial:

- Exchange of Best View Investment Planning Data
- Exchange of Construction Planning Assumptions
- Time Limits on Planning Assumptions
- Provision of Operational Data

The licensees point to a number of amendments to the STC that have sought to clarify and change the restrictions on the exchange of information between the GBSO and the Scottish TOs and that further amendment proposals are in development to seek to allow greater information exchange to improve the analysis of transmission system investments, these include:

- Rewriting STC - Schedule Three, to improve the transparency and understanding of the information/date that the Transmission Licensees are able the exchange.

- Removing the limitation (to the current year plus six into the future) on the number of years of data National Grid can provide with regard to the Planning Assumption.

- Rationalising the number of Planning Assumptions that are based on the contracted background to provide more transparency and clarity of the information/data being exchanged.

One Scottish TO [SPTL] also identified that greater exchange of operation data, specifically relating to constraint limits, volumes of constrained energy and cost associated with relieving constraints would better enable them to meet their licence obligation to develop an economic and efficient system.

5.1.3 Review of licensee response

The licensees' responses tend to suggest that the concept of the Boundary of Influence is somewhat limiting and could be leading to inefficient investment because the different Transmission Owners are required to use different data sets on which to market their investment decisions. The Scottish Licensees are only permitted to see the contract background outside of the Boundary of Influence of the neighbours. This drives different outcomes for each TO for the background against which they could assess investment options. The 'hybrid' model approach is imposed by the limitations that are placed upon the exchange of information in the SO-TO Code. A consistent approach with a single system model and view of generation and demand background would most likely allow better investment decisions to be made on a GB wide basis, earlier in the process.

It will be important to ensure that the competitive market cannot be distorted or jeopardised by STC changes while refining arrangements to ensure that modelling achieves the necessary standards of accuracy. Modelling of this type is a critical element in operating a large and heavily loaded power system securely and it would be unwise not to respond to accuracy concerns.

It is notable that one of the Scottish TOs [SPTL] suggested that ex-post operational data regarding the costs incurred in managing constraint could also form a useful data exchange to be better able to assess the cost/benefit of potential upgrades. This is clearly an area where further investigation would be warranted to understand whether greater data on such issues would enable a better case to be made for investment outside of a purely deterministic standard, which could be a supporting pillar for the development of a probabilistic approach to transmission planning. It is important that an assessment is made as to the potential for any party to be materially advantaged or disadvantaged in the sharing of such information.

5.2 Review the application of GBSQSS (Action C2)

5.2.1 Actions and outputs required of the licensees

The licensees are required to set out their current interpretation of Secured Events within the GBSQSS. The licensees are required to explain the rationale for the most onerous fault condition assessed the appropriateness of the condition and assess the impact of reducing the most onerous fault condition used in assessing reinforcement of the transmission system.

5.2.2 Summary of licensee responses

The licensees provided a common view on the current interpretation of the secured events that the transmission system is required to be planned to. The licensees noted that the most onerous fault condition, i.e. the limiting factor for transfer capability, was dependent on the location within the network. The current interpretation of the GBSQSS secured events, consider in all cases that the fault results in a long-term disconnection, transient voltage at the fault location is zero and that all other systems operate as intended, e.g. generators ride through the fault, protection systems operate as intended.

One Scottish TO [SPTL] provided a statistical and risk based analysis of the different types of faults that could be considered the most onerous condition for which the transmission system could be planned. This suggested that the particular licensee would expect a zero impedance, three phase to earth fault once every five years. It was noted that the effect of this is critical to stability of the system in limited locations and as such the probability of this occurring on a critical double circuit at a critical time reduces to 1 in 24,000 years. This was assessed against the Health and Safety Executive risk protection of people scale. This suggested that if the cost of maintaining the existing standard was small compared to the impact of the event occurring then the existing standard should be maintained.

