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Further Assessment of Transmission Investment Proposed by the Three GB Electricity Transmission Owners: Review of Requests for Funding for 2011/12 – Final Report

London, 20 January 2011

Client: Ofgem

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EXECUTIVE SUMMARY

In 2009.the 3 GB Transmission Owners (TOs) submitted additional funding proposals for investments beyond existing price control allowances.

The general objective of the portfolio of network investments is to enable substantial enhancements in north to south power flows and from outer-lying parts of the GB network. The underlying investment driver is the anticipated portfolio and pattern of generation required to meet the Government targets for renewables in 2020.

This 2009 programme was considered as part of Ofgem's work regarding enhanced transmission investment incentives. To support this assessment, Ofgem appointed KEMA and PB Power to review the TOs' proposals. In April 2010, Ofgem implemented the framework to fund such investments within the current price control period, and allowed funding for an initial tranche of projects.

In August 2010, Ofgem received further funding requests from the GB TOs for the period 2011/12, and in November 2010 KEMA was appointed to support Ofgem's assessment of the funding requests. KEMA adopted an assessment approach aligned with that adopted in 2009, extended at a high-level to include issues as addressed by PB Power previously

The funding requests proposed by the three TOs are categorised according to Pre-Construction and Construction funding requirements. This Final Report sets out the findings of KEMA's review and makes recommendations for consideration by Ofgem.

The conclusions and observations are summarised in Table 1 overleaf. In summary, all Pre-Construction funding requests appear appropriate for approval in 2011/12, and all "on-shore" reinforcement Construction funding requests appear appropriate subject to some suggested amendments to the funding level.

With respect to the offshore Western HVDC Link, KEMA concludes that the commencement of construction can be justified in 2011/2012 for NGET's chosen set of input assumptions to the related Cost Benefit Analysis. However, the uncertainties around the investment drivers are sufficient to support the view that there would be limited sub-project delivery and renewables deployment risks associated with conducting further analysis in 2011/2012. Consequently, KEMA has reservations as to the approval of construction funding for this sub-project in 2011/2012 and believes that further investigation work should proceed regarding detailed options and costs.

Table 1 – Summary of 2011/2012 funding requests

[Table removed]

1 INTRODUCTION

Under the GB Transmission Access Review jointly conducted by Ofgem and the Department of Energy and Climate Change (DECC) in 2009, the Transmission Access Review[1] (TAR) Final Report proposed the introduction of enhanced transmission investment incentives to encourage the GB Transmission Owners (TOs) to invest ahead of signalled need by anticipating future demand for connections to their networks and investing efficiently to ensure timely delivery of capacity. This proposal was taken forward by Ofgem through its work on enhanced transmission investment incentives (the TO incentives project)[2].

Complementing this work, Ofgem also asked the TOs to undertake a joint study, overseen by the Electricity Network Strategy Group (ENSG) to identify the future reinforcements likely to be needed to accommodate potential increases in renewable and conventional generation by 2020. Through this work[3], published in summary form in March 2009, and later in full in July 2009, the TOs put forward proposals for circa £5.5bn of investment, a significant proportion of which was proposed to commence construction within the current price control period[4]. In the context of the ENSG work and Ofgem's work on TO incentives, the TOs in 2009 sought additional funding for this investment, above the existing price control allowances.

To support Ofgem in the identification and development of appropriate funding arrangements for relevant projects; Ofgem sought an independent review of (a) the overall robustness of the system-wide development plan jointly produced by the TOs to facilitate the achievement of the Government's 2020 targets, and (b) the justification for proceeding with and the forecast capital expenditure of relevant projects.

This was undertaken through two complementary reviews undertaken respectively by KEMA, which focussed on the overall investment plans, and PB Power, which reviewed individual projects in detail. KEMA and PB Power delivered their final reports in January 2010[5] and Ofgem subsequently published its final proposals on 19 January 2010[6]. These proposals funded an initial tranche of investment and also introduced a process for considering further investment, triggered by funding requests from the TOs.

In August 2010, Ofgem received a number of further additional funding requests from the TOs for the period 2011/12. Consistent with the approach it adopted in the previous year,

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1 Documents available at: http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/tar/Pages/Traccrw.aspx

2 See the following documents available at the link in footnote 1:
"Transmission Access Review – Initial Consultation on Enhanced Transmission Investment Incentives", Ofgem (175/08), 19 December 2008
"Transmission Access Review - Enhanced Investment Incentives Open Letter: Consultation on Short Term Measures", Ofgem (12/09), 27 February 2009
"Transmission Owner Incentives Licence Modification – Decision letter", Ofgem, 31 March 2009

3 Documents available at: http://www.ensg.gov.uk/index.php?article=126

4 The current price control period (Transmission Price Control Review 4 – TPCR4) was due to end in March 2012 however in late 2009 Ofgem determined TPCR4 should be extended by one year to March 2013.

5 Hereafter the assessment which was undertaken by KEMA and PB Power will be referred to as the "2009 assessment"

6 The Ofgem, KEMA and PB Power documents are available at http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?file=100118_TOincentives_final_proposals_FINAL.pdf&refer=Networks/Trans/ElecTransPolicy/TAR

Ofgem sought an independent review of the submissions and in November 2010 engaged KEMA to further review the TOs' proposals in order to inform Ofgem's assessment of the funding requests.

This Final Report sets out the findings of KEMA's review and draws conclusions and makes observations for consideration by Ofgem.

2 SCOPE OF THIS REPORT

Ofgem sought an independent review of the investment proposals put forward by the TOs for which funding was requested from 2011/12. With respect to the assessment of these requests KEMA's objectives included:

- Identification of key changes since the previous assessment in 2009 and (where relevant) any overlaps with existing funding provisions, and review the extent to which the projects could be divided into separable sub-components for funding consideration;
- Reviewing the projects against the criteria relevant to the assessment of funding needs, in order to make recommendations as to the economic justification for proceeding with the projects (or sub-components) at this stage and the readiness of the TOs to take forward the planned work;
- Provision of an overall view as to the extent to which the projects (or sub-components) had materially different characteristics (for example in terms of utilisation risk, cost risk or deliverability risk) compared to projects for which construction funding has already been provided under the TO incentives work;
- Provision of an overall view as to whether sufficient information is available to permit detailed assessment for construction funding consideration and whether such information adequately addresses issues identified in the previous assessment; and
- Where relevant, undertake a detailed cost assessment in order to make recommendations as to the extent to which the TOs' cost estimates should be accepted for the purposes of determining relevant funding allowances.

With respect to the determination of appropriate funding provisions the overall objective of KEMA's work was to update the 2009 assessment in line with the approach previously adopted in KEMA's 2009 review, appropriately extended to address the aspects previously covered by PB Power in the 2009 assessment, and in particular to:

- (for new funding provisions) review milestones and output measures proposed by the TOs and make recommendations as to the extent to which they should be accepted; and
- where applicable, review expenditure and progress against deliverables set out in existing funding provisions and make recommendations as to the extent to which the assumptions in the existing baseline remain valid for the purposes of providing further funding.

The scope of KEMA's review included funding requests for the period 2011/12 in relation to pre-construction and construction works for the following 13 individual sub-projects:

- Preconstruction funding requests submitted by National Grid Electricity Transmission (NGET) for the following projects previously assessed in 2009 – listed by project and sub-project:
  - Central Wales: (1) - Mid-Wales – Ironbridge 400kV Overhead Line;
  - East Anglia: (2) - Bramford – Twinstead Tee 400kV Overhead Line;
  - Humber: (3) - Humber – Mumby – Walpole Overhead Line;
  - London: (4) - Hackney – Waltham Cross 400kV upgrade; and
  - South-West: (5) - Hinkley – Seabank 400kV Overhead Line;
- Preconstruction funding request submitted by NGET for the following new project:
  - Wylfa-Pembroke: (6) - Wylfa – Pembroke HVDC Link;
- Construction funding requests submitted by NGET, Scottish Power Transmission (SPT) and Scottish Hydro Electric Transmission Limited (SHETL) for the following projects (and components):
  - Anglo-Scottish Incremental (NGET): (7) - Shunt compensation at Harker, Hutton and Stella West[7];
  - Incremental Reinforcement (SPT): (8) - SPT-NGET Interconnection and (9) - East-West upgrade[7];
  - Western HVDC Link (NGET): (10) - HVDC Link and Converter station, and (11) - rebuilding and extension of the Deeside 400kV sub-station;
  - Western HVDC Link (SPT): (12) - SPT proportion of the HVDC Link; and
  - Beauly – Mossford (SHETL): (13) - Mossford sub-station.

It should be noted that in most cases, the above sub-projects are part of wider projects. These wider projects are described in outline within this report, and in assessing certain elements of the funding requests KEMA has had to consider the sub-project in the context of the wider project to which it relates. For example, the Mossford Sub-station forms part of a wider project which includes replacement of existing 132kV overhead lines. In assessing matters such as the "need" for the proposed works, the reasonableness of the proposed scope, certainty of timing and cost effectiveness, KEMA has considered the wider project as well as a detailed assessment for each specific sub-project for which funding has been requested.

[7] For the purposes of this report, these works are referred to collectively under the title "Anglo-Scottish Schemes" and relate to the on-shore projects only.

In this context, this Report documents KEMA's assessment of the TOs proposed system-wide investment plans and is structured as follows:

- **Section 3**: describes KEMA's approach to the assessment covering both the process it followed and the information on which its assessment was based;
- **Section 4**: provides an overview of KEMA's high level assessment of the component sub-projects within the investment plans for which the TOs are seeking additional funding, providing (a) details of the sub-projects including costs, deliverables and key dependencies/interactions; (b) KEMA's views on the certainty of requirement, reasonableness of scope, certainty of timing, and cost effectiveness of each sub-project; and (c) the sub-project assessment in terms of deliverability, certainty of design and costs;
- **Section 5**: details KEMA's review and assessment of the Cost Benefit Assessment (CBA) modelling undertaken by NGET and used as the basis for determining the need and timing of the boundary B6 related reinforcement options;
- **Section 6**: provides KEMA's conclusions for Ofgem in relation to the overall need, scale, phasing of the plans and thus implications for Ofgem funding these plans;
- **Appendix A**: details KEMA's high level assessment of the component sub-projects within the investment plan for which the TOs are seeking additional funding, as underpinning the overview provided in Section 4; and
- **Appendix B**: provides some further information on undersea cable technology.
- **Appendix C**: discusses alternative options for Boundary B6 reinforcements.

3 APPROACH TO ASSESSMENT

KEMA adopted an assessment approach in line with that which it undertook for the 2009 assessment, extended to include the matters addressed by PB Power in its part of the 2009 assessment. An outline of the process followed by KEMA is provided below:

- Firstly, KEMA undertook a review of the information provided by the TOs to Ofgem setting out the proposed projects/sub-projects and funding requests. Initial information was provided by e-mail by Ofgem and subsequently KEMA was provided access to the Ofgem Extranet which contained all documentation submitted by the TOs in relation to the above requests.
- Secondly, KEMA and Ofgem met each of the TOs to discuss both the overall investment plan and the component projects/sub-projects. KEMA's focus at these meetings was to obtain TO perspectives on the need, scope and timing of the component sub-projects. KEMA also sought to explore TOs views on key dependencies and interactions of the investment projects/sub-projects within the proposed overall investment plan. These meetings took place between 15 and 17 November 2010 and resulted in a number of questions being raised with each of the TOs. These questions were prioritised so as to facilitate KEMA providing an Interim Report (in the form of a presentation) to Ofgem on 23 November 2010. KEMA reviewed costs in discussion and Question and Answer exchanges, with the TOs and based on a review of equivalent works and market information.
- Straddling the TO meetings, the provision of the Interim Report to Ofgem and the preparation of a Draft Report, KEMA engaged in a Q&A process with the TOs (conducted via Ofgem) to obtain further information, confirm KEMA's understanding and to ensure an informed assessment of the proposed projects/sub-projects.
- Alongside this Q&A process, KEMA conducted its assessment and evolved its observations and conclusions which formed the basis of a Draft Report.
- The Draft Report was provided to the TOs for comment on 17 December 2010.
- After the 17 December, the TOs made specific observations, up to and including the 10th January 2011, which required further investigations and analysis upon which KEMA subsequently updated a number of conclusions in the report.

This report refers to a number of responses provided by the TOs in answer to questions raised by KEMA during the assessment. However, the detailed responses are not provided as part of this report.

4 REVIEW OF FUNDING REQUESTS

In this section KEMA provides an overview of its assessment of the 13 funding requests from 2011/12. A more comprehensive coverage of the sub-projects and the associated assessment results, observations and conclusions is provided in Appendix A. This Section therefore provides:

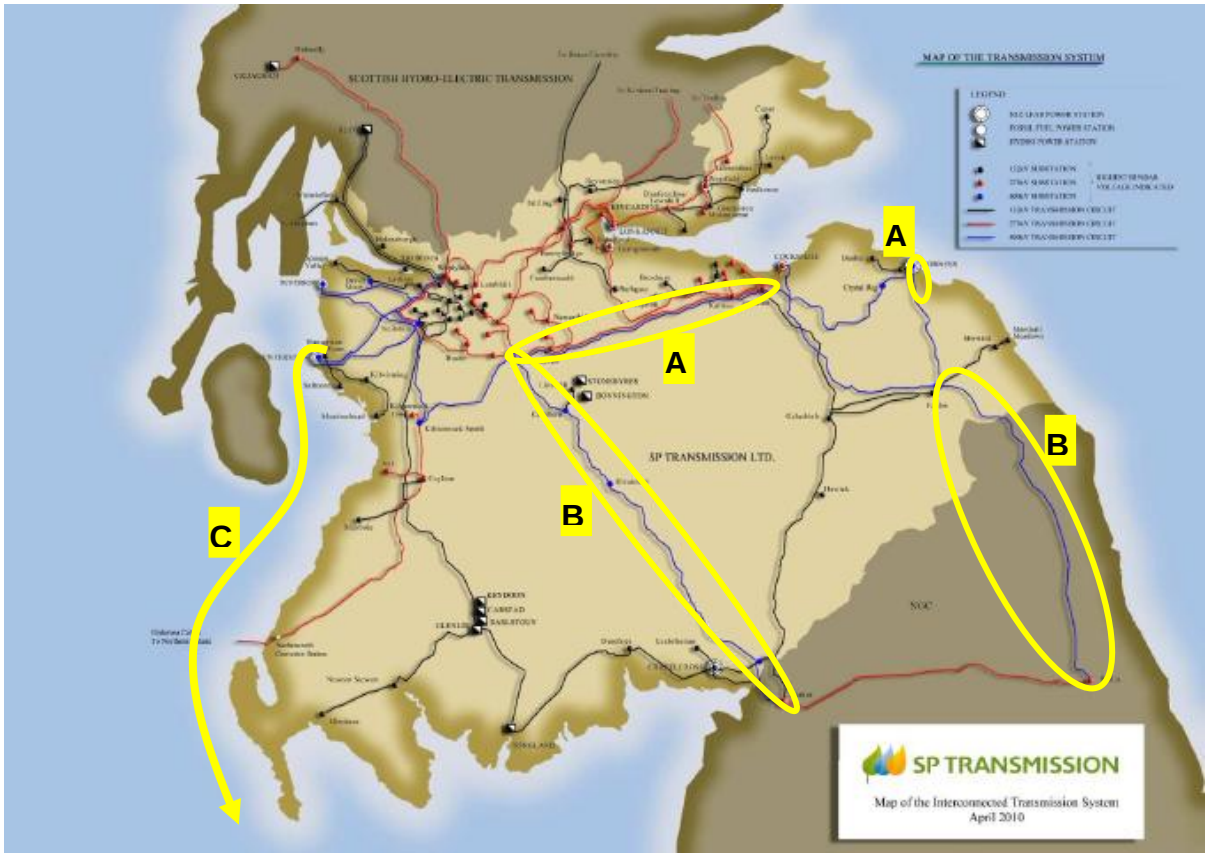
- An overview of the sub-projects – using charts to illustrate their location, the wider projects to which they relate and other key features which are apparent when the projects are viewed collectively;
- An overview of KEMA's assessments – using tables to collate the individual sub-project details; and
- Project specific observations.

4.1 Illustrative Overview of the Proposed Sub-Projects

This Section provides an overview of the transmission network extensions and reinforcements identified by the TOs for additional funding. The three diagrams provided in this section highlight the extensive nature of the projects/sub-projects and their diverse locations across the GB transmission network.

The general objective of the broad portfolio of network investments is to enable substantial enhancements in north to south power flows and outer-lying parts of the GB network towards the major demand centres in England. The underlying investment driver is the anticipated portfolio and pattern of generation required to meet the Government targets for renewables in 2020. Much of this new renewable generation will consist of wind generation and will be located in northern and outlying parts of the GB network both onshore and offshore.

Figure 1 - Proposed Network Projects – SPT Submissions



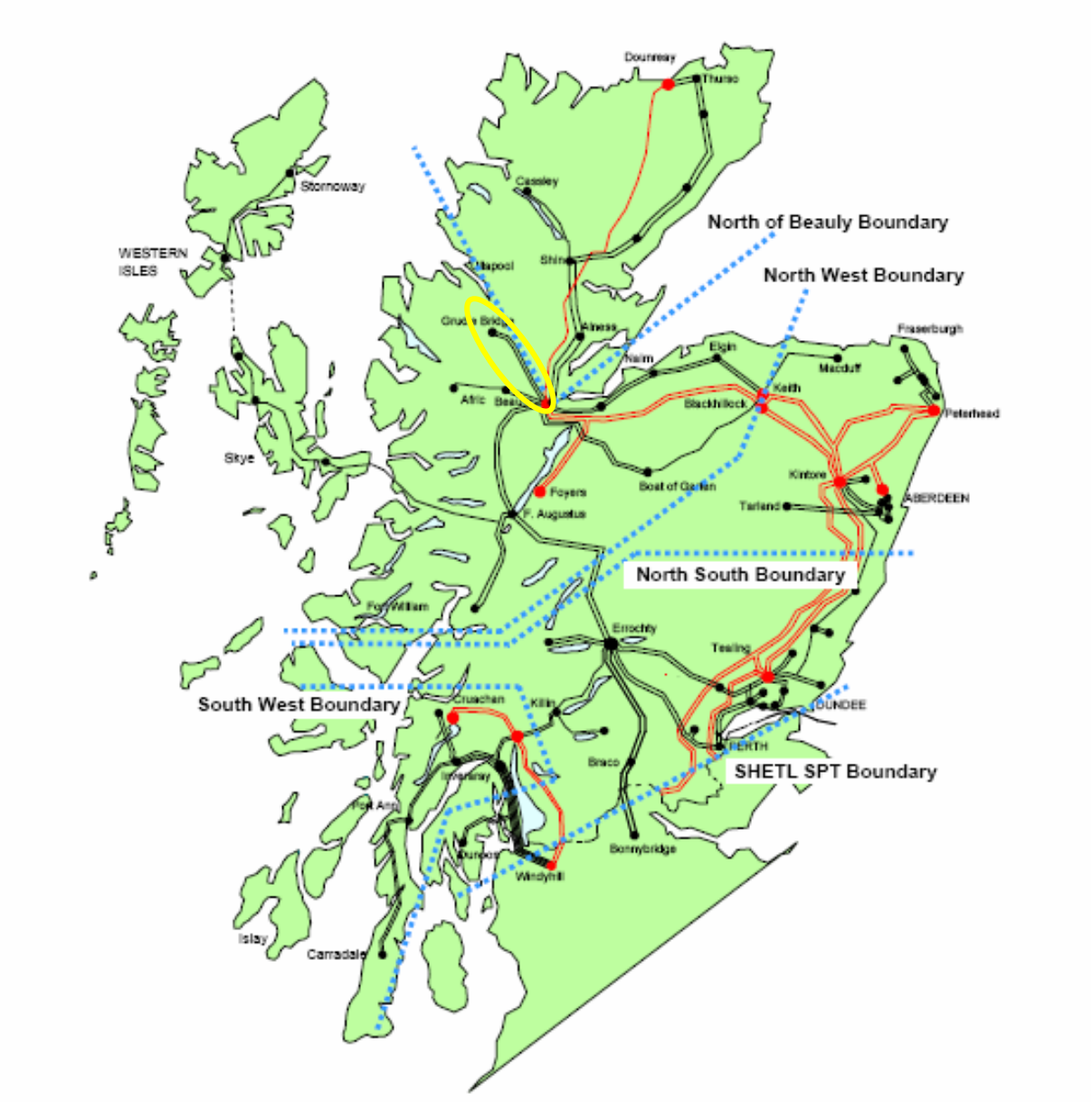
The sub-project labelled A in the above Figure 1 is the SPT sub-project termed the "East-West upgrade" and comprises the upgrade of the existing double overhead line from Strathaven to Smeaton to full 400kV operation and the installation of a second cable per phase on the Torness – Eccles No.1 and No.2 400kV circuits. The sub-project labelled B is referred to as the "SPT-NGET Interconnection" and seeks the introduction of 6 series capacitors into the East and West coast 400kV double circuit transmission lines between Scotland and England. These works taken together and also in conjunction with works to be undertaken by NGET as part of the Anglo-Scottish Incremental sub-project (some of which is described further below) will facilitate the increase of the transient stability limit towards 4,400MW[8] (subject to the successful completion of other works funded under TPCR4 and the Transmission Investment for Renewable Generation (TIRG) works).

The sub-project labelled C on the diagram relates to the SPT element of the "Western HVDC Link" (described further below in relation to the NGET submissions) and comprises the SPT contribution to the costs of the HVDC cable. It should be noted that the SPT element of the Western HVDC Link also includes a new 400kV sub-station at Hunterston North, however, at

[8] For the purposes of this report, these works are referred to collectively under the title "Anglo-Scottish Schemes" and relate to the on-shore projects only.

this stage, SPT have not requested funding for this sub-project and therefore this document focuses on the SPT proportion of the HVDC Link in relation to SPT.

Figure 2 - Proposed Network Reinforcement Projects – SHETL Submission



The SHETL “Beauly-Mossford” project comprises the replacement of the existing single circuit 132kV overhead lines and tower structure with a higher capacity double circuit 132kV tower line and the establishment of a new 132kV switching station close to the existing Mossford sub-station. The works will facilitate connection of proposed new windfarms in the area and facilitate compliance with the Security and Quality of Supply Standards (SQSS). Additional funding for 2011/12 is sought only in relation to the sub-project associated with the sub-station at Mossford.

Figure 3 - Proposed England & Wales Projects – NGET Submissions

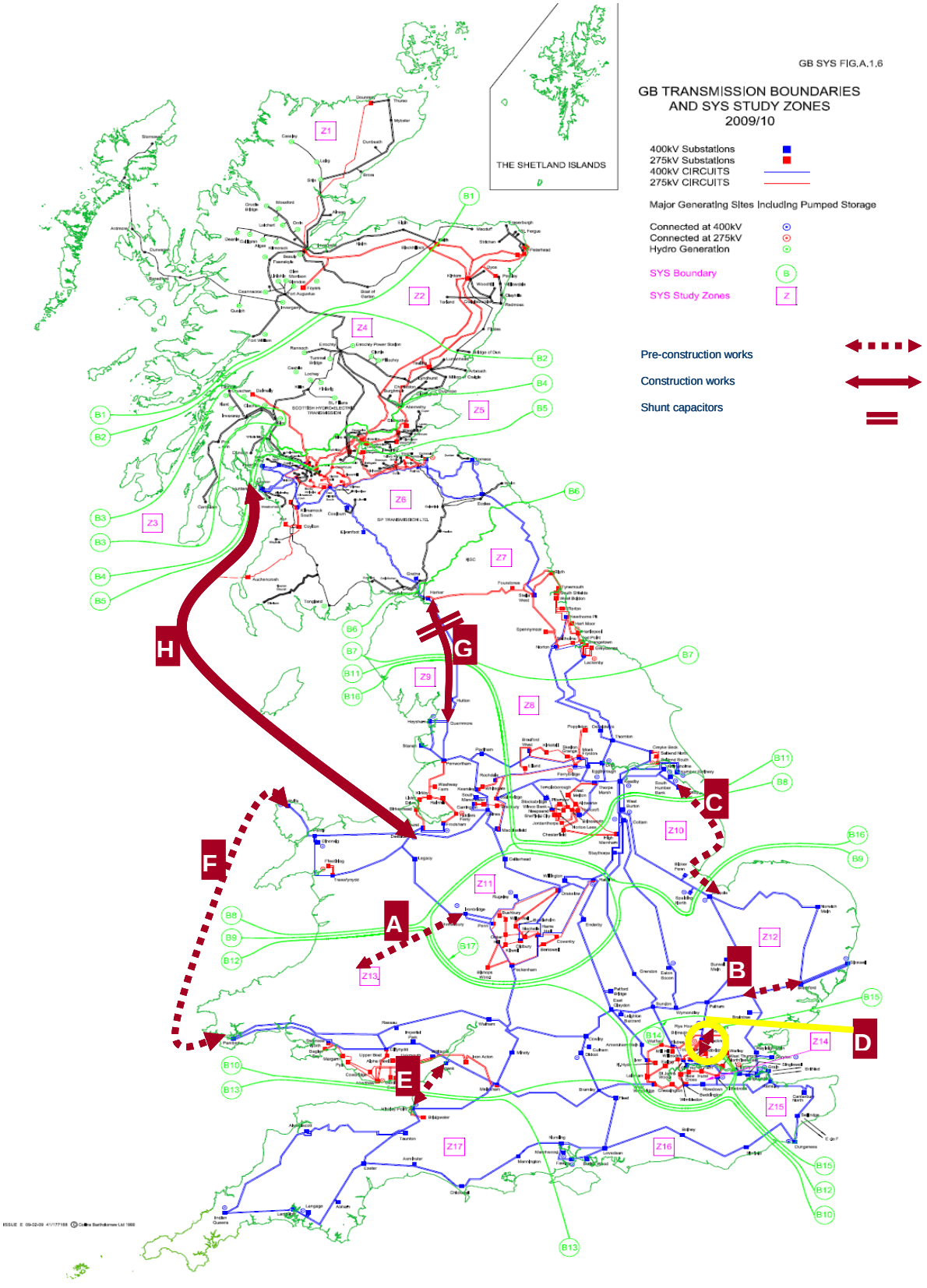


Figure 3 above highlights the range of sub-projects across the England & Wales network for which NGET has applied for funding in 2011/12, which is additional to funding already awarded for these sub-projects. In relation to the projects labelled A to E, NGET is seeking pre-construction funding in relation to specific sub-projects to address additional costs identified by NGET to progress the sub-projects through the Infrastructure Planning Commission (IPC). For the avoidance of doubt, projects A to E are outlined below with the specific sub-projects for which NGET have requested additional funding for 2011/12 highlighted in *italics*:

A. Central Wales:
    - Mid-Wales 400kV Sub-station;
    - Ironbridge Sub-station works; and
    - *Mid-Wales – Ironbridge 400kV Overhead Line;*
B. East Anglia:
    - Reconductor Norwich Main – Walpole;
    - Reconductor Bramford to Norwich Main;
    - Extend and reconfigure Bramford Sub-station;
    - 2 x Quad Boosters at Walpole;
    - *Bramford – Twinstead Tee 400kV Overhead Line; and*
    - 132kV Mitigation works;
C. Humber:
    - Humber Sub-station works;
    - *Humber – Mumby – Walpole Overhead Line;*
    - Mumby Sub-station works; and
    - Walpole Sub-station works;
D. London:
    - *Hackney – Waltham Cross 400kV upgrade;*
    - Brimsdown Sub-station;
    - Hackney Sub-station; and
    - Waltham Cross Sub-station; and
E. South-West:
    a. *Hinkley – Seabank 400kV Overhead Line;*

b. Hinkley Sub-station extension;

c. Seabank Sub-station extension; and

d. 132kV Mitigation works.

Project F (Wylfa – Pembroke HVDC Link) is a new project proposed by NGET for which funding is required in order to commence pre-construction works.

The construction sub-project labelled G (introduction of shunt compensation equipment at Harker, Hutton and Stella West) forms part of the "Anglo-Scottish Incremental" works that also comprises two further NGET sub-projects to reconductor the Harker – Hutton – Quernmore Tee circuits and to introduce series compensation equipment on the Harker – Hutton, Harker – Strathaven and Stella – Eccles circuits. No additional funding request has been made by NGET in relation to either of these two sub-projects. NGET's Anglo-Scottish Incremental scheme has changed since last year, such that the previous series compensation project has been redesigned and supplemented by the shunt compensation solution in sub-project G.

NGET's Anglo-Scottish Incremental scheme is linked to the Incremental Reinforcements being undertaken by SPT described earlier (SPT-NGET Interconnection and the East-West upgrade), which represent a package of measures associated with upgrading the capacity of the Scottish interconnector circuits to 4400 MW.

The final project (labelled H) is the "Western HVDC Link" running from Hunterston to Deeside and is a joint project between NGET and SPT (and is thus related to the project labelled C in Figure 1 above). The NGET project comprises rebuilding and extension of the Deeside 400kV sub-station (funding for which was approved by Ofgem in the 2009 assessment but which NGET is now seeking additional funds for 2011/12 following a re-profiling of the capital expenditure and the identification of further costs) and the commencement of works to construct the converter station and lay the cable (the latter covering the NGET proportion of the link costs). This project is also designed to improve Scotland to England transfer capability by by-passing Boundaries B6 and B7 and improving the transfers across Boundary B7a, providing additional capacity ([redacted]) for North-South transfers.

It should be noted that an alternative or complementary HVDC link (the Eastern HVDC Link) is also under consideration by the TOs, which could run from Peterhead to Hawthorn Pit or from Torness to Hawthorn Pit although no additional funding request has been made for this project in 2011/12. To date, the TOs have selected the Western HVDC Link as the initial offshore reinforcement option.

Given the significant focus on undersea DC cable solutions in this year's submissions, KEMA has provided (in Appendix B) a brief summary of the technology and its features to further inform Ofgem.

4.2 Overview of Sub-Project Costings and Timescales

Table 2 below provides a summary profile for each of the sub-projects for which additional funding has been requested for 2011/12[9]. As described earlier each sub-project is part of a wider project proposed to be developed - Table 3 presents the profile for the associated wider projects proposed to be developed in order to place the funding requests in context.

Table 2 – Sub-Project Phasing of Pre-Construction and Construction Costs

[Table removed]

[9] Funding requirements are only shown in relation to dates from 2011/12 onwards except where specifically identified; and pre-construction costs/funding is not shown in relation to projects where only construction funding is requested for 2011/12.

The total cost of the proposed funding requests in 2011/12 is [redacted], of which approximately £43m relates to pre-construction.

The additional funding requests for 2011/12 from the TOs total £160m, of which circa £12m relates to pre-construction. In relation to these pre-construction sub-projects Ofgem have already allowed expenditure of £54m in 2011/12 (having been informed by the 2009 assessment).

As noted earlier, Table 3 below provides the pre-construction and construction cost phasing for the overall projects which incorporate the above sub-projects. It should be noted that there are other projects (including the Eastern HVDC Link and North Wales projects) for which the TOs have declared information but have not requested additional funding for any of the associated sub-projects and, therefore, they are not included in the table below.

Table 3 – Associated Project Phasing of Pre-Construction and Construction Costs

[Table removed]

For ease of reference the expenditure information in the above two tables is reproduced in the following two figures.

Figure 4 – Total Cost Profile for Sub-Projects for which Additional Funding has been Requested

[Figure removed]

Figure 5 – Total Cost Profile for Projects Containing Sub-Projects for which Additional Funding has been Requested

[Figure removed]

In aggregate, significant expenditure is being forecast in the first two years of TPCR5 (now termed RIIO[10]-T1) – i.e. in the years 2013/14 and 2014/15. The year 2013/14 shows the peak annual expenditure at just over [redacted]. Inclusion of the Eastern HVDC and North Wales projects would add over £100m to the expenditure for 2013/14 and in excess of £200m in the three following years, shifting the timing of the peak expenditure such that it occurs in the year 2014/15 (at circa [redacted]). It should be noted that all the figures presented focus only on those sub-projects (and associated projects) for which additional funding has been requested by the TOs for 2011/12 and relate to expenditure from 2011/12 onwards only (except where specifically identified). If the costs associated with other previously requested projects were also to be considered (such as the East Coast Upgrade and SHETL's Beauly – Blackhillock – Kintore project) the forecast expenditure would increase further.

As in last year's assessment, the charts below (Figure 6 and Figure 7) provide alternative perspectives of the projects (and relevant sub-projects) namely (i) an overview of the absolute cost of the projects (rather than the specific sub-projects being considered for additional funding) and the corresponding unit cost relative to the incremental network capacity provided for each such project (this is calculated on a £/kW basis by dividing the construction costs by the capacity provided across the key constrained boundary and thus may not capture all the benefits provided by the investment); and (ii) a ranking of the sub-projects (rather than the projects) by proposed expenditure in the TPCR4. Note that in Figure 7 the sub-projects are referred to by their associated Project name (for example Sub-Project Hackney – Waltham Cross 400kV Upgrade is referred to by its Project name - London). Furthermore, due to their close inter-linkage, Western HVDC includes the Converter Station costs, the costs of rebuilding and extending the Deeside sub-station and both the NGET and SPT proportions of the Western HVDC Link costs; and Anglo-Scottish Schemes includes the East – West Upgrade, the SPT – NGET Interconnection and Shunt Compensation at Harker, Hutton and Stella West sub-projects.

Figure 6 – Forecast Project Costs by Start Date and Corresponding £/kW Costs of Increased Network Capacity

[Figure removed]

[10] **R**evenue set to deliver strong **I**ncentives, **I**nnovation and **O**utputs

Figure 6 provides a high-level indication of the cost of the proposed network capacity enhancements in £/kW as well as their absolute cost. KEMA acknowledges that this £/kW metric could be regarded as simplistic as it does not take account of circuit length and that alternative unit cost metrics can also be applied for benchmarking purposes. A £/MW.km metric could also be applied for overhead line and cable investments which would moderate the unit cost of long circuits.

Figure 6 confirms that the Western HVDC Link is the most expensive in terms of absolute and unit cost of all the projects considered. This high cost of the proposed Western HVDC link can be attributed to the capacity of the proposed reinforcement, technology requirements and circuit length. Some preparatory expenditure has already been committed for the link (with Ofgem's approval) relating to the renewal and extension the Deeside Sub-station. However, Ofgem was also clear that approval for the Deeside Sub-station works should not imply approval of expenditure for construction of the Western HVDC Link. As the sub-station works are necessary for delivery of the link, the Deeside costs have been included within the overall costs in the above chart (as presented to Ofgem by NGET). Given the scale of the project and the stated requirement to commence works in 2011/2012, the key issues for anticipatory funding are the uncertainties associated with investment need and timing (e.g. generation and key modelling assumptions as adopted in NGET's CBA analysis).

The proposed East Anglia reinforcement provides the lowest unit cost with respect to capacity increases according to the data provided by NGET which indicates an increase in the EC1 Boundary transfer of 6 GW as a result of this project. The Central Wales project also represents a relatively low cost for the additional capacity provided, although this figure is based on KEMA's expectation of the line capacity (based on the declared construction) rather than a figure provided by NGET.

The cost per capacity increase shown for the Anglo-Scottish Schemes considers all three relevant projects together rather than as individual projects as this is more representative of the interdependent nature of these projects.

The chart below (Figure 7) shows the sub-projects ranked by expenditure proposed to be incurred in TPCR4 up to 2012/13. It should be noted that (a) both pre-construction costs and construction costs are included in this chart and (b) the indicated TPCR4 funding incorporates the level of additional funding that is being sought by the TOs and has not yet been granted by Ofgem.

Figure 7 – Sub-Project Costs Ranked by Materiality of Proposed TPCR4 Investment

[Figure removed]

In total, circa [redacted] of additional funding (comprising pre-construction and construction costs) has been requested for the period 2011/12, constituting around [redacted] of the total forecast costs for these sub-projects.

4.3 Overview of KEMA's Assessment of Proposed Funding Requests

Appendix A provides detailed coverage of the 13 individual requests which have been proposed by the 3 GB TOs for additional funding to facilitate the achievement of the Government's 2020 targets for renewables. This section provides a summarised overview of each request and KEMA's assessment. This section sets out this information in two tables which respectively provide:

- **Table 4: A Summary Overview of the Proposed Sub-Projects** – covering (a) scope; (b) cost; (c) timing; (d) indicated network capacity benefits (in relation to the wider project); (e) critical drivers/dependencies (also in relation to the wider project); and (f) interactions with other projects; and

- **Table 5: KEMA's Assessment of the Proposed Projects** – covering (a) certainty of need; (b) reasonableness of scope; (c) certainty of timing; (d) cost effectiveness (in terms of provision of capacity across the primary targeted network boundary).

Within the summary tables KEMA has clustered together three projects relating to the expansion of the Scotland-England transfer capacity across Boundary B6, as these have been indicated by the TOs to represent a collective (and interactive) solution delivering 1100 MW additional transfer capacity to Boundary B6 under the title "Anglo-Scottish Schemes". The sub-projects are:

- SPT's East-West Upgrade (Appendix A - Section A.8);
- SPT's SPT-NGET Interconnection (Appendix A – Section A.9); and
- NGET's Anglo–Scottish Incremental (Appendix A - Section A.9).

Furthermore KEMA has also clustered together the SPT and NGET elements of the Western HVDC Link project for the same reasons. These elements are:

- SPT's SPT Cost Proportion of the HVDC Link[11];
- NGET's HVDC Link and Converter Station; and
- NGET's Rebuilding and Extension of Deeside Sub-station.

As in last year's assessment, Table 5 uses a 5 step traffic light colour coding to indicate KEMA's view of items (a) to (d) identified above with at one extreme a green dot (●) representing "high/strong" and at the other, a red dot (●) representing "low/weak". Combination with amber dots (●) represents intermediate assessment ratings.

[11] For the purposes of the assessment KEMA has also included the Hunterston Sub-station although no funding for this element of the link has been requested for 2011/12.

Table 4 – Summary overview of Proposed Sub-Projects (all prices in 2010/11 prices)

Project (Proposer)	Scope of sub-project for which funding is sought	Cost (£m)	Timing (Constrn)	Benefit/capability provided by the wider Project	Critical drivers and dependencies for the wider Project	Interaction with other projects
Central Wales (NGET)	400kV OHL from Ironbridge to mid-Wales. Additional Pre-construction funding of £2.8m sought to meet IPC requirements.	122	12/13 – 17/18	Enables connection of 800MW of generation (assumed to be wind) in mid-Wales.	Driven (and dependent upon) by Welsh Assembly TAN-8 statement for the development of significant wind generation in mid-Wales.	None – stand alone.
East Anglia (NGET)	400kV OHL from Bramford to Twinstead Tee. Additional Pre-construction funding of £2.2m sought to meet IPC requirements.	104	12/13 – 16/17	Enables connection of additional generation in East Anglia, both new nuclear at Sizewell and offshore wind. Also caters for possible additional gas-fired generation (e.g. at Sutton Bridge or King's Lynn).	The project is driven by (and reliant upon) the additional generation being constructed.	Some interaction with the Humber project.
Humber (NGET)	400kV OHL from Humber to Walpole via Mumby. Additional Pre-construction funding of £0.7m sought to meet IPC requirements.	300	14/15 – 18/19	Provides additional export capability from the south Humber estuary system. Enables wind farms off the Lincolnshire coast to be connected to the system. Provides additional north-south capacity.	Volume and location of offshore wind power, located off the coast of Lincolnshire/Yorkshire. Possible closure of first generation CCGT's at Killingholme.	In order to derive the full benefit from the new line, additional east-west transmission to link the West Burton Walpole route to the Cottam – Eaton Socon route may be required to avoid overloading the system south of Walpole.

Project (Proposer)	Scope of sub-project for which funding is sought	Cost (£m)	Timing (Constrn)	Benefit/capability provided by the wider Project	Critical drivers and dependencies for the wider Project	Interaction with other projects
London (NGET)	Uprating existing 275kV OHL from Hackney to Waltham Cross to 400kV. Additional Pre-construction funding of £2.4m sought to meet IPC requirements.	62	12/13 – 19/20	Improves power flow into north-east London.	Main driver is increasing generation feeding London from the North-East. Dependent upon an increase in generation in East Anglia.	Some interaction with the East Anglia works.
South-West (NGET)	Uprating the Hinkley-Bridgewater 275kV OHL to 400kV and constructing a new 400kV OHL from Bridgewater to Seabank. Additional Pre-construction funding of £3.1m sought to meet IPC requirements.	152	12/13 – 22/23	This project provides 1.75GW of additional export capacity out of the South West area across boundary SW1.	The key driver for this project is anticipated new generation in the South West, principally new nuclear generation at Hinkley Point and new CCGT generation; but also potential offshore generation off the Cornwall and Devon coasts.	None – stand alone.
Wylfa-Pembroke (NGET)	New HVDC undersea cable between Wylfa and Pembroke. Funding of £0.5m sought for pre-construction works.	[redacted]	17/18 – 20/21	This project provides around 2GW of additional export capacity out of the North Wales.	The key driver for this project is anticipated new generation in North Wales, both new nuclear generation at Wylfa and onshore and offshore wind generation.	Likely to interact with other transmission schemes within North Wales, and also with the Western HVDC Link into Deeside.