The licensee presented some indicative modelling of reducing the most onerous fault condition on the ability to transmit power. Its study suggested that by reducing the most onerous fault to be considered under the stability analysis from three-phase to earth, to phase-phase-earth, would allow an additional 8% of capacity, (the capability could be increased to 17% if the standard was changed to a single-phase to earth fault). In conclusion, however, the licensee regarded potential consequences of a higher impact fault that were considered, were felt to outweigh the benefits of moving to a lower standard. The exact quantities considered in determining the impact was referenced to the cost of a total system shutdown, with the US Eastern Seaboard being used as an example where to cost to the regional economy was comparable to half the annual energy bill for the region. On this basis, it considered that the potential costs of an incident far exceeded the ongoing costs (constraints) of maintaining the existing standard.

5.2.3 Review of licensee response

There was little consideration here of the current N-2 security standard that applies even though there would appear to be merit in considering at least calculated reductions in the standard e.g. extending time-limited derogations to a lower security level where there is a cost benefit of allowing the new generation to connect earlier. This would require some form of reliability analysis tool to test the likelihood of a loss of demand. Furthermore, the number, location and character of double circuit fault events (N-D) might be re-examined to enable a more permanent but targeted relaxation to N-1 operation. To support this, a strategic assessment of double circuit faults could be undertaken with the aim of seeking ways to reduce the incidence of double circuit events, covering issues including tower lightning vulnerability and protection stability.

It may be possible to extend extra flexibility in standards that allows some form of bad weather system configuration of generation (including distributed generation) and network that would enable the system to operate at an acceptable standard e.g. N-2, for bad weather circumstances (recognising that this would bring additional costs to operations at times due to constrained despatch).

All of the above require a more probabilistic or risk based approach to the setting of the standards that in order that an acceptable level of security is maintained to demand points, i.e. with redundancy in transmission being one element that enables that security, alongside generation, demand side response etc. A reliability analysis tool would be required together with an agreed acceptable loss of load probability to enable the risks and solutions to be quantified and assessed.

The licensee responses also provide little new information that could help to make any quantifiable assessment of the implications of a move to a less onerous fault condition as the standard to which they should plan. Internationally the most onerous fault condition considered does vary, however, for many the most onerous condition considered for stability analysis is a three phase fault, however, not necessarily for a double circuit. Further analysis should be undertaken and a proper assessment of the quantifiable risks of changing the standards, based upon experience in GB and internationally.

5.3 Identify requirements in the planning criteria of the GBSQSS that were key triggers for transmission system reinforcement for generation projects in the GB Queue (Action C3)

5.3.1 Actions and outputs required of the licensees

The licensees were required to identify the GBSQSS criteria that are the key drivers for the reinforcement of the GB transmission system for generation projects in the GB Queue. The licensees were required to provide a report to define the key triggers for reinforcement, provide a view on the merit of the review of criteria and set out proposals for a review of these criteria.

5.3.2 Summary of licensee responses

GBSQSS Driver	Percentage of reinforcements across GB driven by the GBSQSS requirement
Thermal	70%
Voltage	18%
Stability	2%
Short circuit	9%

GBSQSS Event	Percentage of reinforcements across GB driven by the GBSQSS Event
N -2	55%
N- D	34%
N- 1	4%
N -3	7%

No information available from SHETL, above data is aggregation of NGET and SPTL responses.

5.3.3 Review of licensee response

The licensee responses showed that thermal limitations i.e. not to have unacceptable overloaded equipment drove nearly 70% of all system reinforcements. The underlying data in the responses also showed that these potential overloads most often occurred under the N-2 secured event. Having to secure against N-2 or N-D (worst double overhead line fault outage) events drove nearly 90% of all transmission reinforcements. This suggests that there is a benefit of moving to an N-1 security standard, at least on a selective basis, as it would significantly reduce the need for investment in the transmission system to accommodate additional generation. Consideration must be given to the potential impact of such a reduction on demand security and should quantify the risks associated with high impact, low probability events. Such work should be contained in the reviews of the security standard and are included in the proposed work plan for the development of the current GBSQSS.

5.4 Develop GBSQSS review work plan (Action C4)

5.4.1 Actions and outputs required of the licensees

The licensees were asked to develop a work plan for reviewing the GBSQSS. The licensees were required to consider the inclusion of probabilistic planning criteria, the use of intertrips in the planning phase, changing the outage condition from N-2 to N-D and from N-2 to N-1 and seek to resolve the regional differences in the GBSQSS.