Project (Proposer)	Scope of sub-project for which funding is sought	Cost (£m)	Timing (Constrn)	Benefit/capability provided by the wider Project	Critical drivers and dependencies for the wider Project	Interaction with other projects
Anglo-Scottish Schemes (NGET/SPT)	East-West Upgrade (SPT): Upgrading existing 275kV line between Strathaven and Smeaton to 400kV, new sub-station (Wishaw) new cables on Torness to Eccles 400kV circuits.	[redacted]	11/12 – 15/16	In isolation it is indicated to provide 200MW extra capability. However there is an interaction with the SPTL and NGET compensation schemes which means this project should be considered as a package of investments delivering 1.1GW expansion of B6 capability.	Project depends on assumed overall volume of Scottish renewable generation connecting by 2015 (having accounted for conventional and nuclear plant closing or becoming out of merit). The key justification for this project is provided by the NGET Cost-Benefit Analysis.	The project design interacts with the NGET/SPT compensation schemes.
	SPT-NGET Interconnection (SPT): Installation of 6 series capacitors – 4 on the western route at Strathaven (2), Gretna and Moffat and 2 on the eastern route at Eccles.	[redacted]	10/11 – 15/16	These schemes (together with further series and shunt capacitors to be installed by both NGET and SPT) provide 1.1GW further transfer capability across boundary B6, removing any stability limitations and ensuring that the maximum use is made of the existing infrastructure. However, there is an interaction with the East-West project above which means this capacity increment would not be achievable if these schemes were to proceed in isolation.	Project requirements depend on (i) assumed overall volume of Scottish renewable generation connecting by 2015, and (ii) assumed impact on conventional generators. The key justification for these schemes is provided by the NGET Cost-Benefit Analysis.	The schemes interact with the SPTL East-West Project.
	Anglo-Scottish Incremental (NGET): Installation of shunt capacitors at Harker, Hutton and Stella West.	[redacted]	11/12 – 13/14			

Project (Proposer)	Scope of sub-project for which funding is sought	Cost (£m)	Timing (Constrn)	Benefit/capability provided by the wider Project	Critical drivers and dependencies for the wider Project	Interaction with other projects
Western HVDC Link (NGET/SPT)	SPT Cost Proportion of HVDC Link (SPT): [redacted] MW undersea HVDC cable from Hunterston to Deeside.	[redacted]	11/12 – 15/16	[redacted]MW extra capacity across boundaries B6 and B7a.	Project depends on assumed overall volume and operational performance of Scottish renewable generation connecting by 2020, counterbalanced by closure of existing plant. Key justification provided by the NGET Cost Benefit Analysis of project costs versus reduced constraints costs.	The Eastern HVDC link is an alternative project.
	NGET Cost Proportion of HVDC Link and Converter Station at Deeside: [redacted]MW undersea HVDC cable from Hunterston to Deeside and 400kV AC/DC Converter Station.	[redacted]	11/12 – 15/16			
	Rebuilding and Extension of Deeside 400kV Sub-Station (NGET).	[redacted]	10/11 – 17/18			
Beauly-Mossford (SHETL)	New sub-station at Mossford. Forms part of a project to upgrade the existing 132kV OHL.	13	11/12 – 13/14	Together with the associated OHL upgrade, enables connection of Loch Luichart wind farm (and possibly other wind farms). Ensures system complies with GB SQSS.	Loch Luichart windfarm proceeding. Also some dependency on obtaining consent to rebuild the overhead lines.	None – stand alone.

Table 5 – Summary of KEMA's Assessment of Proposed Projects

Project	Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
Central Wales (NGET)	●● The requirement for this project is based on a Welsh Assembly aspiration as outlined in TAN8 and partly supported by an NGET indicated 300MW of wind farms seeking to connect in the "TAN8 region". Consequently, there is high uncertainty regarding investment need and the project represents a clear example of anticipatory TO investment.	● On the assumption that sufficient generation will seek to connect in Mid-Wales thus meriting an additional transmission spur, under current planning standards the proposed scope of the project appears reasonable as it is probably the lowest scale spur which could sensibly be constructed at 400kV transmission voltage.	●● Given the sole reliance on projected generation interest and the uncertain status of such generation, there is strong uncertainty over the timing of the associated investment.	● The project has a cost of £186M and could permit up to 1800 MW of windpower to be connected under the GB SQSS[12]. However, this amount of generation is unlikely: adopting a more realistic value of 600MW gives a cost of around £300/kW. Even if only 600 MW transpires (that is in the mid-range of the projects considered), KEMA has not identified an alternative solution which is superior in terms of cost-effectiveness. The key question resolves around the actual usage of the transmission spur if it is built on an anticipatory basis and the extent of underground cabling which may be required.

[12] Assumes minimum loss of generation is increased.

Project	Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
East Anglia (NGET)	🟡 The drivers behind this project consist of generation projects over a large area of a diverse type (nuclear, wind and gas). It therefore seems likely that the need for this project will transpire, although it cannot be stated with certainty.	🟢 On the assumption that sufficient generation will seek to connect in East Anglia, thus meriting the additional transmission investment, the project is reasonable.	🟡 Given the reliance on future generation projects there is some uncertainty over the timing of the construction phase.	🟢 This project involves the maximum use of existing infrastructure, with minimum new construction, and is almost certainly the cheapest way of providing additional capacity. Nevertheless, the cost of the new overhead line, at 100M for 30 km, is expensive at £3.3M/km.
Humber (NGET)	🔴🟡 Uncertainty remains that the relevant offshore wind farms will be developed.	🟢 If significant offshore windpower in the Dogger Bank/Hornsea area does transpire, significant new transmission will be required. There are a number of possible options, depending on the precise pattern of new generation and associated closures.	🔴🟡 The requirement for transmission south of Humberside (i.e. the Grimsby West – Mumby leg) is critically dependant on the balance of new generation against closure of existing generation. The leg south of Mumby is more certain, as it would be required for the Triton Knoll offshore wind power project.	🟢🟡 As there is still considerable doubt concerning the scope and extent of the transmission required (including how much might need to be undergrounded), it is difficult to estimate the cost-effectiveness. However, if an AC overhead solution can be found, it is likely to be cost-effective.
London (NGET)	🟡🟢 The requirement for this project depends on the evolution of the GB generation fleet. Given the large amount of potential new generation in East Anglia of diverse fuel types (nuclear, gas and wind) it is probable that the project will be needed.	🟢 On the assumption that additional capacity into London is required, the project is reasonable and – as it involves no new overhead lines – is likely to be the cheapest and most environmentally friendly solution.	🟡🟢 Given the reliance on future generation interest and the uncertain status of such generation, there is some uncertainty over the timing of this investment.	🟡 Although the project provides only a modest additional 600MW transfer capacity across Boundary B14 (London Imports), it is probably the most cost-effective way of providing additional capacity. Nevertheless, the cost does seem excessive – perhaps twice as much as would be considered reasonable.

Project	Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
South-West (NGET)	🟡 There is significant uncertainty regarding investment requirements for this project given its dependence on new generation connections which are expected to connect before 2020.	🟢 Should the forecast generation in the South West materialise the scope of the project is reasonable.	🟡 The same uncertainty over generation connection which impacts on certainty of need also makes the timing of this project highly uncertain.	🟢 Where the project proceeds as proposed, the additional network capacity provided is highly cost effective at a cost of £163/kW.
Wylfa-Pembroke (NGET)	🔴 There is high uncertainty regarding investment requirements for this project given its dependence on new generation connections which are expected to connect before 2020.	🟢🟡 Should the forecast generation in North Wales materialise the scope of the project appears reasonable.	🔴 The same uncertainty over generation developments which impact on certainty of need also makes the timing of this project highly uncertain. The project is proposed for completion after a number of significant on-shore reinforcements have been completed, hence is unlikely to be required until after 2020.	🟡 In the event that additional reinforcement is required out of North Wales, this project is probably the most cost-effective.

Anglo-Scottish Schemes (NGET/SPT)	**East – West Upgrade (SPT)**			
	● There is reasonable certainty that B6 capacity will need to be expanded beyond 3.3 GW by 2015.	● The scope appears reasonable although it should be noted that in order to deliver the full range of benefits, this scheme must be considered with the other Anglo Scottish interconnection and incremental schemes.	● Given the dependence on key assumptions within the CBA relating to generation and its performance; as well as constraint costs which influence project scheduling, there is limited uncertainty regarding the timing of this project.	●● Whilst some cost items for this scheme appear expensive (e.g. Wishaw substation), the scheme interacts with other B6 upgrade schemes suggests it should be considered within an overall package of schemes [redacted].
	SPT / NGET Interconnection (SPT) and Anglo-Scottish Incremental Works (NGET)			
	● There is reasonable certainty that B6 capacity needs to be expanded from 3.3GW by 2015.	● In 2009, both NGET and SPTL indicated that there remained some scope/project design refinement to be undertaken. Nearly all these issues have been resolved, resulting in minor cost savings. The scope appears reasonable and relevant interactions have been properly considered.	● Given the dependence on key assumptions within the CBA relating to generation and its performance there is some uncertainty over the timing of this project. KEMA also notes that the proposed 2011/12 works are timed to coincide with another local outage to seek to avoid potential high (£20m) constraints costs.	● (SPT) / ● (NGET) The interaction with other B6 upgrade schemes suggests it should be combined with the SPTL East-West project [redacted].

Western HVDC Link (NGET/SPT)	● There is reasonable likelihood that B6 capacity will need to be expanded from 4.4 GW but some uncertainty remains concerning the date of any such requirement. The need case is dependent on the amount of new generation to be installed in Scotland (offset by generation closures), and CBA modelling assumptions.	● The scope is reasonable should additional capacity over and above 4.4 GW be required, and should the western link be preferred to an Eastern link.	● The commencement of construction for the Western HVDC Link in 2011/12 can be justified for a particular set of input CBA assumptions. However there also appears to be limited cost or delivery downside risk associated with conducting further analysis in 2011/2012 with a view to commencing construction in 2012/13.	● In absolute terms, this project is requires considerable network investment, at an overall cost of approximately [redacted] (inc. Deeside) for an additional [redacted] of transfer capacity. However, the unit cost baselined according to incremental capacity provided and geographic distance is not excessive. Some uncertainties remain regarding the accuracy of cost estimates which can be addressed through a tendering process.
Beauly-Mossford (SHETL)	● The line is already at full capacity and outside of SQSS so need is clear. Extra generation will increase requirement for this investment.	● Scope seems appropriate for the requirement.	●● Planned timing is appropriate. No reasons to delay. However, consents for substation still required.	● Considered to be least cost approach to comply with SQSS.

Further observations on specific aspects of these projects and associated sub-projects are provided in Section 4.5 and the review of NGET's Cost Benefit Analysis in Section 5. In the following section, KEMA has provided a summary of Infrastructure Planning Commission (IPC) requirements associated with the pre-construction sub-projects for which NGET is seeking funding for 2011/12.

4.4 IPC Requirements

Four of the sub-projects proposed involve potential new overhead lines and in one case, a new consent for an existing overhead line, within England and Wales, and are therefore subject to consideration by the Infrastructure Planning Commission (IPC). These are:-

- Central Wales
- South-West;
- London;
- Humber; and
- East Anglia.

For the London sub-project the proposal does not involve a new overhead line (except perhaps for new line entries at rebuilt sub-stations): rather it involves uprating an existing line from 275kV to 400kV, requiring a new consent to be obtained (the existing consent is for 275kV). We were informed by NGET that this would fall under the criteria of a major project and hence be subject to IPC consideration.

NGET are expecting to spend a considerable amount on pre-construction work – for example, for the Mid-Wales sub-project NGET expects to commit £3.9M in 2011/12. It is anticipated that such expenditure relates to in-depth environmental surveys, impact assessments etc. We are not in a position to evaluate whether these costs are reasonable on a project by project basis since, although NGET have provided a breakdown for an example sub-project (South West) to provide an indication of the level of detail to comply with IPC requirements, we have not been provided with equivalent information for the other individual sub-projects. Therefore, it is not possible to determine the veracity of the estimated IPC costs for other sub-projects, other than to interpolate the information from the South West sub-project.

For the proposed South-West reinforcement, NGET provided additional information regarding general changes to the planning process. This information supplemented KEMA's discussions with NGET during which NGET outlined a number of the key features, and in particular the need to fully evaluate potential project options. For example KEMA was

informed that all options for any given sub-project will need to be analysed in a high degree of detail, including (for example) tower positions and construction access routes. NGET identified that under the previous planning framework such detail would only be considered for the selected option and, therefore, considerable additional scoping work is required to provide such details for all possible options. Furthermore, NGET has stated that the criteria utilised by the IPC would be "wider" than criteria previously applied, such that, for example, where a particular option for a sub-project had a very high cost it would previously have been discarded on economic grounds. However under the IPC this would not necessarily be the case since in the event that the option had other redeeming features – such as a much lower environmental impact (physical or visual).

In a supplemental note, NGET highlighted the need for project proponents to discuss public consultation approaches with the relevant local authorities in advance of undertaking consultation and to discuss with them, prepare and publicise in advance a formal note setting out how that consultation will be undertaken. Government guidance sets out the key objectives for the consultation process and by way of affirmation the IPC will ask the relevant local planning authorities for their views about whether the pre-application consultations have been adequate.

In summary NGET has identified under the new planning framework the need for:

1. Earlier and more wide-ranging public and stakeholder engagement and consultation, with increased associated publicity, consultation tracking requirements and associated manpower, IS infrastructure and resource costs;
2. More work to evaluate connection alternatives and to provide information to inform pre-application consultations about strategic options (e.g. technology alternatives, HVDC, sub-sea options, underground cables and gas insulated lines), requiring more manpower and resource costs;
3. A multi-stage approach to pre-application consultations, particularly for medium to larger-scale projects where there may be many different connection and routeing/siting alternatives, starting with strategic options, moving to route corridor/siting options and then at a later stage to precise alignment options. Previously more limited public pre-application consultation would have been undertaken, and usually once when a preferred route corridor had been selected.
4. Such multi-stage approaches could require pre-application consultations in future with the need to provide feedback to respondents at each stage. In addition, requirements to modify proposals will need to be addressed which could impact scheme design where location and technology options are varied or where there are project interdependencies. Such consultations will need to be performed before selection of

the preferred route and commencement of detailed alignment and environmental impact assessments.

While KEMA has not been provided with the IPC specific costs for each proposed sub-project for which additional funding has been requested, NGET has provided a cost breakdown for the South-West project as shown in Table 6.

Table 6 – NGET Cost Breakdown of Forecast IPC Driven Spend for Hinkley – Seabank 400kV OHL

Item	Prior Years (£m)	10/11 (£m)	11/12 (£m)	12/13 (£m)	Total (£m)
Communications: Consultation Strategy, Public Events, Distribution Materials	0.8	1.2	0.7	0.6	3.3
Land and Development: Environmental Consultants/Surveys, Land Agent Consultants/Surveys, PPA and L&D Time	0.7	1.6	3.7	0.5	6.5
NGET Time: System Design, Network Investment, Project Management	0.2	0.4	0.4	0.3	1.3
Legal: Barrister and QC support through to public enquiry	0.1	0.3	0.3	1.2	1.9
Alliance Partners: Provision of full design for IPC application/Consultation support	1.5	2.4	0.8	0.0	4.7
Total:	3.3	5.9	5.9	2.6	17.7

Table 7 provides a simple comparison of pre-construction costs from 2011/12 for the five NGET sub-projects involving considerable interactions with the planning process.

Table 7 – Comparison of Pre-Construction Costs for Overhead Line Sub-Projects

Sub-Project	**Length of new OHL required**	**Total Pre-construction costs £M**	**Cost per length of OHL £'000**
Mid-Wales – Ironbridge	60	5.0	83.3
Bramford – Twinstead Tee	30[13]	4.3	143.3
Humber – Mumby – Walpole	120	14.8	123.3
Hackney – Waltham Cross	(20)	6.2	(310.0)
Hinkley - Seabank	60	5.3	88.3

It can be seen that the pre-construction funding costs for all of the above sub-projects other than the Humber-Mumby-Walpole sub-project are similar orders of magnitude. A review of the earlier Table 2 will identify that the Humber-Mumby-Walpole sub-project forecasts a further 3 years of pre-construction funding before construction is due to commence – perhaps explaining the somewhat higher cost identified for this sub-project. Construction for

[13] This taken from a KEMA estimated length based on the replacement of an existing line of 26km compared to NGET's quoted value of 35km

the other 4 sub-projects is due to commence in 2012/13 and therefore these will all need to be progressed through the IPC process in the coming year.

Of the above sub-projects, the pre-construction costing for the Hackney – Waltham Cross route merits further consideration. Although no new overhead line construction is envisaged, NGET states that advice from the IPC regarding consenting for an existing 275kV line to operate at 400kV would be subject to similar detailed examination as construction of a new overhead line. Therefore NGET considers that a range of alternative designs for this sub-project must be considered, at significant cost. However, this appears potentially inconsistent with NGET's response to related question (2010_NG_NG_A004_v1) stating "*The London scheme has lower than average [IPC] costs as this involves the upgrading of an existing route, i.e. there are not multiple routes to be considered*". No further information is available on this apparent discrepancy.

4.5 TO Readiness in Respect of Construction Sub-Projects

In 2009, the review of TO submissions was performed by two consultancies. In respect of an examination of TO readiness, PB Power prepared a detailed report considering each of the TO funding requests. Following the PB Power approach in relation to these submissions for additional funding for 2011/12, KEMA has reviewed progress on the particular sub-projects, and provided our opinion concerning the state of readiness of the TOs in respect of the construction funding requests discussed below. In this context, readiness considers:

- Deliverability – in particular this considers the status of consents and the supply chain;
- Certainty of design – how clear and reasonable is the design proposed by the TOs; and
- Costs – how reasonable are the costs proposed by the TOs.

As part of the process for approving funding, Ofgem will need to assign appropriate milestones and output measures against which delivery can be monitored, and these are also considered in this section.

This section considers a Green/Amber/Red rating approach consistent with that used in the January 2010 PB Power Report.

Deliverability	Design	Costs
Green Consents already obtained or are not required	**Green** Design firm	**Green** Cost estimates are considered be to be reasonable, reflecting content, quantities and market prices.
Amber Consents required but are not expected to be problematical	**Amber** Some design decisions required but may be addressed in the near future and the impact on cost may already be known	**Amber** Cost estimate considered reasonable but may be updated in short term
Red Consents required and may cause a delay to the programme	**Red** Design decisions will be addressed over a period of time and may influence cost of project	**Red** Estimate not firm and may change with development

The sub-projects for which construction funding has been sought by the TOs are:

- Anglo-Scottish Incremental (NGET): - Shunt compensation at Harker, Hutton and Stella West;
- Incremental Reinforcement (SPT): - SPT-NGET Interconnection series compensation;
- Incremental Reinforcement (SPT): - East-West upgrade;
- Western HVDC Link (NGET): - HVDC Link and Converter station and(SPT): SPT proportion of the HVDC Link;
- Western HVDC Link (NGET): - rebuilding and extension of the Deeside 400kV sub-station; and
- Beauly – Mossford (SHETL): - Mossford sub-station.

Anglo-Scottish Incremental (NGET): – Shunt Compensation at Harker, Hutton and Stella West

Deliverability

This sub-project replaces the previously proposed 2009 series compensation to the Harker-Hutton circuits. In accordance with the planned timescales site selection has been achieved at the end of December 2010, which gives confidence that the sub-project is on track and also identifies that the installation of Mechanical Switched Capacitors (MSCs) at all three

locations can be accommodated on operational land, and NGET's permitted development rights should apply.

Whilst still subject to surveys and detailed drawings, planning permissions are not expected/not likely to be required, and construction is planned to commence in 2011/12. As the MSC equipment does not fall within the definition of a Nationally Significant Infrastructure Project (NSIP), it will not require development consent from the IPC.

Therefore, KEMA would rate "Deliverability" of this sub-project as **Green**, but would make the observation that timescales may be affected by equipment manufacturing capacity.

Design

A previous project comprising series compensation to the Harker-Hutton circuits was considered. However, with the use of shunt capacitors, and subject to other minor design considerations, this sub-project is ready to implement in 2011/12 and KEMA would rate the "Design" of this sub-project as **Green**.

Cost

KEMA has assessed the costs as reasonable, but have made specific observations in relation to Wishaw sub-station and would rate the "Cost" of this sub-project as **Amber**.

Overall Assessment

KEMA therefore regard TO readiness in relation to this project as satisfactory.

Milestones - Anglo-Scottish Incremental[14]:

In order for Ofgem to assign appropriate milestones / output measures for this sub-project, the following measures have been proposed by NGET:

Target milestone items by 31 March 2012 will comprise:

- Place purchase order for main electrical units;
- Commence detailed design; and
- Establish construction site offices/working areas, fences etc

Given the level of proposed expenditure for 2011/2012 associated with these deliverables [redacted], it would be informative for Ofgem to make further enquiries regarding the profile of the proposed expenditure for assessment of future funding requests in relation to this sub-project.

[14] Information provided by NGET 17/12/2010 – "A-S shunt milestones and outputs_final.doc"

Incremental Reinforcement (SPT): - SPT-NGET Interconnection

Deliverability

The January 2010 PB Power Report noted SPT's own concerns that the sub-project is subject to significant planning and environmental consents representing a potential delay to the sub-project; and they also noted no allowance for manufacturing design time, and installation following equipment manufacture suggesting the sub-project implementation timetable contains little contingency allowance.

The planning and environmental consents still appear to present a risk regarding the timing of the commencement of the sub-project, but SPT have provided milestones consistent with construction work commencing in 2011/12. However, there may be further consideration required regarding the contractual treatment and equipment specification of retrofit thyristors to address any potential sub-synchronous resonance as mentioned elsewhere in this document and there may also be "learning curve" issues associated with the implementation of this technology on such a scale.

Since the majority of these works make use of space at, or limited extension to, existing sub-stations, and do not include substantial overhead line builds, any problems obtaining consents are minimised. The new substation at Moffat has all consents in place, and, KEMA would rate the "Deliverability" of this sub-project as **Amber**.

Design

Since the January 2010 PB Power Report was completed in January 2010, SPT has progressed development[15] significantly and KEMA now rate the "Design" of this sub-project as **Green**.

Cost

There remain no outstanding significant cost issues and KEMA rate the "Cost" of this sub-project as **Green**.

Overall Assessment

KEMA therefore regard TO readiness in relation to this project as satisfactory.

Milestones - *SPT – NGET Interconnection*[16]*:*

In order for Ofgem to assign appropriate milestones for output measures for this sub-project, the following is proposed by SPT:

[15] Enhanced Transmission Investment Incentives – Incremental Reinforcements (16 Aug 2010)
[16] Information provided by Scottish Power 17/12/2010 – "2010-12-17 SP Transmission Output Measures.docx"

Target milestone items by 31 March 2012 will comprise:

- All consents granted for Gretna, Moffat, Strathaven and Eccles;
- ITTs for all civil works, main substation plant and OHL deviations at Gretna, Moffat, Strathaven and Eccles;
- Place contracts for all civil works, substation works and OHL deviations at Gretna, Moffat, Strathaven and Eccles; and
- Complete OHL deviations at Eccles.

Incremental Reinforcement (SPT): - East-West upgrade

Deliverability

The January 2010 PB Power Report expressed concerns over planning and environmental consents, particularly in relation to the new Wishaw substation.

SPT's current assumptions are that Wishaw substation will be a non EIA project and that the new S37 and planning permissions will progress unopposed. This is recognised in the sub-project's planned activities, milestones and cashflow, however, the timing of commencement for the Wishaw substation is likely to remain a risk and KEMA rate "Deliverability of this sub-project as **Amber**.

Design

Since the publication of the PB Power Report in January 2010 SPT has progressed this development[17] significantly and KEMA now rates the "Design" of this sub-project as **Green**.

Cost

Despite an overall reduction in sub-project costs since last year ([redacted]) KEMA has queried the cost of particular items and remains concerned that the total cost quoted for the Wishaw substation appears high, by an estimated £5M. Therefore, KEMA rate the overall "Cost" of this sub-project as **Amber**.

However, given that only [redacted] of funding is requested in 2011/12, there should be no reason not to authorise expenditure in 2011/12 allowing subsequent funding requests related to the items under concern to be reviewed at a later stage.

Overall Assessment

KEMA therefore regard TO readiness in relation to this project as sufficiently satisfactory.

[17] Enhanced Transmission Investment Incentives – Incremental Reinforcements (16 Aug 2010)

Milestones – East-West Upgrade

In order for Ofgem to assign appropriate milestones for output measures for this sub-project, the following is proposed by SPT:

Target milestone items by 31 March 2012 will comprise[18]:

- Consents granted for XH route OHL deviation;
- ITTs issued for all civil works, main substation plant and OHL deviations at Smeaton, Currie, Kairnes;
- ITTs issued for 400kV cable and cable installation and 400kV switchgear at Torness;
- ITTs issued for XH Route OHL deviation/reinsulation;
- Place contracts for all civil works, main substation plant, and relevant OHL deviations at Smeaton, Currie, Kairnes;
- Place contracts for 400kV cable and cable installation, and 400kV switchgear at Torness; and
- Place contracts for XH Route OHL deviation/reinsulation.

Western HVDC Link (NGET): - HVDC Link and Converter station and Western HVDC Link (SPT): SPT proportion of the HVDC Link

Deliverability

The January 2010 PB Power Report recognised that the programme looked achievable but is subject to many risks relating to planning approvals, manufacturing capacity, cable laying skills and resources, and weather installation windows.

These risks still remain for a sub-project which is technically and logistically challenging, and this is recognised in both the NGET CBA and SPT[19] documentation. Both parties believe a commissioning date in 2015 is achievable, but there are a number of issues which could serve to prevent this, the most significant of which is the availability of manufacturing capacity to deliver the cable.

Whilst the planning implications are apparently less onerous and the onshore cables will be permitted development, and the fact that the NGET/SPT joint venture vehicle is due to issue tendering documents shortly, given the significance of the challenges a KEMA rate the "Deliverability" of this sub-project as **Amber**.

[18] Information provided by Scottish Power 17/12/2010 – "2010-12-17 SP Transmission Output Measures.docx"

[19] "Anticipatory Investment – West Coast DC Link; Hunterston North 400kV Connection", Version 1,0

Design

Since the January 2010 PB Power Report reasonable progress has been made to determine the design and undersea cable routing and overall KEMA would rate the "Design" of this sub-project as **Amber**.

Cost

The January 2010 PB Power Report had concerns about the overall cost of this project (including Deeside), and there remains a large degree of uncertainty around the costing of elements of this sub-project. PB Power's January 2010 observations that costs were too low, have been subsequently justified and incorporated in the Cost Benefit Analysis. However, due to the nature of this sub-project, costs are likely to remain uncertain until these become firmer through the proposed tendering process and KEMA therefore rates the "Cost" of this sub-project as **Amber**.

Overall Assessment

KEMA makes further specific references to the treatment of this sub-project in the Section 5, 6 and Appendix A of this document.

Milestones

No information is provided for this sub-project.

Western HVDC Link (NGET): - rebuilding and extension of the Deeside 400kV sub-station

Deliverability

Funding and works are already committed to this sub-project and construction works are progressing. Changes have been made to the scope of works but these are not expected to impact the deliverability of the sub-project.

The Deliverability is achievable and allocated a **Green** rating.

Design

Following the revision to the scope of works, the design is complete and is also afforded a **Green** rating.

Cost

The costs for the additional scope of work elements do give cause for concern, and only circa 75% of the additional cost is specifically identified by NGET. The January 2010 PB Power Report accepted that NGET's cost estimates at that time were reasonable, assuming

that this included 3 switch bays for unlicensed generator connections. However, these assets (at an estimated £20M) are explicitly excluded from the current costing. Therefore, KEMA rate the "Cost" at this sub-project as **Amber**.[20]

It is worth noting that the funding award that was made in 2010 was based on an incomplete scope of work, which has now been remedied, and requires additional funding in 2011/12.

Overall Assessment

KEMA therefore regard TO readiness in relation to this project as satisfactory.

Milestones

KEMA is not aware of any additional milestones or outputs that have been identified for Deeside substation since 2010 following the changed scope of works and KEMA recommends that Ofgem review this with NGET.

Beauly – Mossford (SHETL): - Mossford sub-station

Deliverability

This is a new scheme that was not considered in last year's PB Power Report. In accordance with information from SHETL, the planning submission for Mossford sub-station proposed for December 2010 has been delayed at the request of planning officers until early January 2011. SHETL assume that the planning process will complete in 6 months, and have specified milestones for all consents granted, land purchased and main contracts awarded by 1 April 2012. The Mossford substation is classified as a major development and on that basis the planning risks for construction commencement in 2011/12 should be considered as **Amber** for "Deliverability".

Design & Cost

The Design of the sub-station is appropriate and it is believed to provide the cheapest solution to comply with SQSS, and therefore a **Green** rating is appropriate for both "Design" and "Cost".

Overall Assessment

KEMA therefore regard TO readiness in relation to this project as satisfactory.

[20] However, KEMA is aware that additional information has been provided, since the 10th of January regarding the costs of this sub-project that Ofgem will also need to consider.

Milestones

As part of the process for approving funding, Ofgem will need to assign appropriate output measures against which delivery can be monitored. The following provide potential measures for the Mossford Sub-station sub-project:.

Delivered items by 31 March 2012 will comprise:

- All consents granted;
- Land purchased; and
- Main contracts awarded.

The proposed output measure by 31 March 2012 will be the commencement of construction of the new Mossford 132kV switching station including provision of double 132kV busbars and associated 132kV switchgear[21].

[21] Extract from "SHETL 300710 Mossford.pdf" entitled "Request to change Annex A of Special Licence Condition J12: transmission investment project Beauly-Mossford"

5 ASSESSMENT OF COST BENEFIT ANALYSIS

This Section provides KEMA's assessment regarding the investment cases made for the Anglo-Scottish Reinforcements and the Western HVDC Link in the NGET paper "Cost-Benefit for 2020 Reinforcements" dated 29th July 2010 (CBA) and subsequent information provided by NGET. KEMA acknowledges that this NGET paper clearly sets out the economic rationale to underpin the proposed Anglo-Scottish reinforcements.

The proposed reinforcements for the Anglo – Scottish boundary and associated schemes in northern England are addressed by the following 6 schemes:-

(i) Anglo-Scottish Interconnector (the "TIRG works");

(ii) SPTL's East – West Upgrade (ie: sub-project A on page 15);

(iii) SPTL's SPTL – NGET Interconnection (ie: sub-project B on page 15);

(iv) NGET's Anglo-Scottish Incremental project comprising Shunt compensation (ie: Project G on page 17) and reconductoring of the Harker-Hutton-Quernmore Tee; and series compensation on various circuits;

(v) Western HVDC Link; and

(vi) B7a Reinforcements (as discussed in section 5.1.3 and are not the subject of funding consideration in this Report).

Sub-project (i) is currently underway. It consists of a combination of reconductoring and uprating (from 275 kV to 400 kV) cross-border circuits, and will give a B6 capability of 3300 MW.

Sub-projects (ii), (iii) and (iv) consist of a combination of uprating from 275 kV to 400 kV, reconductoring, cable reinforcements, shunt capacitors and series capacitors. Although proposed as separate schemes, these are interdependent as the full benefits can only be realised if all schemes proceed. This will maximise the use of the existing onshore infrastructure, and will give a B6 capacity of 4400 MW.

KEMA regards this combination of sub-projects provides as an appropriate means of delivering capacity increases to 4400MW across Boundary B6 and other key boundaries such as B4, and B7/7a. It seems appropriate that the Scottish Interconnector Incremental schemes are regarded as the preferred 1st stage capacity expansion option to be followed by one of the HVDC links as a 2nd stage option. KEMA concludes that the TO explanations regarding the onshore sub-project interactions are reasonable and that the sub-projects provide a means of delivering the required 1st stage capacity increases. KEMA considers that the onshore reinforcements show an economic benefit, and should proceed.

KEMA also considers that, if there is a requirement for additional capacity across the Anglo-Scottish boundary (B6) beyond 4.4 GW, then an undersea HVDC link represents an appropriate approach.

However, given the high value of the Western HVDC Link [redacted] it is important to undertake a comprehensive assessment regarding investment approval and timing.

5.1 Investment drivers for the Western HVDC Link

With respect to the Western HVDC link, KEMA has thoroughly analysed NGET's investment case and highlights the following items of particular relevance:

- The treatment of Losses;
- The treatment of Hunterston and the Moyle Interconnector between Scotland and Northern Ireland;
- The treatment of Boundary B7a; and
- Constraint price assumptions as discussed in Section 5.1.4.2.

During December 2010, KEMA and NGET explored these CBA issues in greater detail which prompted further information provision and analysis. This report summarises the conclusions of this most recent analysis from KEMA's perspective.

KEMA has also analysed a number of other issues including the treatment of Longannet and Peterhead and the consideration of Boundary B5 in the analysis (referred to in the Boundary B7a context) as discussed in the following sections.

5.1.1 Treatment of Losses

The original CBA report suggested that the Western HVDC Link reduces losses from 1668 MW/10.6 TWhr to 1518 MW/9.9 TWhr. This appeared a high reduction in losses, equating to a reduction of 150 MW/0.7 TWhr. Consequently KEMA requested further explanation from NGET.

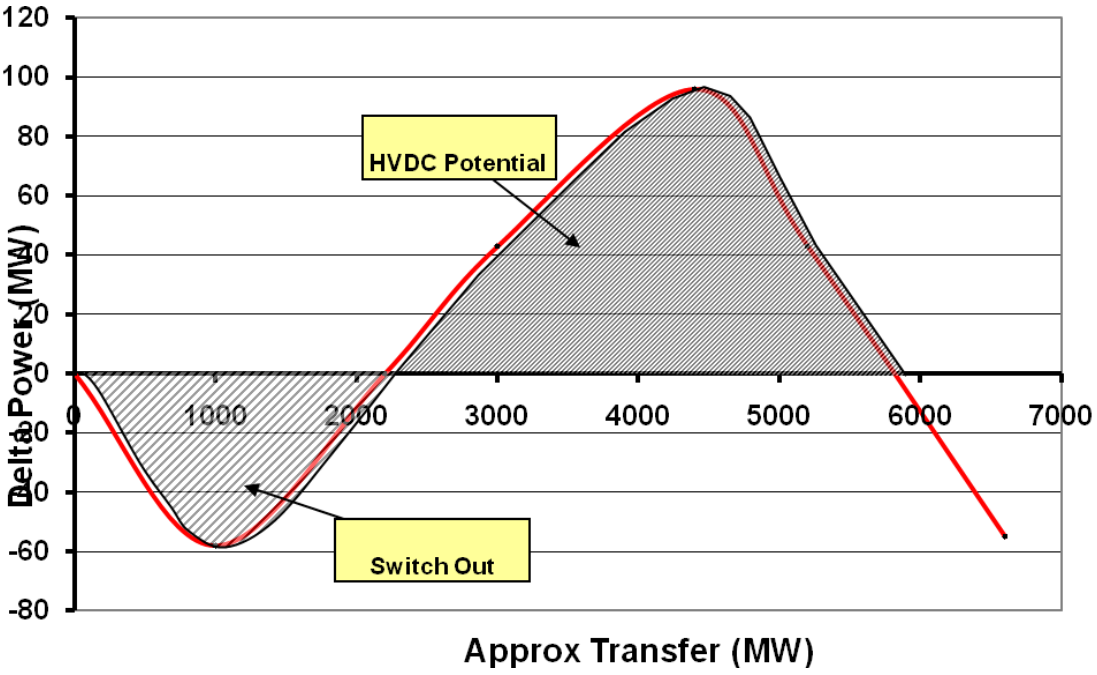
NGET confirmed that the initial value of 150 MW covered the AC system only, and excluded losses on the HVDC Link, which were calculated to be 31 MW in the cable, plus 24 MW in the converter stations. Hence the loss saving for 2015 at peak (assuming 4.4 GW transfer) would be (133 – 31 – 24) = 78 MW, or closer to half the value given in the CBA.

However, the proposed HVDC link is effective at reducing system losses for a range of loading conditions. This can be ascribed to the following three factors:-

a) HVDC transmission has inherently lower losses than HVAC transmission;
b) HVDC cables typically utilise copper as the conductive medium, rather than aluminium as used for overhead lines; copper has a much lower resistivity than aluminium; and
c) The proposed HVDC link will be approximately 400 km and reduces the relatively heavily-loaded HVAC system.

NGET's graph below shows how the savings in losses from installation of the Western HVDC link vary according to power flow across boundary B6. At low transfer levels (less than [redacted]) the fixed losses in the link dominate, and the presence of the link actually results in increased losses (the operational solution would therefore be to switch it out of service).

Figure 8 – The effect of the Western HVDC Link on system losses



As the transfer increases to 4.4 GW the saving in losses increases, until at 4.4 GW it is a saving of about 100 MW.

As the potential transfer increases beyond 4.4 GW, the savings in losses decrease. Without the link, transfers are limited to 4.4 GW (and significant constraint costs can arise). With the link in operation, transfer capacity is increased, thereby reducing constraint costs. However beyond 4.4 GW, the saving in losses reduces until at a transfer of approximately 5.9 GW the loss saving equates to zero (i.e. the losses for a 4.4GW transfer without the link are equal to

the losses for a 5.9 GW transfer with the link). Although the saving in losses reduces, these benefits are outweighed by the savings in constraint costs.

Whilst the shape of this graph is understood, some doubt remains regarding the precise values quoted. NGET initially stated[22] that losses on the ac system represented 150 MW. NGET then later increased this figure[23] to 250 MW[24]. KEMA believes that the transfer across B6 will typically be between 3GW and 6 GW, and so a saving in losses of 60 MW (equivalent to £33M/yr[25]) is considered appropriate. Using NGET's figures from the CBA report, the cost of these losses is £48.6M/yr[26] compared to the annual capital cost for the Western HVDC Link of [redacted][27], i.e. the initial (NGET) analysis suggested that the Western HVDC Link could nearly be justified on losses alone.

NGET has also stated[28] that "*given developments in HVDC technology, we would anticipate benefits to be higher than those quoted in the report*". It should be noted that such developments are only likely to affect losses in the converter stations and if these losses were halved it would represent a saving of 12 MW. Consequently KEMA considers HVDC technological developments to be less material.

5.1.2 Capacity of Hunterston and the Moyle Interconnector

In the CBA, NGET assumed a capacity for Hunterston of 1074 MW and, at least in the Gone Green scenario, a life extended to 2021. Hunterston currently has a capacity of 860 MW and is due to close in 2016. In KEMA's view the life-extension is a reasonable assumption, but we consider it to be unlikely that Hunterston will regain its initial capacity due to plant issues. Consequently KEMA regards NGET's assumed capacity for Hunterston as potentially 200MW too high.

NGET's CBA also assumes that the Moyle Interconnector exports a constant 100 MW to Ireland. While flows across the Moyle Interconnector have been observed in both directions in recent years it seems reasonable to assume that the general flow direction will be from Scotland to Northern Ireland. However KEMA considers the 100 MW volume to be

22 NGET Cost-benefit analysis report, and Response A-026
23 Email of 24/12/10 – 11:03 – "Sophisticated profiling of system losses"
24 The 2010 Seven Year Statement gives a value for the total thermal losses on the system of 1124 MW, which means that a saving of 250MW from the dc link appears overstated. Furthermore, the "southern SPTL" loss factor is 92%, which is again consistent with a total loss saving of about 100 MW.
25 60MW by 8760 hours by £60/MWhr
26 NGET Cost Benefit Analysis Section 8.
27 i.e. the effective cost if the capital cost is converted to an annual revenue cost using a 6.25% discount rate.
28 NGET Response 2010_NG_NG_A026_v1.

pessimistic given that, on average, Moyle exports to Northern Ireland have exceeded 200MW in recent years.

Further discussions with NGET in December 2010 confirmed that forecasting future export power flows on the Moyle interconnector to be uncertain due to interactions between renewable generation projections for Ireland and power flows across the new East – West interconnector (between Deeside & Dublin). However, taking these two issues together and moderating the impact of Moyle exports to Northern Ireland would suggest that transfer requirements for the B6 Boundary could be overstated by up to 250 MW[29].