5.4.2 Summary of licensee responses

Current GB SQSS Reviews

Title	Expected End Date	Duration	Status	Priority
Review of Onshore Intermittent Generation	Jun-2008	18 months	Active	High
Housekeeping	Jun-2008	15 months	Active	High
Review of Chapter 2 (Design of Generator Connections)	Jul-2008	10 months	Active	High
Review of Chapter 4 (Bus Coupler Security)			On Hold	Low
Review of Voltage Criteria	Winter 2008	6 months	Pending	Medium/High
Review of Stability Criteria	Spring 2009	9 months	Pending	Medium/High
Review of Infeed Loss Limits	Jun-2009	15 months	Active	High

Prospective Areas for GB SQSS Review

Review Area	Expected Start Date	Duration	Status	Priority
Inclusion of probabilistic planning criteria	Summer 2009	12 months	Pending	Low
Allowing use of intertrips to be considered in planning timescales	Autumn 2008	12 months	Pending	High
Replacing requirements to consider N-2 outage condition with N-D outage condition	Autumn 2008	18 months	Pending	Med
Replacing requirements to consider N-2 outage condition with N-1 outage condition				Med
Resolving regional differences within GB SQSS	Autumn 2008	9 months	Pending	Med
International Benchmarking (action D2)	Summer 2008	9 months	Active	High
Contribution of embedded generation to demand security	Review after introduction of ER P2/7	12 months	Pending	Low
Impact of offshore network on GB SQSS (interface between systems)	Review after Offshore Go-Active	9 months	Pending	Med
Review of GB SQSS to seek clarification on pre and post fault demand transfer between GBSO and DNO	Review after Authority decision on Grid Code B/07	9 months	Pending	Low
The use of 'registered capacity' in the GB SQSS vs 'TEC'	Review after Transmission Access Review	12 months	Pending	Low

5.4.3 Review of licensee response

The licensee response outlines a large number of areas for review with an indication of priority, however, there is no indication against what criteria those priority categories were set or to what extent they would address the objective of better using the infrastructure that currently exists. It is noteworthy that adopting probabilistic planning (even in a limited way) may have the potential to provide the greatest flexibility in releasing network capacity, however, this is shown as a low priority.

The options that have been considered are generally not unique to GB and comparisons can be made to many other jurisdictions where different security standards are used, e.g. N-1 where security of supply is adequate to support a developed economy or a mix of probabilistic and deterministic standards are applied (for example New Zealand) to justify investment in network infrastructure or alternatives, e.g. distributed generation.

6. Development

Three actions were placed on the licensees in this area, covering research and development projects that may release additional capacity or facilitate the connection of new generation, initiatives to enhance the capability of the transmission system and a comparison of the GBSQSS with those standards that apply in other countries.

6.1 Provide information about research and development projects that may release capacity or facilitate the connection of new generation and on initiatives for enhancing transmission system capability (Action D1 and D3)

6.1.1 Actions and outputs required of the licensees

The licensees were required to provide information on the timescales for assessment and implementation of projects that would lead to the release of capacity on the networks or facilitate the connection of new generation. The report was to include those that had been completed, in progress and those that have been initiated under the Innovation Funding Initiative.

6.1.2 Summary of licensee responses

The licensees provided an overview of the relevant research projects which covered three main areas:

- improving the thermal ratings, both physically (different materials and constructions) and through modelling e.g. for dynamic ratings;
- seeking faster and new types of protection solutions to secure against widespread collapse of the transmission system as the system is run closer to the limits of stability, with a greater variability of power sources; and
- evaluation of new technologies connecting to the grids, e.g. renewable generation technologies and demand side solutions or storage solutions.

All of the projects identified will complete between 2009 and 2011, and further updates will be made through the annual Innovation Funding Initiative reporting process in July 2008.

In addition, SPTL highlighted their progress on implementing the Critical Unit Program ratings scheme that provides short-term ratings for circuits based on the limiting plant item SPTL currently has coverage of the main interconnected 400kV and 275kV network and is expanding the scheme to cover its 132kV interconnected network.