5.1.3 Treatment of Boundary B7a

The Anglo – Scottish boundary capability is planned to increase from 2.2 GW to 4.4 GW. NGET states in the CBA that there is a requirement to further increase this capacity. In considering further reinforcement options, it is necessary to consider if, following this doubling in capacity, boundary B6 still remains the significant bottleneck on the system, or whether reinforcement across other boundaries also needs to be undertaken before further reinforcement of B6 is worthwhile.

[redacted]

NGET's CBA indicates that, particularly in the years prior to 2020, there is a significant constraint across Boundary B7a and at times this can be more restricting than Boundary B6. Boundary B7a is a boundary in England, consisting of the Norton – Thornton and Lackenby – Thornton 400 kV circuits in the east (the first and second Yorkshire Lines) and the Penwortham Padiham/Carrington – Daines 400 kV and Penwortham - Washway Farm – Kirkby 275 kV circuits in the west. NGET indicate a constraint cost of £143M/yr[32] for this boundary in 2015 for the "Gone Green" scenario (without the HVDC Link) compared with £57M/yr on Boundary B6. The relevant extract from NGET's CBA shown below in Table 8.

[29] This value is less than the sum, of 300 MW, to take into account availability and scaling factors.

[redacted]

[32] NGET CBA

Table 8 – Extract of Figure 11 from the NGET CBA showing Annual Constraint Costs at Key Boundaries[33]

Reinforcement	Boundary / Area / Constraint Price	2015_16 SP	2015_16 GG	2015_16 AG	2020_21 SP	2020_21 GG	2020_21 AG	2025_26 SP	2025_26 GG	2025_26 AG
a+i+b+d+e	B1	0	1	1	10	24	112	25	70	95
	B4	0	0	16	14	105	376	49	145	226
	B6	28	57	187	85	415	1,215	247	413	1,110
	Scotland	28	57	203	109	544	1,703	322	627	1,431
	B7a	202	143	144	7	166	0	0	0	0
	Other Eng & Wales	1	0	0	12	3	3	14	11	99
	England & Wales	203	143	144	20	169	3	14	11	99
	GB	231	200	348	129	713	1,706	336	638	1,530
	Constraint price (£/MWh)	*69.7*	*75.2*	*88.3*	*82.5*	*106.1*	*134.1*	*88.4*	*95.8*	*119.4*

NGET's CBA Report appeared to overstate constraint costs as it did not recognise the authorised works to increase the capacity across this boundary in 2012 – 14[34]. This consists of the installation of quadrature boosters at Penwortham which gives an increase in B7a capacity of approximately 300 MW. According to NGET's analysis, this gives a reduction in constraints of £31M/yr by 2015.

If this increase in Boundary B7a capability is included, Boundary B7a appears to remain more restrictive than Boundary B6[35] [redacted]

Constraints in the short-term might be resolved more cost effectively for 2015 by uprating the transfer capacity of Boundary B7a (by uprating the Penwortham – Washway Farm – Kirkby circuits to 400 kV) giving an increase in capacity of 1000 MW at a cost of £120M[36]. This appears to represent a cost effective means of reducing constraint costs compared to the early construction commitment to the HVDC Link.

As the NGET analysis does not consider boundary B5[37], KEMA has been unable to determine whether this is a significant omission.

33 The Reinforcements referred to in the table are (a) Mybster-Blackhillock offshore circuit, (i) Harker-Hutton-Quernmore Reconductoring, (b) SHETL East Coast, (d) B5 Uprating and (e) SPT East-West Upgrade, SPT-NGET Interconnection and NGET Anglo-Scottish Incrementals (shunt and series compensation)

34 NGET Response 2010_NG_NG_A044_v1

35 NGET Response 2010_NG_NG_A044_v1 Attachment 2 Figure 11b

36 CBA Report P6.

37 CBA Report, P20.

5.1.4 Other CBA Observations

5.1.4.1 Longannet & Peterhead

Another important aspect of the CBA analysis concerns the economics of the fossil fuelled generation at Longannet (coal) and Peterhead (gas).

The assumptions made by NGET (for the "Gone Green" scenario) are as follows[38]:

- In 2015 and 2020, half the capacity of Longannet (1142 MW) is assumed to be operating at base load (operating with bid/offer prices of 30/75 £/MWhr) and the remaining half is considered marginal coal with bid/offer prices of 40/105 £/MWhr;
- In 2025 the entire Longannet Power Station is replaced with Carbon-Capture and Storage (CCS) technology, at which point it becomes fully base load; and
- For all years, Peterhead is assumed to operate half (590MW) as base gas, with bid/offer prices of 25/60 £/MWhr, and the remaining half as marginal gas with bid/offer prices of 35/90 £/MWhr.

These bid/offer prices have been reduced from the values used in 2009, when KEMA expressed doubts regarding the price assumptions.

NGET has confirmed[39] that the treatment of Longannet is similar to the treatment of the coal stations in England and Wales. While Longannet is clearly a candidate station for the installation of CCS, KEMA considers that the assumption that it is replaced in its entirety may be optimistic. Given that full scale CCS deployment is largely unproven, we would consider a more conservative scenario to be for the new CCS station to have a capacity of approximately 50% the existing station, i.e. 1200 MW.

Thus KEMA would highlight that, to a certain extent and especially in the short-term, some of the proposed reinforcements in Scotland (including the Western HVDC Link) will be to export fossil fuelled electricity from Longannet or Peterhead rather than low-carbon electricity.

5.1.4.2 Impact of Market Reforms

The CBA highlights the potential for a significant degree of uncertainty over the affected time period. This uncertainty is increased by generation scenario uncertainties which have coherent modelling assumptions, but also by uncertainties relating to the opportunities for demand side response (DSR) and the potential for significant market restructuring as

[38] CBA Report Figures 8-10
[39] NGET Response 2010_NG_NG_A028_v1

discussed in Ofgem's Project Discovery document and the most recent Government statement regarding the energy market reform on 24 November 2010 which identified the creation of an Electricity Market Reform project under the Energy and Climate Change Committee. DECC's "Electricity Market Reform – Consultation Document" published on 16th December recognises the potential for locational elements in a capacity mechanism targeting DSR in areas of high demand to avoid detriment to wind and nuclear generation.

Uncertainties regarding future constraint costs can significantly impact the investment case for the Western HVDC Link. It is possible that the Government is minded to introduce a form of capacity mechanism to reward investment in power generation capacity and it is well recognised that the absence of capacity mechanism in the present (energy only) market requires mid merit generators to include an element to ensure the recovery of plant investment when offering system and network balancing services. This feature of the current market design increases constraint costs.

NGET has stated that typical constraint resolution involves constraining off Scottish baseload gas-fired generation (at £25/MWhr) and replacing it with English "marginal gas" (at £90/MWhr)[40] giving a price differential of £65/MWh. It is not clear whether such a price differential will apply under revised market arrangements

NGET recognise the impact of market arrangements in Section 7.6 of the CBA by referring to the fact that *"It seems unlikely to us that constraint pricing will evolve to these levels (£25-£40/MWh) under current market arrangements*", but that this is more likely if there is a *"fundamental change to current market arrangements…* [by a] *….move towards more regulated constraint pricing"*. In light of possible market reforms it would seem worthy of consideration as to what market arrangements might be constructed to reduce constraint pricing and what the likelihood of such arrangements might be, although NGET identify the above suggestions and the consequences for constraint pricing as "*improbable*".

5.1.4.3 Cost Estimates

It is notable that NGET's estimated costs for undersea HVDC cables have increased by [redacted] since the submissions used and published in January 2010 and it is also noted that Deeside substation costs have increased significantly since January 2010 from £108.2m to £149.6m, an increase of £41.5m or 38%. This is further increased by the unspecified generator connection estimated by NGET at circa £20M which would increase total substation costs to £169.6M, an increase of 57%. NGET's response to KEMA questions regarding this[41] provides further details of the cost increase, which excludes an unresolved potential £20m

[40] In practice this is constraining off Peterhead. See CBA Report P 13 and P20
[41] 2010_NG_NG_A022_v1

for the connection of generation assets. Given that most of these issues have arisen from further detailed investigation, there appears to be the potential for cost underestimates in the CBA. We note that, in relation to HVDC undersea cables, the previous PB Power analysis identified that the costs associated with the schemes had been underestimated and, given the above, the possibility for further cost increases cannot be discounted.

5.1.4.4 Wind Sensitivities

It is apparent from Figure 16 in the CBA that Wind availability is a significant contributor to constraint cost sensitivity. Compared with 2009, alternative wind capacity factors and distributions have been adopted by NGET which indicate a more robust and plausible profile for wind generation than assumed previously.

Section 10.2 of the CBA states the use of an onshore wind Load Factor (LF) of 28% annual average as the "best" Poyry onshore site. Additional information provided by NGET[42] on the performance range of onshore sites within the Poyry data set indicated that this figure related to West Freugh compared to Drumalbin and Wick which had annual average LFs of 17% and 24% respectively. An average of all three sites indicates an annual average LF of 23%.

Section 10.2 of the CBA also states that the use of Poyry offshore wind LF of 34% annual average is based on the “largest” Poyry offshore wind farm. This is slightly less than the assumption last year based on the ENSG load factor of 35%. Additional information provided by NGET on the performance range of offshore sites within the Poyry data set indicates that this figure relates to Dogger Bank compared to South Wales, Thames, and North West with annual average LFs of 29%, 29% and 33% respectively. An average of all 4 sites indicates an annual average LF of 31%. Figure 16 in the CBA indicates the relative effect of wind sensitivity and this may have a material effect on a number of cases.

NGET subsequently provided access to other studies[43] to support the wind load factors used in the CBA. The figures utilised in the CBA appear to be consistent with other wind yield data available to KEMA and therefore represent a reliable base case, but that a 5% reduction in load factor does represent a realistic sensitivity. The reduction in benefits of associated with reduced load factors from wind generation, combined with potential reduction in constraint pricing could have a significant impact on the CBA investment case.

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[42] 2010_NG_NG_A043_v1

[43] DECC UK Energy Statistics (Sept.2009) and a 2005 Report by Oswald Consultancy

5.1.4.5 Demand/Supply Scenarios

Since last years review of Anticipatory Investment there has been significant progress in terms of Government initiatives, large customer behaviour and generation development and the understanding of the potential of smart meters and smart grids. As such it may be appropriate to review the potential for demand/supply scenarios relating to demand side response, the potential for embedded renewables, and the use of new technologies such as heat/energy storage.

In the three ENSG scenarios it was assumed that electricity demand would remain flat (Gone Green) or would recover slowly (Accelerated Growth; Slow Progression). It is notable that DECC's latest Impact Assessment in the Smart Meter Prospectus (July 2010) assumes household consumption falling by the order of 5% by 2020. This is in recognition of the Government's energy efficiency measures reducing the energy reduction potential of smart meters. Under such conditions, only 140TWh[44] of renewable generation is required to meet Government targets by 2020[45]. Ofgem's "Demand Side Response Discussion Document" also recognises the potential for a 10% shift in peak demand and addresses system balancing and constraints (paragraphs 2.30 & 1.14 of that document refer).

In future, it will also be important to recognise the potential for distributed renewable generation to impact centralised production. There are already examples of large customers investing in on-site renewable plant to become "self-sufficient"; and Feed-In-Tariffs are promoting increased numbers and larger renewable installations.

The impact of demand-side and supply-side response initiatives have the potential to provide alternative sources to meet the renewable targets, and alternative means to alleviate Transmission capacity constraints. Many of these initiatives will become more prevalent as smart metering is deployed, and smart grid solutions develop.

The following table is an illustration of possible initiatives and consequences:

Table 9 – Possible Demand/Supply Initiatives and their Impact

Initiative	**Consequence**
Winter Period at GMT+1	Reduction in overall system energy requirements and winter tea-time peak
Time of Use Tariffs – (wider use of; including domestic)	Flattening of peaks (including potential to manage system constraints)
Large customer on-site renewable	Reduction in overall system energy

[44] The ENSG study concluded that the GB electricity sector would need to produce 147TWh from renewable generation by 2020 to meet Government targets. A 5% reduction in energy consumption reduces this figure to 140TWh.

[45] NGET recognise the potential for a reduction in demand, due to recession, and the impact on generation requirements in 2020 in their response 2010_NG_NG_A019_v1.

generation	requirements and winter tea-time peak
Large customer ancillary services – load response extended beyond STOR and Frequency Response to include Constraint Services (increasing and reducing demand)	Manage Transmission constraints through customer price incentives
Domestic Real-Time Pricing and/or End-use load control	As above

A range of commercial models are possible, but Transmission System Operators already have a range of solutions to address Short-Term Operating Reserves and Frequency Response, and these could be extended to applications for Network Constraint Management. Innovative third parties are already established to participate in this market, and would expand into this service if there were the appropriate financial incentives – which would appear to be viable, and may be influenced by DECC's Electricity Market Reform. This would include incentives or controlled loads to increase or decrease demands at particular times.

There is also considerable interest in new technologies and promoting innovation to address the energy supply concerns, including the development of "smart grids", with a specific aim to integrate low carbon generation sources and simultaneously avoid high capital cost network reinforcements. Similarly, it may be worthy of further consideration to assess and model the potential for demand/supply response in support of traditional reinforcement options.

5.1.5 Overall summary of Cost-Benefit Analysis

This section concentrates on the position in 2015, using the "Gone Green" baseline scenario. An important part of the justification for constructing the Western HVDC Link (and in particular the timing of its construction) is the CBA modelling undertaken by NGET. KEMA has analysed the information provided in the original NGET Report, together with information provided in response to supplementary questions. This analysis is summarised in Table 10.

Table 10 – Summary of 2011/2012 costs & benefits with different input assumptions

* All figures quoted are in £M pa	Constraints Costs		Losses Savings	Return on Capital	Depreciation	Net benefit	Comments[46]
	Without Link	With Link					
NGET original calculation	201	-16	49	-60		174	Constraint costs in CBA Table 11
Losses corrected, Depreciation added	201	-16	33	-60	-25	132	
Hunterston and QB on B7a	158	-12	33	-60	-25	94	Constraint costs from Table 11b
Penwortham – Kirkby to 400kV	74	-6	33	-60	-25	16[47]	Constraint costs from Table 11d

NGET's original analysis in the Cost Benefit Report provided the following cost assessment:

- Cost of Constraints – Boundary B6 without link £ 57M
- Cost of Constraints – Boundary B7a without link £ 143M
- Cost of Constraints – Other Boundaries without link £ 1M
- Cost of constraints - Remaining constraints after link built £ -16M
- Losses £ 49M
- Less 6.25% of capital cost £ [redacted]

This provided a net benefit of [redacted] in 2015, and is summarised in the first row of Table 10. In the CBA costing, NGET has made provision for a 6.25% "test discount rate", representing NGET's pre-tax rate-of-return on transmission[48].

Subsequent modelling has resulted in a number of adjustments as summarised in Table 10. Firstly, the cost savings associated with reductions in losses have been reduced (section) 5.1.1. An allowance for depreciation has been added to reflect an assumed 40 year asset life

[46] Tables 11b and 11d are included in NGET's Response NG_A044b, which also includes the original CBA Table 11 for ease of reference.

[47] It could be argued that this value should be adjusted for the depreciation and cost of capital of the Penwortham – Kirkby uprating, in which case the net benefit becomes £23M.

[48] NGET CBA analysis Report Page 28

of the proposed link, i.e. 2.5% per annum. These adjustments result in the net benefit of constructing the link by 2015 reducing to [redacted].

Table 10 also shows the effect of amending Hunterston generation capacity to 860MW (section 5.1.2), and of increasing the capacity across Boundary B7a by including the quadrature boosters planned for installation at Penwortham (section 5.1.3). The net benefits are thus reduced to **£94M** in 2015.

Most of this resultant benefit of constructing the link, in the short term, come from the elimination of constraints across Boundary B7a as opposed to Boundary B6. However, the constraints on this boundary can be efficiently relieved by uprating the Penwortham – Kirkby circuits to 400 kV at a cost quoted by NGET to be £75M[49]. The impact of addressing B7a constraints in this manner further reduces the benefit of building the link to **£16M** in 2015.

KEMA notes that, although the above analysis includes depreciation and an allowance for NGET's rate of return, it does not include any discounted cash flows. The application of a discount rate (even as low as 5%) would appear to make the case for commencing construction in 2011/2012 (with commissioning in 2015) marginal.

KEMA does not, therefore, believe that it is essential to commence construction of the Western HVDC towards the end of the 2011/2012 financial year although KEMA accepts that further reinforcement of Boundary B6 may be required in the future.

5.1.6 Western HVDC Investment Timing

NGET is seeking to construct the Western HVDC Link for operation in 2015, and the CBA Report quoted a significant constraint cost saving (£174M in 2015) from this project. It was shown that uprating the Penwortham- Kirkby circuits to 400 kV would reduce these benefits substantially in 2015. KEMA believes that some uncertainty remains whether the Western HVDC link will be required by 2015, in which case construction funding does not need to be committed in 2011/2012.

[49] NGET CBA Report Figure 1.

6 CONCLUSIONS

6.1 Summary of KEMA's Assessment

Based on this review of the proposed projects and the supporting CBA modelling exercise, KEMA has assessed the need, timing and scope for each investment. A summary of the key funding requirements are provided in Table 11. Conclusions relating to the pre-construction and construction finding requests are provided in the following sections.

KEMA have based these conclusions on information made available over the course of this work. Where there has been insufficient information to address the project or sub-project assessment, KEMA have identified this in course of this document, and highlighted any such concerns in this section.

6.1.1 Pre-Construction Funding Requests

In relation to the sub-projects for which pre-construction funding is requested, the materiality of the funding requests are all relatively low and, with the exception of the Wylfa – Pembroke HVDC Link, are all associated with the requirements of the Infrastructure Planning Commission process which is now better understood than when the TOs submitted funding requests in 2009 (section 4.4). While specific details of the estimated funding for the IPC requirements have not been provided on a case specific basis, NGET has explained the requirements to consider a variety of alternative options in relation to each sub-project and to develop such options further than would have been required previously where detailed analysis would have been reserved for the preferred option. Furthermore, NGET has provided specific details in relation to the Hinkley – Seabank 400kV OHL sub-project (part of the proposed South-West investment) which provides insights into IPC requirements as a basis for assessing other IPC related requests.

KEMA considers that the information provided by NGET for Hinkley-Seabank is sufficient to confirm that the IPC process will incur greater costs than the previous arrangements and **KEMA conclude that the additional funding requests for pre-construction funding in 2011/12 appear reasonable, subject to the observations below**.

Table 11 – Summary of 2011/2012 funding requests

[Table removed]

Due to the uncertainties associated with the early stages of IPC implementation, KEMA cannot provide a firm view on the IPC costs for 2011/12, other than the fact that additional costs will be incurred, and they look reasonable on the basis of information made available by NGET.

KEMA suggests that Ofgem seek further clarification regarding forecast IPC costs for the Hackney – Waltham Cross sub-project which requires the re-consenting of an existing line. This implies that the IPC costs should be lower, and Ofgem's attention is drawn to the apparent discrepancy in NGET's review in relation to the Hackney – Waltham Cross line as referred to in Section 4.4.

KEMA proposes that Ofgem continue to monitor additional information and supporting evidence for the review period 2012/13, as the costs associated with the IPC process become clearer during 2011/12.

In relation to the Wylfa – Pembroke project, KEMA's believes the need for this project is uncertain and interacts (to some extent) with the proposed Western HVDC Link. It should be noted that whilst the pre-construction funding request for the Wylfa – Pembroke project in 2011/2012 is the lowest of the schemes submitted (at £0.5m), pre-construction activities are forecast to continue for 6 years, much longer than the previously declared pre-construction phases for the Western HVDC Link (3 years) or the Eastern HVDC Link (4 years). While this discrepancy may warrant further clarification from NGET, KEMA considers that early consideration of the project is worthwhile.

Apart from the observations above for Hackney – Waltham Cross and Wylfa - Pembroke, KEMA do not have any major concerns with the remaining sub-projects, other than the IPC issues identified.

6.1.2 Construction Funding Requests

The situation regarding construction funding is complex and more financially material. Therefore it is important to consider the state of readiness of each sub-project in addition to the Need, Timing, Scope and Interactions as addressed in Table 5. KEMA's assessment of TO readiness in relation to construction funding has been summarised in section 4.5 in terms of Deliverability, Design and Cost.

NGET has confirmed that the East-West upgrade sub-project in the SPT region is part of a package of measures associated with upgrading the capacity of the Scottish interconnector circuits to 4400 MW, and represents the most cost-effective way of achieving a 1st stage

capacity increase for Boundary B6. KEMA accepts that there is a need to increase transfer capacity across the B6 boundary from 3.3 GW and that this sub-project, together with the NGET/SPTL interconnector is justified. On this basis, the general scope and timing of this sub-project appears reasonable.

Therefore KEMA concludes that the construction funding of £0.8M requested by SPT in relation to the East-West Upgrade for 2011/12 appears appropriate, and the TO readiness appears sufficiently satisfactory.

However, KEMA has concerns that in subsequent years, the cost of the Wishaw GIS substation investment appears high indicating a potential reduction of £5M for this sub-project unless further information can be sourced from SPT.

Regarding the SPT-NGET interconnection and NGET Anglo-Scottish incremental sub-projects, KEMA concludes that, together with the SPT East-West upgrade, the scope and timing appears reasonable. There is a manageable risk that Sub-Synchronous Resonance (SSR) could occur requiring the size and location of the series capacitors to be re-evaluated – this will need to be accounted for in TO contracts with suppliers.

KEMA raised concerns regarding the installation of new 275 kV capacitor equipment at Cockenzie (as it could perpetuate the 275 kV network or result in stranded assets). However, we understand that, in the light of our comments, SPTL are re-evaluating the position, but it is likely that any change in design would have an adverse effect on the overall delivery timescales.

KEMA concludes that the 2011/2012 additional funding requests for the SPT sub-projects for SPT-NGET Interconnection [redacted] and NGET's Shunt Compensation investment at Harker-Hutton and Stella West (£32.4M), appear appropriate and the TO readiness appears satisfactory.

However, given the proposed deliverables associated with the level of proposed expenditure for 2011/2012 [redacted], it would be informative for Ofgem to make further enquiries regarding the profile of the proposed expenditure for milestones and outputs, and an assessment of future funding requests in relation to this sub-project

In relation to SHETL's request for funding for the Mossford Sub-station (as part of the wider Beauly-Mossford Project) KEMA's concludes that the need for the sub-project has been demonstrated given the need to overcome the current SQSS non-compliance issues and the

likelihood of further windfarm connections. Following clarification from SHETL to Ofgem[50] in relation to whether this item was already covered in TPCR 4, KEMA **concludes that the requested funding of £2.5M in 2011/2012 for the Mossford Sub-station appear appropriate[51], and the TO readiness appears satisfactory.**

Western HVDC Link Assessment

In section 5 KEMA presented its detailed comments on the supporting Cost Benefit Analysis provided by NGET. KEMA's main observations and conclusions regarding construction funding for the Western HVDC link between Hunterston and Deeside are summarised below:

- KEMA recognises that additional N/S transmission reinforcement will be required to integrate existing and new power generators located in Scotland – from both conventional and renewable sources.
- KEMA supports the proposals to immediately reinforce existing onshore transmission infrastructure across the Scotland – England interconnecting circuits to achieve 4.4GW transfer capacity.
- KEMA acknowledges that additional N/S reinforcements may be required in future and that this will be largely dependent on generation scenarios – new plant investments; plant closures; fuel types and costs. For each of these variables, uncertainties are apparent.
- Future shortfalls of N/S transmission network capacity could constrain the output of some generators during particular periods. However, given the projections for Scottish generation in 2015, KEMA believes that any constrained generation is unlikely to be from renewable sources and therefore should not impact the delivery of UK emission targets.
- With increased generation investment in Scotland, further transmission network capacity is likely to be required, particularly in the latter half of the current decade.
- Various options for increasing N/S interconnection capacity exist:
    - Onshore reinforcement and new overhead line circuits;
    - Western submarine DC Link(s); and/or
    - Eastern submarine DC Link(s).
- NGET has selected the Western HVDC Link as the preferred 2nd stage reinforcement option and KEMA recognises this as a valid solution to increase N/S transfer capacity.
- KEMA has some concerns that additional network constraints and reinforcement costs could arise in North West England in future years due to additional power flows into Deeside from the Western DC Link.

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50 As received by KEMA in an email from Ofgem dated 9 January 2011 with attached file "SHETL 241210 Beauly Mossford.pdf"\

51 Subject to any existing TPCR4 funding under consideration by Ofgem

- KEMA regards the CBA methodology as developed by NGET as an appropriate means of assessing the overall economics of investments to increase N/S transmission transfer capacity in Great Britain. As with any modelling exercise, outputs and conclusions are clearly influenced by input assumptions.
- NGET CBA assumptions indicate that significant constraint and loss savings will arise from 2015 following construction of the Western Link. However, this is dependent on a number of generation capacity and constraint price uncertainties.
- Future constraint costs could be impacted by DECC's Electricity Market Reform. Should some form of capacity mechanism be introduced, it may not be necessary for marginal generators to include investments costs in bids/offers, thus reducing constraint costs.
- Updated model runs of the CBA analysis show the investment case to commission the Western DC Link by 2015 to be marginally justified. Lower generation build rates, earlier plant retirements, lower constraint price differentials could also imply that a later commissioning date to be justified.
- The cost of the Western DC Link as proposed is [redacted] which is scheduled to be committed over approximately 5 years. However, in the first year of construction, approximately [redacted] of funding is forecast to be allocated in 2011/12. This represents less than [redacted]% of the total sub-project cost, although it effectively commits the remaining [redacted]% of investment in future years.
- During 2011/2012 NGET/SPTL plan to complete a tendering process to appoint vendors for the construction of the Western HVDC Link. This tendering exercise is scheduled to complete in late 2011. Therefore, it appears that construction funding for the Western HVDC Link relates to the latter months of the 2011/12 financial year. KEMA believes that initiating this tendering process in 2011 represents a sensible means of reducing cost uncertainty and therefore should progress as planned.
- Throughout 2011/12, uncertainties regarding short-term generation forecasts should reduce. In parallel, further independent analysis could also be undertaken to confirm the likely range of future constraint price differentials.

Given the nature of anticipatory investment and the current uncertainties impacting GB electricity market development, it will be necessary for Ofgem to apply judgement regarding the validity of the assumptions employed in the TO investment case for the Western HVDC link. Should there be confidence that the input assumptions are representative of future market arrangements and that transmission capacity reinforcements will accelerate renewable generation investment, then a business case for the early construction of the Western HVDC Link can be justified.

KEMA concludes that whilst the commencement of construction for the Western HVDC Link in 2011/12 can be justified for a particular set of input assumptions, there also appears to be some input assumption uncertainty which would suggest limited

sub-project delivery risk and/or renewables deployment risk associated with conducting further analysis in 2011/2012.

Deeside Substation

The Deeside Sub-station sub-project is closely related to the proposed Western HVDC Link funding request and KEMA has some concerns regarding the magnitude of the additional funding identified during the first phase of construction.

Ofgem's "TAR-TO Incentives: Final Proposals" of January 2010 recognised that the Deeside substation required replacement independent of any requirements of the Western HVDC Link, but that such a replacement would cost £20m less than the current proposal. Based on the existing TPCR4 settlement allowance for Deeside (£20.4m at 2004/05 prices), Ofgem allowed a total of £43.3m under TPCR4 and Special Licence Condition D11 for both 2010/11 and 2011/12.

KEMA notes the position in 2010 that only £20m of the Deeside substation costs were additional due to the HVDC Link, compared to the standard sub-station replacement. The additional costs of £41.4m that have been identified for 2011/12 and the overall costs are a concern to KEMA. Continuing to fund the Deeside substation represents an ongoing commitment to the potential development of the Western HVDC Link, which will remove Deeside from the critical path for link completion.

KEMA concludes that the request for additional funding for the Rebuilding and Extension of the Deeside 400kV Substation represents a substantial commitment to a time-critical component of any Western HVDC Link should it ultimately proceed. Whilst additional information from NGET remains outstanding at the time of writing, **KEMA concludes that £31.1m of the additional funding request (of £41.4m) appears appropriate for 2011/2012 unless further clarification of these costs can be provided by NGET, and that the sub-project TO readiness appears satisfactory.**

Future funding for Deeside sub-station should be monitored accordingly.

APPENDIX A KEMA'S REVIEW OF COMPONENT PROJECTS

This Appendix A provides details of KEMA's high level assessment of each of the investment projects proposed individually or jointly by the GB TOs for additional funding to facilitate the achievement of Government 2020 targets. Each sub-Section addresses a specific project/sub-project and provides:

1. Project/Sub-project detail including the proposer, the indicated requirement/drivers, the content/investments within the project/sub-project, the proposed timing of construction works, the transmission capacity/capability provided by the project/sub-project, the suggested cost and any dependencies/inter-actions;

2. KEMA's view of robustness of the TOs' indicated drivers for each project/sub-project including assessments of relevant dependencies on predicted drivers and interactions with other projects;

3. KEMA's interpretation of the investment requirement and high-level assessment of the scope of the proposed project solution – this is assumed under current GB SQSS planning standards;

4. KEMA's view of the proposed timing of the project/sub-project; and

5. KEMA's summary view.

In this Appendix KEMA uses a 5 step traffic light colour coding to indicate its view of (i) certainty of need; (ii) reasonableness of scope; (iii) certainty of timing and (iv) cost effectiveness, with at one extreme a green dot (●) representing "high/strong" and at the other, a red dot (●) representing "low/weak". Combination with amber dots (●) represents intermediate assessment ratings.

A.1 Central Wales (NGET)

A.1.1 Project details

The Welsh Assembly Government Technical Advice Note 8 (TAN8) identifies an onshore wind generation target of 800 MW and that this could come from central Wales, the area identified as providing the majority of wind resource in Wales. However, at present central Wales is distant from the main interconnected transmission system. To facilitate/enable connection of onshore wind generation in central Wales, new transmission assets including an overhead line with, possibly, some cable sections would need to be constructed in order to connect the new generation to the transmission network.

As any such onshore wind generation in central Wales is expected to be made up of a number of small to medium wind farms, the current proposal is to create a hub sub-station to which all wind farms would connect. A single transmission route would then be used to connect to the Ironbridge 400kV sub-station. This requirement was identified in the ENSG Report, although then it was only a route to "connect into the Legacy – Shrewsbury – Ironbridge route". The requirement to terminate at Ironbridge seems to have been identified in the last year, although it is a logical requirement as it would avoid the risk of creating a bottleneck between the new sub-station and Ironbridge. With the projected closure of Ironbridge Power Station (1000 MW coal, not LCPD compliant) there should be capacity available at Ironbridge.

Based on 400kV double circuit construction KEMA would expect the proposed transmission spur under this project to have at least a 2000 MW capacity which would provide flexibility for any future transmission growth requirement.

In 2009 NGET stated that there was a possibility of connecting the central Wales sub-station to the transmission system in North Wales, possibly requiring an underground DC link as the route would traverse an area where it could be difficult to achieve an overhead line solution. The key dependency/interaction of this project is the likelihood and potential capacity of onshore wind generation which might seek to connect in North Wales if such a transmission network spur existed.

Currently, NGET indicate that two developers have signed Connection Agreements for wind farms in the "TAN8 region" totalling 300 MW and that they hold a Modification Agreement with the local DNO to build a new sub-station to accommodate a further 500 MW of projects seeking a distribution voltage connection in the region. The position is summarised in the Table below.

Windfarm	Capacity MW	Status
		Connection Agreement
Carnedd Wen	184	Yes
Mid-Wales West	408	Yes
Llanbrynmair	96	Yes

The project comprises three sub-projects – a new mid-Wales 400kV sub-station, works to the existing Ironbridge sub-station and the new 400kV overhead line. NGET have requested additional pre-construction funding for 2011/12 in relation to the 400kV overhead line only. In early 2010, Ofgem approved an additional funding request from NGET for pre-construction works in relation to the overhead line element for the 2009/10 period. Construction work on the project would be due to begin in 2012/13 with completion in 2017/18.

This submission seeks a further £2.8M for pre-construction funding in 2011/12 for the overhead line sub-project (making a total of £3.9M pre-construction funding for the overhead line). The funding is requested to meet anticipated IPC costs. A further £1.1M of pre-construction funding for the overhead line is envisaged for 2012/13.

In 2009 NGET indicated a total Central Wales project cost (including all pre-construction works), in 2008/09 prices, of £251M. This has now been reduced to £191.1M.

This expenditure from 2011/12 is summarised in the Table below.

Project (at 2010/11 prices)	2009/10		2010/11	Total Pre-construction work	Construction cost	Total Cost
	Requested	Approved	Requested			
	£M	£M	£M	£M	£M	£M
Central Wales OHL	1.0	1.0	2.8	5.0	117.1	122.1
Ironbridge Substation				0.2	11.1	11.3
Central Wales substation				3.9	53.9	57.8
Total				9.1	182.2	191.3

A.1.2 Headline Assessment

KEMA's headline assessment of the proposed Central Wales project is summarised within the two tables provided below:

Benefit/capability provided	Critical dependencies	Interaction with other projects
Enables connection of 800MW of generation (assumed to be wind) in Mid-Wales.	The merit of this project is dependent on whether the 800MW of generation materialises in Mid-Wales	None – stand alone

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
🔴🟡 The requirement for this project is based on a Welsh Assembly aspiration as outlined in TAN8 and partly supported by an NGET indicated 300MW of wind farms seeking to connect in the "TAN8 region". Consequently, there is high uncertainty regarding investment need and the project represents a clear example of anticipatory TO investment.	🟢 On the assumption that sufficient generation will seek to connect in Mid-Wales thus meriting an additional transmission spur, under current planning standards the proposed scope of the project appears reasonable as it is probably the lowest scale spur which could sensibly be constructed at 400kV transmission voltage.	🔴🟡 Given the sole reliance on projected generation interest and the uncertain status of such generation, there is strong uncertainty over the timing of the associated investment.	🟡 The project has a cost of £186M and could permit up to 1800MW of windpower to be connected under the GB SQSS[52]. However, this amount of generation is unlikely: adopting a more realistic value of 600MW gives a cost of around £300/kW. Even if only 600 MW transpires (that is in the mid-range of the new generation considered), KEMA do not believe that there is an alternative solution which is superior in terms of cost-effectiveness. The key question resolves around the actual usage of the transmission spur if it is built on an anticipatory basis and the extent of underground cabling which may be required.

[52] Assumes minimum loss of generation is increased.

This project is a strong example of anticipatory TO investment. In this case it is driven by Welsh Assembly aspirations as outlined in TAN8 and supported to some extent by some initial generation interest in the area (as represented by the two new connection agreements for 300 MW of wind generation in the "TAN8 region") and potential local DNO development (i.e. proposed 500 MW capacity distribution voltage substation). KEMA is not in a position to evaluate if this proposal is reasonable and cost-effective until, firstly, the generation requirement materialises, and secondly the costs are established – this will depend critically on how much underground cabling might be required.

The additional funding requested is identified as relating to the need to meet additional costs associated with the IPC process (see section 4.4 for further information on this process). NGET have provided a detailed explanation of IPC funding requirements and have used a case study relating to the Hinkley-Seabank 400kV overhead line (addressed later in this Appendix). This note identifies the additional complexities and processes which need to be undertaken to meet IPC requirements and highlights that IPC related expenditure remains uncertain at this stage given the limited experience of the IPC process. The note further highlights that the estimated cost may vary on a case by case basis depending on local conditions – for example it highlights that funding for IPC requirements for the London project (see later) is lower than average as it is limited to an existing route and, therefore, multiple route considerations may not required.

While the specific IPC requirements for which the funding is requested have not been identified by NGET in relation to this sub-project, it is clear that the IPC process is more complex and, therefore, likely to incur greater costs. Furthermore since such pre-construction funding will, *inter alia*, help determine the amount of cabling and hence the overall costs of the sub-project, KEMA supports this proposal for pre-construction funding.

A.2 East Anglia (NGET)

A.2.1 Project details

In 2009, NGET sought agreement for funding for a large range of works in East Anglia to facilitate connection of (i) an anticipated 3-4 GW of Round 3 offshore wind farms forecast to be built off the East Anglia coast and connect into the Norwich Main or Sizewell sub-stations, (ii) anticipated new nuclear generation at Sizewell, and (iii) expected additional CCGT

capacity in the region, including King's Lynn B (981 MW, due to be connected in 2014/15[53]). The works consisted of:-

(i) Extension of the Bramford 400kV sub-station, including two circuit turn ins;

(ii) Reconductoring of the Bramford to Norwich to Walpole 400kV circuits (planned for 2011/12)[54];

(iii) Construction of a new 400kV overhead line circuit from Bramford to Twinstead Tee, approximately 30 km in length; and

(iv) Installation of two quad boosters on the Walpole-Pelham 400kV circuits.

NGET is seeking additional funding of £2.2M in 2011/12 (making £4.3M in total) to address IPC costs as part of the pre-construction work associated with the proposed new Bramford – Twinstead Tee overhead line. Completion of the overhead line is currently planned for 2016/17[55] with the remaining project works (associated with the extension and reconfiguration of the Bramford sub-station) due to complete the following year.

These works would substantially increase transfer capability from the East Anglia network south towards London and the major demand centres in the south east. The Table below gives a summary of the project costs from 2011/12.

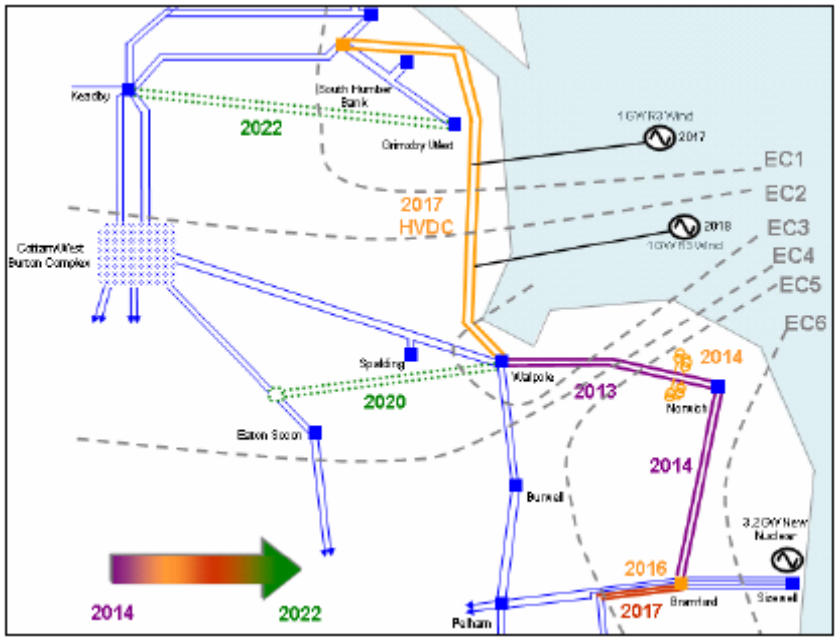
Project (at 2010/11 prices)	2009/10		2010/11	Total Pre-construction work £M	Construction cost £M	Total Cost £M
	Requested £M	Approved £M	Requested £M			
Bramford – Twinstead overhead line	2.1	2.1	2.2	4.3	99.7	104
Reconductor Norwich - Walpole					33.4	33.4
Reconductor Bamford - Norwich					45.0	45
Bramford substation	1.2	1.2		1.2	92.5	93.7
QB Walpole				1.0	51.5	52.5

[53] Information from 2010 Seven Year Statement, Table B7c.
[54] Information from 2010 Seven Year Statement, Table B7c.
[55] Information from 2010 Seven Year Statement, Table B7c.

132 kV mitigation[56]				0.2	25.8	26.0
Total				6.7	347.9	354.6

NGET are proceeding with the work authorised in 2009. However, NGET state that the costs of obtaining consent for the new overhead line will be significantly greater than initially anticipated due to the requirements of the IPC (see section 4.4) and have therefore applied for additional funding.

Figure 9 – Illustration of East Anglia/Humber Network and Proposed Project and Timing



Source - the Full ENSG Report "Our Electricity Transmission Network: A Vision for 2020", published July 2009

The most significant part of these reinforcement proposals concerns the requirement for a new section of overhead line between Bramford and Twinstead. This would relieve the existing bottleneck west of Bramford.

This bottleneck has been in existence for over 30 years: when Sizewell B was studied it was considered to be a candidate for reinforcement, but was subsequently identified as not required.

As the project would require new overhead construction, it has a long lead time as it progresses through the planning process. NGET has, indeed, been consulting over this proposal during the last year. Because of the planning timescales, construction of this length

[56] Thought to represent cost of dismantling 132 kV line (and installation of transformer to replace the line) to permit re-use of the wayleave corridor.

of line is likely to sit on the critical path for transmission reinforcements. Consent for the line could also be required before construction of Sizewell C could be envisaged.