6.1.3 Review of licensee response

It is clear that the projects being pursued are likely to deliver enhancements that would go towards meeting the requirement to allow greater connection of generation. The timing of implementation, materiality and durability of these enhancements was not clear in the response. If the timeframes for implementation of these enhancements is sufficiently long it will be important that the projects are considered in the context of the evolution of the industry. Alternative futures e.g. where there are large numbers of small generators embedded in lower voltage systems or greater demand response from smart metering and direct load control to gain access to material quantities of demand response could create very different challenges to the ones being considered in the responses. For example, understanding how the developments of mass mobile storage e.g. electric vehicles, might be act as interruptible demand or storage/export sources.

For the innovative approaches to succeed there is a need to address the core technology and the commercial and regulatory implications together with issues such as availability of skilled resources, test facilities and diagnostics. Some of the innovations clearly require a strategic approach to achieve full roll-out in a reasonable timescale and need to encompass solutions that make an impact for GB as a whole, e.g. for wider areas protection schemes or co-ordination of demands side schemes. It is not clear that the current projects will become in use widely for many years to come that may not satisfy the immediate need for greater utilisation of infrastructure. It may require greater leadership (either from the companies, regulators or an appointed third party) and emphasis on sharing of learning within GB and beyond to accelerate deployment of technology or techniques to release new network capacity.

As a general observation, and noting developments internationally, it can be expected that new materials, new products and new techniques will become increasingly available. However, it can also be noted that innovation on networks is observed to be problematic for companies where there has been a period of status quo and lack of familiarity with new approaches. If there is a wish to be more innovative going forward the following principles may be helpful to consider:

- Pilot and demonstration projects are key; an organisation will be unlikely to make any substantive progress in this area by desk top studies and third party research alone,
- Collaboration between transmission companies, between distribution companies and between transmission and distribution companies, is likely to be advantageous,
- The technology is only part of the challenge: regulatory and commercial implications of any new development are best considered systematically and in the early stages,
- New technology can have impact on many parts of a company's business operation (for example standards, procurement, spares and first line support, and control room facilities and skills) and an integrated approach is needed for successful delivery and utilisation.

6.2 Compare GBSQSS with planning and operational standards that apply in other countries (Action D2)

6.2.1 Actions and outputs required of the licensees

The licensees were required to develop terms of references for a study that identified appropriate benchmarks, an approach for identifying and evaluating key differences, with a final report on the findings being delivered by 31 March 2009.

6.2.2 Summary of licensee responses

The licensees propose to select transmission systems for study that reflect similar societal, political and economic background to the UK and include key European countries (UCTE members), USA, Australia and a selection of similar/smaller island networks, i.e. Japan, New Zealand and Ireland.

The proposed study would examine the basic approach to the design planning and operation of each network, i.e. deterministic, probabilistic or cost benefit etc. The proposed review would take relevant parameters into account, e.g. network size, physical disposition of assets, network demand, industry structure, regulatory regime, incentive schemes and market arrangements etc. Where possible, supporting information on out-turn operating cost, network performance and resilience etc. will be gathered. The general satisfaction of the utilities balance of cost and security benefit will be reported along with any initiatives, enduring or ad hoc, to revise the current standards.

The form of the benchmarking exercise by the licensees is a questionnaire that will seek to identify the key reasons for differences between each sample network and the GB SQSS.

6.2.3 Review of licensee response

The licensee review timescale for this action seems to be long compared to the effort that is likely required to capture such information.

7. Concluding remarks

The TSORG work has demonstrated effective collaboration between the transmission companies which is to be welcomed in the interests of all system users and it has usefully identified a number of technical opportunities that is developing an agenda for fresh thinking

The more detailed consideration by TSORG of system capacity limitations has also identified challenges such as the potential for introducing increased system risk, the balance to be struck between information sharing and the protection of competitive markets, and the complexities that arise when seeking to maximise capacity on Britain's heavily loaded and highly interconnected grid.

In all cases there is more analysis and evaluation needed before wholesale implementation of techniques can be expected, but this is the nature of such work: having commenced the TSORG process it will be most valuable for the companies to pursue this work in a systematic and collaborative manner.

The focus to date has intentionally been technical; it is likely that progress will be best facilitated by prioritising the work programme and incorporating consideration of regulatory, commercial and business impacts. It is unlikely that a well developed technical solution will achieve effective roll-out and deployment if these additional factors are not addressed in good time and in a holistic way.