A.2.2 Cost-effectiveness

The overhead line itself is costed at £100M for about 30km, or £3.3M/km. This is much higher than other new construction, where the cost is estimated at £2 - £2.5M/km. KEMA is unable to reconcile this cost differential at this stage.

It should be noted that the Bramford – Norwich – Walpole circuits are estimated to be circa. 40 years old, and hence would likely be due for asset replacement (reconductoring) in the not too distant future were this project not to proceed.

As a further observation, although outside of the project under immediate consideration by KEMA, the identified costs of the two Quadrature Boosters at Walpole - £52.5M – seems high.

A.2.3 KEMA Assessment

The key dependency for this project is the capacity of nuclear and Round 3 offshore wind generation expected to commission in the area. There are no real interactions with other projects, although it is worth highlighting that if the proposed Humber project as discussed in Section A.3 (an onshore line between Grimsby West and Walpole) were to proceed it would reinforce/underpin the long term requirement for the reinforcements proposed in this East Anglia network upgrade project.

Benefit/capability provided	Critical dependencies	Interaction with other projects
Enables connection of additional generation in East Anglia, both new nuclear at Sizewell and offshore wind. Also caters for possible additional gas-fired generation (e.g. at Sutton Bridge or King's Lynn)	The project is reliant on the additional generation being constructed	Some interaction with the Humber project

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● The drivers behind this project consist of generation projects over a large area of a diverse type (nuclear, wind and gas). It therefore seems likely that the need for this project will transpire, although it cannot be stated with certainty.	● On the assumption that sufficient generation will seek to connect in East Anglia, thus meriting the additional transmission investment, the project is reasonable.	● Given the reliance on future generation projects there is some uncertainty over the timing of the construction phase.	● This project involves the maximum use of existing infrastructure, with minimum new construction, and is almost certainly the cheapest way of providing additional capacity. Nevertheless, the cost of the new overhead line, at 100M for 30 km, is expensive at £3.3M/km.

The funding request for pre-construction work to support the consent process for the new overhead line seems reasonable given the additional IPC process requirements described earlier in this document, although, in common with the other submissions, specific details of the estimates for this project have not been provided and therefore the interaction between existing funding and this new funding request cannot be established.

This project will potentially have a long lead time as it proceeds through the consenting process of the IPC. Overall KEMA's view is that Ofgem should support this project pre-construction funding. It is important that obtaining consent for the line is not on the critical path for the construction of Sizewell C or other low-carbon generation such as offshore windpower.

KEMA notes, however, that construction of the line would be likely to be much faster than a nuclear build, so that, once consents are obtained, it may be possible to moderate the construction timescales.

A.3 Humber (NGET)

A.3.1 Project details

The purpose of this project is to enable transfer of substantially increased power flows out of the Humber area driven by potential high volumes of Round 3 offshore wind generation off the Yorkshire/Lincolnshire coasts, estimated to be 4-8 GW by 2020.

In 2009, the project consisted of a proposed new line from Killingholme to Walpole via Mumby (in Lincolnshire between Skegness and Mablethorpe), where a significant amount of offshore windpower is expected to make its landfall, with associated sub-station works at Humber and Walpole. In the ENSG Report (and in NGET's 2009 request for funding) an overland DC link was proposed. It is now understood that an AC overhead line is being considered, and the northern termination of the line is Grimsby West; the change in termination point from Killingholme to Grimsby West is not considered material. The pre-construction work is to determine if the line is to be AC or DC, what should be its route and how much (if any) should be underground.

The key dependency is the actual capacity of offshore wind generation in the Humber/Lincolnshire coast for connection in future.

Ofgem approved the funding for pre-construction works for 2009/10 and this submission requests additional pre-construction funding of £0.7M in relation to the overhead line works only for 2011/12. This additional funding is identified as being associated with IPC processes. Further pre-construction works for the sub-project are indicated annually up to 2013/14 with construction work due to begin in 2014/15 and due to be completed in 2018/19.

This expenditure from 2011/12 is summarised in the Table below.

Project (at 2010/11 prices)	2009/10		2010/11	Pre-construction work post 2010 £M	Construction cost £M	Total Cost £M
	Requested £M	Approved £M	Requested £M			
Humber substation	0.3	0.3	0	0.7	60	60.7
Humber – Mumby Walpole OHL	3.3	3.3	0.7	14.8	285.1	299.9
Mumby Substation	0	0	0	0.7	33.2	33.9
Walpole Substation	0.3	0.3	0	0.5	125.4	125.9
Total				16.7	503.6	520.3

A.3.2 Cost-effectiveness

The overhead line is costed at £285.1M for a length of approximately 135 km, or around £2 M/km.

A.3.3 KEMA Assessment

The table below summarises the position with respect to generation south of the Humber estuary

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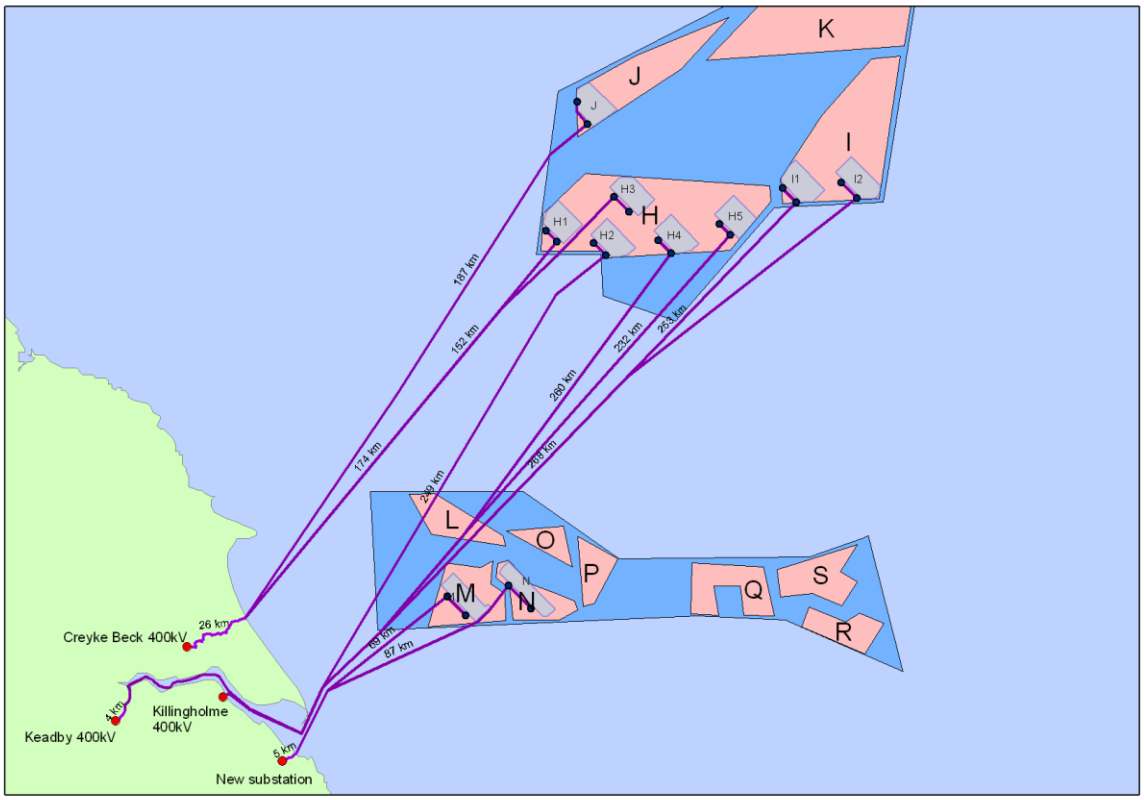
Power Station	Fuel	Capacity (MW)	Status
Killingholme 1	Gas	900	Existing
Killingholme 2	Gas	665	Existing
South Humber Bank	Gas	1285	Existing
Immingham Renewable	Biomass	290	Future
Humber Refinery	Gas/CHP	1438	Existing
Stallingborough Biomass	Biomass	35	Future

There is thus a total of 4.6 GW of existing and committed plant in the South Humberside area, although the two CCGT's at Killingholme could well close by the time significant offshore wind can be connected.

The existing transmission capacity out of Humberside is stated by NGET to be 4.8 GW, although the ENSG Report gave a value of 6 GW. NGET have clarified that while 6 GW is the theoretical capability, it cannot be achieved without further reinforcement, or a significant change in the wider system power flows.

There is a large offshore windpower potential off the Yorkshire coast at Dogger Bank (areas H – K in the Figure below) and Hornsea - up to 11 GW. This would almost certainly connect to the system in the Humber area, either at Creyke Beck to the north of the Humber estuary or to the Killingholme/South Humber Bank/Grimsby West system south of the estuary (see figure below).

Figure 10 – Connection Options for Hornsea Offshore wind farms



(from "Round 3 Wind Farm Connection Study", published by Crown Estate.

Although there is a large potential, the only currently contracted windfarms in this area are Humber Gateway (220 MW) and Westernmost Rough (175 MW), both to be connected at Hedon north of the Humber estuary in 2013/4 and 2014/15 respectively.[57] Recently connection agreements have been signed for Hornsea Offshore wind Farm (1000 MW in 2015) and Dogger Bank 1A and 1B (1000 MW in 2017).

There is also significant offshore windpower potential off the Lincolnshire coast, with no obvious landfall site: there is no existing coastal transmission between the Humber estuary and Walpole. The Triton Knoll windfarm (1200 MW) is contracted to connect at Mumby, between Mablethorpe and Skegness, in three stages between 2018/19 and 2020/21.

The requirement for additional transmission capacity out of the south Humberside area is therefore critically dependant on the amount of offshore windpower to be connected, to be offset against possible closure of first-generation CCGT plants.

[57] Information from "TEC Register" and 2010 Seven Year Statement

There is clearly a requirement for some transmission out of Mumby, to connect it to the system. In the Seven Year Statement this is stated to be a new line from Mumby via Bicker Fen to connect into the Cottam - Eaton Socon line in 2018. The location of the connection point on the Cottam – Eaton Socon circuits was not specified, although NGET's submission suggests Bainton, near Peterborough.

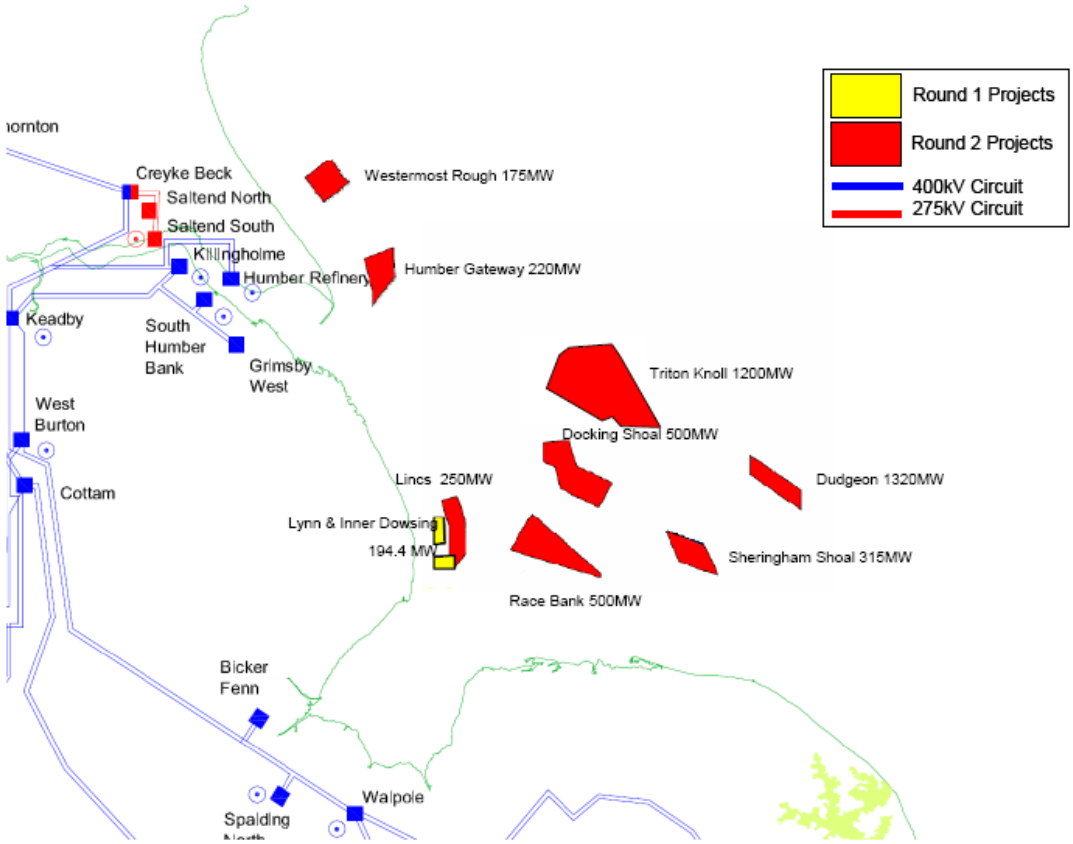


Figure 11: TEC associated with each site in East Coast

At first sight, terminating this new line on the Eaton Socon line at Bainton would seem to be preferable to termination at Walpole: there is already a large amount of generation connected at Walpole and injecting additional power from the north at this site runs the risk of overloading the system to the south of Walpole.

There are clearly a large number of options here, and it is appropriate for NGET to explore these in some detail.

This is summarised in the Tables below.

Benefit/capability provided	Critical dependencies	Interaction with other projects
Provides additional export capability from the south Humber estuary system. Enables offshore wind farms off the Lincolnshire coast to be connected to the system. Provides additional north-south capacity.	Volume and location of offshore wind power, located off the coast of Lincolnshire/Yorkshire. Possible closure of first generation CCGT's at Killingholme .	In order to get the full benefit from the line, additional east-west transmission to link the West Burton Walpole route to the Cottam – Eaton Socon route may be required to avoid overloading the system south of Walpole.

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
🔴🟡 Uncertainty remains that the relevant offshore wind farms will be developed. .	🟢 If significant offshore windpower in the Dogger Bank/Hornsea area does transpire, significant new transmission will be required. There are a number of possible options, depending on the precise pattern of new generation and associated closures.	🔴🟡 The requirement for transmission south of Humberside (i.e. the Grimsby West – Mumby leg) is critically dependant on the balance of new generation against closure of existing generation. The leg south of Mumby is more certain, as it would be required for the Triton Knoll offshore wind power project.	🟢🟡 As there is still considerable doubt concerning the scope and extent of the transmission required (including how much might need to be undergrounded), it is difficult to estimate the cost-effectiveness. However, if an AC overhead solution can be found, it is likely to be cost-effective.

The level of additional expenditure to fund forecast IPC requirements is modest and as such, given the above assessment, KEMA supports the request. KEMA notes, however, that there is still considerable uncertainty over the project costings.

A.4 London (NGET)

A.4.1 Project details

Historically, the network in and around London was developed to secure demand in the capital and its surroundings, when the major generation sources were the oil and coal fired plant in the Thames Estuary, or the coal-fired plant in the East and West Midlands. Additionally, it handled transfers to and from the interconnector at Sellindge, which until 2001 were typically 2,000 MW power imports to the UK.

Several factors are viewed to drive a need for additional transmission capacity in the London area. Specifically:

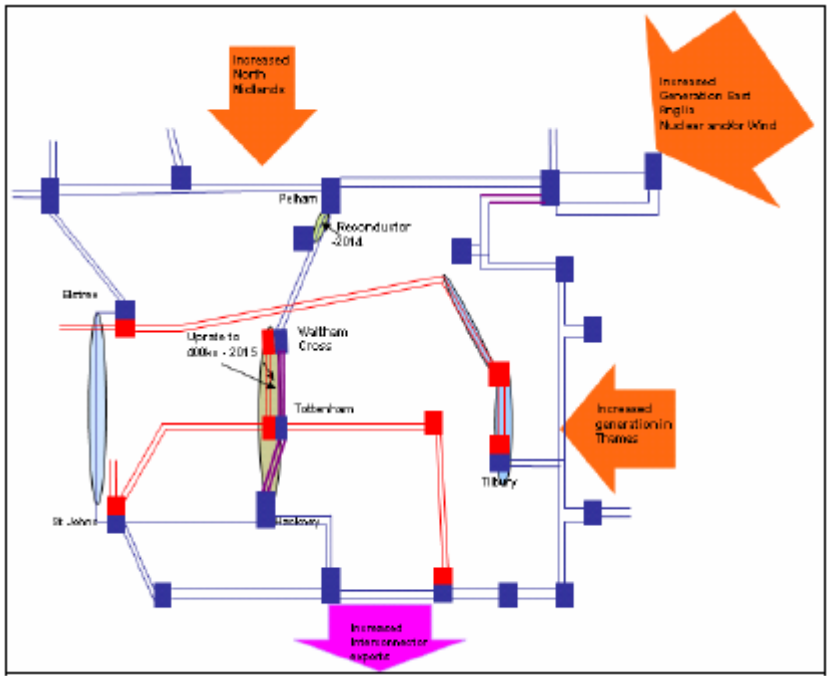
(i) increased generation in East Anglia and the Thames Estuary;

(ii) potential increase in interconnection with mainland Europe; and

(iii) the potential for future demand increases associated with the electrification of transport and/or the decarbonisation of space heat.

Although the generation portfolio in the Thames estuary is changing – with new generation at Grain and offshore windpower in the Thames estuary counterbalancing the projected closure of LCPD non-compliant plant at Tilbury and Kingsnorth – the main driver is seen to be an increase in generation feeding London from the north-east.

Figure 12 – Illustration of Proposed London Project and Key Drivers



Source - the Full ENSG Report "Our Electricity Transmission Network: A Vision for 2020", published July 2009

This NGET project was outlined in the ENSG report, when it envisaged uprating a 275 kV overhead line from Waltham Cross to Hackney via Brimsdown and Tottenham to 400 kV, necessitating constructing new 400 kV substations at Waltham Cross, Tottenham and Brimsdown. In 2009 NGET proposed to reconductor (and thus uprate) the existing 400kV Pelham-Rye House – Waltham Cross route, but the need for this was questioned by KEMA and it no longer seems to be being considered.

Prior to 2009 Ofgem approved funding for pre-construction works for 2009/10. NGET's latest submission indicates further pre-construction works annually until 2012/13. Construction work on the project has been delayed by a year, and is now due to begin 2012/13, with completion in 2019/20[58].

NGET are now seeking a further £2.4M funding for pre-construction work in 2011/12 in relation to the overhead line only (increasing the total pre-construction forecast expenditure for the overhead line for 2011/12 to £4.4M) with a further £1.8M pre-construction funding indicated as being required in 2012/13, making a total for the pre-construction funding for the overhead line of £6.2M. The construction cost for the project is predicted to be £180M, of which £55.8M is associated with the overhead line.

The project costing from 2011/12 are summarised in the table below.

Project (at 2010/11 prices)	2009/10		2010/11	Total Pre-construction cost	Construction cost	Total Cost
	Requested	Approved	Requested			
	£M	£M	£M	£M	£M	£M
Waltham Cross – Hackney uprating	2.1	2.1	2.4	6.2	55.8	62.0
Brimsdown Substation				0.2	19.2	19.4
Hackney Substation				0.2	34.2	34.4
Waltham Cross Substation				0.3	70.8	71.1
Total				6.9	180.0	186.9

A.4.2 Costs

The predicted costs for the overhead line appear high. The existing overhead line is to be reconductored, but the cost translates to £3M/km which is high compared to expectations. This is more expensive than new build for some of the other projects. It could be argued that at least some of this cost should be ascribed to asset replacement, rather than infrastructure improvement. NGET explain that much of the extra cost is for access – the lines run down

[58] Although the majority of the expenditure for the overhead line is scheduled to complete in the year 2016/17.

the Lea valley where there is a lot of water – and we are unable to definitively state that NGET's costs are excessive here.

At Hackney all that is required is to replace two 275/66kV transformers with 400/66kV units, and to construct a banking compound, yet the quoted cost of £34M appears excessive. NGET have provided a breakdown of costs[59]; most notable is a civil engineering cost of £6.4M, when KEMA's estimates are less than £1m.

At Brimsdown, it is proposed to install two 400/132kV transformers and 220m of 132kV cable. The cost of this (at circa. £20M) also appears excessive: for example, protection is costed at £3.9M[60] when in KEMA's view it should cost less than £0.5M.

The new substation at Waltham Cross is a 14 bay (although confusingly also referred to as 10 bays in the documentation) GIS sub-station costing £71M. Some of the investment appears to be associated with a separate project, namely to uprate the Tilbury – Warley – Elstree line to 400kV and to turn it into Waltham Cross, although elsewhere this is not planned until 2019/20[61]. This cost again appears excessive: for example, civil engineering costs are quoted at £15.5M[62] when in KEMA's view a more realistic figure would be £3M - £4M.

In conclusion, KEMA considers the projected cost to be excessive and should be significantly less than that quoted by NGET.

A.4.3 Headline Assessment

NGET state that the capacity provided by this network reinforcement (Hackney - Waltham Cross) is an increase of 600MW in import capability into London from the north east (an increase from 10.2GW to 10.8GW). The alternative reinforcement (uprating the Sundon – Elstree route with a second cable from Elstree to St. John's Wood) is considerably more expensive.

KEMA's headline assessment of this project is summarised within the two tables provided below:

[59] NGET Response 2010_NG_NG_A038_v1
[60] NGET Response 2010_NG_NG_A_039_v1
[61] 2010 Seven Year Statement Table B7c.
[62] NGET Response 2010_NG_NG_A037_v1

Benefit/capability provided	Critical dependencies	Interaction with other projects
Improves power flow into north-east London	Dependent upon an increase in generation in East Anglia.	Some interaction with the East Anglia reinforcements.

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
🟡🟢 The requirement for this project depends on the evolution of the GB generation fleet. Given the large amount of potential new generation in East Anglia of diverse fuel types (nuclear, gas and wind) it is probable that the project will be needed.	🟢 On the assumption that additional capacity into London is required, the project is reasonable and – as it involves no new overhead lines – is likely to be the cheapest and most environmentally friendly solution.	🟡🟢 Given the reliance on future generation interest and the uncertain status of such generation, there is some uncertainty over the timing of this investment.	🟡 Although the project provides only a modest additional 600MW transfer capacity across Boundary B14 (London Imports), it is probably the most cost-effective way of providing additional capacity. Nevertheless, the cost does seem excessive – perhaps twice as much as would be considered reasonable.

There is an interaction with the Bramford – Twinstead reinforcement, as both accommodate the potential additional power flows from East Anglia. Hence the essential key dependency is the assumed volume (and timing) of new generation to the north east and east of London and to a lesser extent the evolution of the generation portfolio (including import/export links) in south-east England.

Given the underlying mix of generation drivers and KEMA's positive assessment of the need and timing for the East Anglia project (which will facilitate increased power flows into London from the north east), the case to proceed with the proposed pre-construction engineering works for the SE transmission network around London is strong.

The project involves uprating an existing 275kV overhead line to 400kV. Although no new overhead line construction is envisaged (with the exception of line entries into the new substations), NGET stated[63] that the existing consent was for only 275kV and hence a new consent would be required. NGET further stated that advice from the IPC is that this would be treated with the same degree of detailed examination as would a request to construct a new overhead line. NGET therefore state that they need to examine many alternatives to this project, thereby involving considerable expense, hence the high estimated pre-construction funding requirement of £6.2M. This does, however, seem inconsistent with NGET's response

[63] At a meeting with KEMA and Ofgem on 15 November 2010

to a KEMA question as presented in 2010_NG_NG_A004_v1 stating that "*The London scheme has lower than average [IPC] costs as this involves the upgrading of an existing route, i.e. there are not multiple routes to be considered*". Further clarification should be sought from NGET on this issue.

A.5 South-West (NGET)

A.5.1 Project details

There is limited additional export capacity out of the south west peninsula of England (i.e. Cornwall, Devon, Somerset, Dorset) and the investment driver(s) of this project relate to potential increases in generation capacity in the region, including new nuclear at Hinkley Point, offshore wind in the Severn Estuary and the potential for further gas fired generation (additional to that connected at Langage, near Plymouth). The purpose of this project is to enhance the export capacity from the south west into the wider transmission network.

The project involves establishing a new double-circuit route from Hinkley Point to Seabank (near Bristol). It entails:

(i) Uprating the existing Hinkley - Bridgwater 275kV circuit to 400kV;

(ii) Constructing a new 400kV double circuit overhead line (possibly with some cable sections) between Bridgwater and Seabank, of a total length approximately 60km, with an associated rearrangement of existing lines in the Bridgwater area;

(iii) Building a new 400kV sub-station at Hinkley Point;

(iv) Extending the existing 400kV Seabank sub-station; and

(v) Replacing the existing 275kV Bridgwater sub-station with a 400kV sub-station.

Item (iii) is specifically associated with new generation at Hinkley Point. The remaining items are generic, and would be required for any additional generation in south-west England.

The proposed project represents an increase of 1,750MW in the transfer capacity in the south west transmission network of England. There are no interactions with other projects assessed within this Report but the requirement is clearly dependent on the volume of

generation assumed to commission in the south west and the consequential potential export of power created.

Ofgem has approved funding for the pre-construction works for 2009/10 in relation to the overhead line project. In its submission NGET seek additional pre-construction for 2011/12 of £3.1M (bringing the total pre-construction costs for the overhead line project to £5.3M). Construction work on the project would be due to begin in 2012/13 with completion in 2022/23. NGET indicate a total cost (including all pre-construction works), in 2010/11 prices, for the whole project of £296M.

This expenditure from 2011/12 is summarised in the Table below.

Project (at 2010/11 prices)	2009/10		2010/11	Total Pre-construction cost	Construction cost	Total Cost
	Requested £M	Approved £M	Requested £M	£M	£M	£M
Bridgwater – Seabank new OHL	2.2	2.2	3.1	5.3	146.6	151.9
Hinkley Point substation works				5.7	88.8	94.5
Seabank substation extension				1.8	14.0	15.8
132 kV mitigation works				0.7	33.2	33.9
Total				13.5	282.6	296.1

A.5.2 KEMA Assessment

KEMA's headline assessment of the proposed South West project is summarised within the two tables provided below:

Benefit/capability provided	Critical dependencies	Interaction with other projects
This project provides 1.75GW of additional export capacity out of the South West area across boundary SW1	The key driver for this project is anticipated new generation in the South West, principally new nuclear generation at Hinkley Point and new CCGT generation; but also potential offshore generation of the Cornwall and Devon coasts.	None – stand alone

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● There is significant uncertainty regarding investment requirements for this project given its dependence on new generation connections which are expected to connect before 2020.	● Should the forecast generation in the South West materialise the scope of the project is reasonable.	● The same uncertainty over generation connection which impacts on certainty of need also makes the timing of this project highly uncertain.	● Where the project proceeds as proposed, the additional network capacity provided is highly cost effective at a cost of £163/kW.

The project is principally driven by expectations for new nuclear and CCGT generation in the South West – the level and timing of these are currently unclear, although during the last year the Government has announced that Hinkley Point is a suitable location for new nuclear build, and it is understood to be the prime candidate site for the first unit to be constructed. Hence the uncertainty surrounding the need for this project has reduced, although its timing is still uncertain. Where the project is required, the scope as proposed appears both a sensible and reasonable approach and the cost effectiveness of the project would be high (though it should be noted that, while it facilitates low-carbon generation, it probably facilitates less renewable generation than any other proposed project). Thus the project is anticipatory in nature but reasonable if it were decided that such anticipatory investment was justified.

The funding request for pre-construction work to support the consent process for the new overhead line is again related to IPC costs. NGET have provided a detailed breakdown of the forecast IPC expenditure in response to a question from KEMA (note 2010_NG_NG_A004_v1 refers) and the request seems reasonable. This project will potentially have a long lead time as it may involve a difficult consent process. KEMA's view is that Ofgem should support this process. It is important that obtaining consent for the line is not on the critical path for the construction of Hinkley Point C. KEMA is unable to support any

request for construction funding at this time, however since construction of the line is likely to be much faster than a nuclear build, the urgency to commence construction appears low.

A.6 Wylfa - Pembroke (NGET)

A.6.1 Project details

This is a new project – its requirement was not anticipated in either the ENSG report or in the 2009 submissions to Ofgem.

The main investment drivers for this project are the anticipated generation developments onshore and offshore in the North Wales area, particularly around Anglesey, encompassing:

(i) commissioning of Round 2 offshore wind farms in Liverpool Bay;

(ii) substantial volumes of Round 3 offshore wind farms expected to seek connection at or near Wylfa;

(iii) possible onshore wind farm developments in North Wales

(iv) potential replanting of the Wylfa nuclear site (the existing plant is now expected to close in 2012[64]); and

(v) ongoing presence of the Pumped Storage plant at Dinorwig and Ffestiniog.

The existing infrastructure in North Wales could be enhanced to give an export capacity of 6.5 GW[65]: this enhancement would include:-

(i) Second double circuit Wylfa – Pentir (proposed for commissioning in 2017/8)[66];

(ii) Second Pentir – Trawsfynydd circuit;

[64] Statutory Security of Supply Report, BERR/Ofgem, Nov 2010. Wylfa's life is now limited by the absence of fuel manufacturing facilities so further significant life-extensions are not possible.
[65] From ENSG Report
[66] 2010 Seven Year Statement, Table B7c.

(iii) Reconductoring of some circuits; and

(iv) Series capacitors (or similar) to remove stability limitations.

These reinforcements are shown in the figure below.[67]

Figure 13 – Reinforcements in North Wales to Permit Additional Generation to be Connected

NB: "Gwynt-y-More" should actually be Gwynt y Môr offshore windfarm. The proposed dc link to Ireland (terminating at Deeside) is not shown.

The proposed project is a DC undersea link from Wylfa to Pembroke. It would be required if the installed capacity in North Wales exceeded the export limit available after the above identified reinforcements have been completed.

The ENSG Report identified that, in the event of a large amount of generation (or quasi-generation, such as DC links) connecting in North Wales/Deeside, additional transmission capacity out of the group would be required. It was suggested that this should comprise a circuit from Trawsfynydd to the proposed new Mid-Wales sub-station (see A.6.1). As this would traverse significant upland areas of environmental sensitivity, including a significant length within the Snowdonia National Park, an underground HVDC link has been suggested.

[67] Taken from NGET Document "North Wales: Studies Update July 2010".

The Wylfa – Pembroke undersea HVDC Link is a potential alternative to the above proposition. Although considerably longer (the undersea length is estimated at 200km, as against around 80km for the underground option), the undersea technology could result in lower unit costs and in KEMA's view is clearly worth investigating.

NGET is seeking pre-construction funding of £0.5M for 2011/12. Further pre-construction funding is identified and, together with the envisaged construction, the total cost is forecast to be circa [redacted]. NGET have provided the following cost profile[68] for pre-construction and construction work.

(at 2010/11 prices)	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	Total
Pre-Const.	0.5	0.5	1.5	1.5	1.5	1.5	£7.5m
			2017/18	2018/19	2019/20	2020/21	Total
Construction			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

A.6.2 KEMA Assessment

The need for this reinforcement remains speculative, as it is predicated on a number of generation developments which may not transpire. KEMA's assessment is summarised in the following two tables.

Benefit/capability provided	**Critical dependencies**	**Interaction with other projects**
This project provides around 2 GW of additional export capacity out of the North Wales	The key driver for this project is anticipated new generation in North Wales, both new nuclear generation at Wylfa and onshore and offshore wind generation, together with the existing pumped storage plant of Dinorwig and Ffestiniog.	Likely to interact with other transmission projects within North Wales, and also with the West Coast dc link into Deeside.

[68] NGET Response 2010_NG_NG_A012_v1

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● There is high uncertainty regarding investment requirements for this project given its dependence on new generation connections which are expected to connect before 2020.	●● Should the forecast generation in North Wales materialise the scope of the project appears reasonable.	● The same uncertainty over generation developments which impact on certainty of need also makes the timing of this project highly uncertain. The project is proposed for completion after a number of significant on-shore reinforcements have been completed, hence is unlikely to be required until after 2020.	● In the event that additional reinforcement is required out of North Wales, this project is probably the most cost-effective.

Significant investment in the South Wales transmission system is required to cope with the new generation at Pembroke (2000MW gas), Rhigos (299MW windfarm) and Prenergy at Port Talbot (350MW biomass)[69]. It is therefore likely that an additional 2000MW effective generation at Pembroke will require further reinforcement to the Power System in South Wales.

As these reinforcements are expected to follow on from the land based reinforcements outlined above, and these are not expected to be completed until 2017 at the earliest, KEMA does not consider progression of this project to be urgent. However, NGET are only requesting funding for pre-construction works and, given that it is clearly a possible alternative which should be investigated, KEMA considers the funding should be approved. KEMA notes, however, that the forecast pre-construction activities will continue for a total of 6 years, much longer than the previously declared pre-construction phases for the Western HVDC Link (3 years) or the Eastern HVDC Link (4 years). While this discrepancy may warrant further clarification from NGET, KEMA nonetheless considers that investigation of the project is worthwhile. It should be stressed that KEMA's support for the pre-construction work should NOT imply that KEMA considers that the project will ultimately be justified.

[69] NGET TPCR4 rollover BPQ Paragraph 185.

A.7 Western HVDC link (NGET/SPTL)

A.7.1 Project details

The driver/purpose of this project is to substantially increase transmission capacity to enable output from forecast new renewable generation capacity in Scotland to be exported to England. The project consists of a [redacted] MW offshore HVDC link between Hunterston and Deeside requiring new 400kV substations (including AC/DC converter stations) to be built at both Hunterston and Deeside. This is shown in the diagram below with the other proposed projects for enhancing Scotland-England export capacity, namely the SPTL "SPTL-NGET interconnection" project and the NGET "Anglo-Scottish Incremental works" project (both of which are discussed further in section A.9 below) and the joint NGET/SHETL Eastern HVDC Link project (which is relevant here in consideration of the Western HVDC Link). Although not shown on the diagram, the project also relates to the SPT East-West Upgrade which is dealt with in section A.8 below.

Figure 14 – Illustration of the Western HVDC Link Route and other Associated Projects

NB The series capacitors in the Harker – Stella West route are not now propose for installation.

This new Western HVDC Link would provide substantial additional capacity between Scotland and England. It would also provide additional capacity across the upper North of England (Boundaries B7 and B7a).

The link as proposed is in addition to the increase in Scottish interconnector export capacity provided by the incremental SPT and NGET works. The Western HVDC Link represents a further step in the expansion of Scotland-England export capacity to meet increased generation in Scotland. Consequently, this investment is highly dependent on the volume and operational performance of new generation projected to locate in Scotland, counterbalanced by possible closures of existing generation.

Furthermore a potential Eastern offshore HVDC link of equal capacity has previously been identified (though an additional funding request for this proposed project has not been received by Ofgem in relation to 2011/12) to link Peterhead and Hawthorn Pit, with a further alternative route, which is both shorter and potentially lower cost, linking Torness and Hawthorn Pit. NGET views the Western HVDC Link as the preferred option for the expansion of Scotland-England export capacity after installation of the series and shunt capacitors in the two aforementioned NGET and SPT projects, i.e. it would precede the Eastern HVDC Link. Whilst the cost-benefits for the Western and Eastern HVDC links are similar (within 5-10%) if the timescale for implementation is ignored, NGET provided the following reasons to prefer the Western HVDC Link to the Eastern route as the 2nd stage B6 reinforcement:

(a) the Western HVDC Link is claimed to have a higher cost benefit than the Eastern HVDC Link in earlier timescales (between 2015 and 2020);

(b) generation sensitivity studies indicate that the Western HVDC Link appears more robust in earlier timeframes, however, by 2020 the Eastern HVDC Link is viewed as more robust; and

(c) there is greater route and project design certainty for the Western HVDC Link due to there being more uncertainty regarding both onshore and offshore generation on the eastern side of Scotland.

So far Ofgem has approved funding for the pre-construction works for 2009/10 for this joint NGET/SPT project and further pre-construction works are indicated to be required in 2011/12. Construction work on the project started in 2010/11 with the rebuilding of the Deeside sub-station (for which Ofgem approved expenditure in 2009/2010) and work on the entire project is due to be completed in 2017/18.

This is summarised in the table below:

[Table removed]

A.7.2 Cost Issues

In 2009 this project was forecast to cost around [redacted], of which just over £100M was for rebuilding Deeside substation. The cost is now projected to be in excess of [redacted], and this includes having accounted for a [redacted] reduction in the forecast costs for the Hunterston sub-station. The reasons provided by NGET for the cost increase of approximately [redacted] are split between the HVDC Link itself and the Deeside Sub-station. In relation to the HVDC Link the key changes are:

- [redacted]; and
- [redacted].

NGET identify a number of other changes (such as allowances for cable crossings and increases in the converter station costs) but critically they note that "*in providing a revised forecast it must be recognised that there still remains significant uncertainties with respect to the final prices until we have signed and agreement with the selected supplier*". [redacted]

In relation to Deeside sub-station, the costs have increased by 40%. NGET have identified these cost increases as arising for the following reasons:

- (a) Further costs associated with migration of the circuits which had not previously been fully considered - £7.6M;
- (b) Costs for two new circuit breakers required for the connection of the DC Link that had previously been omitted - £6.2M;
- (c) Additional civil works, identified from detailed site investigations and presumably influenced by the additional works specified in (a), (b), (d) and (e) - £5.3M;
- (d) Costs for two new transformers (where previously it had been assumed the two newest of the existing transformers could be re-used but further investigation concluded this was not possible. NB the prospect for relocating these removed transformers is recognised but no financial allowance is made) - £4.9M;
- (e) Re-routing of the 132kV cables for the above transformers - £2.1M; and
- (f) An increase in manpower costs associated with all of the above - £5.0M.

The above accounts for £31.1M with the remaining cost increase of £10.4m (25% of the additional cost) resulting from smaller line items. As with the additional costs for the HVDC Link itself, these additional costs have been identified through further detailed work and therefore it is assumed that there remains further uncertainty in the final costs which could result in further increases. [redacted]

A.7.3 Timing Issues

NGET state that they are intending to issue an Invitation to Tender shortly, with contracts to be placed in November 2011 and full commissioning of the link due by the end of 2015.

NGET state that the reinforcement is needed (on cost-benefit grounds) by 2015, and that an Eastern route could not be commissioned before 2017. KEMA remain to be convinced by NGET's argument given the linkage with Boundary B7a (see section 5.1.3) and consider that the link is not necessarily required from 2015.

Therefore, it is KEMA's view that whilst the commencement of construction for the Western HVDC Link in 2011/12 can be justified for a particular set of input assumptions, there also appears to be limited project delivery and renewable deployment downside risk associated with conducting further analysis in 2011/2012.

A.7.4 Implications on NGET Network

In 2009, we stated that "*For the Western HVDC link, KEMA also believes there could be potential knock-on reinforcement works south of Deeside (especially arising with potential interactions with the North Wales scheme (9.14) and a proposed interconnector with Ireland connecting at Deeside)*".

The NGET system across the boundary to the west of the Pennines consists of two L2 double circuits (Deeside – Treuddyn – Legacy – Ironbridge) and Daines – Macclesfield – Cellarhead – Drakelow). These circuits are already, potentially, operating near their limit as evidenced by the installation of quadrature boosters. This part of the network will be even more heavily loaded if new generation in North Wales (new nuclear at Wylfa, or offshore wind in Liverpool Bay) is built.

On the other hand, the network across this boundary to the east of the Pennines is stronger. The relevant circuits are of L6 or L12 (heavy duty) construction, with a greater capacity than the L2 circuits to the west of the Pennines. There are 4 circuits between Teesside and Yorkshire (compared with only two on the west coast) and, south of Yorkshire, additional capacity could be easily created if necessary by uprating the underutilised Thorpe Marsh – Brinsworth –Chesterfield – High Marnham route, most of which currently operates at 275kV. The Humber project discussed earlier may give additional capacity across this boundary to the east of the Pennines.

A.7.5 Capacity out of Deeside/North Wales

In response to queries from KEMA, NGET have provided detailed load-flow information[70]. This shows a capability out of North Wales/Deeside[71] of 7.1GW[72]. This capability will be significantly lower outside winter.

There is about 1025 MW of demand in the North Wales/Deeside group[73], hence the system can cater for a capacity of about 8100 MW in North Wales/Deeside.

The table below shows the existing and possible future generation in North Wales/Deeside[74].

[70] NGET Response 2010_NG_NG_A016_v1 and revision provided on Dec 24.

[71] Comprising the substations Wylfa, Pentir, Trawsfynydd, Dinorwig, Ffestiniog, St. Asaph, Deeside and Legacy

[72] With an export from Deeside of 6.6GW, the loss of the Deeside – Daines double circuit results in the Legacy – Shrewsbury/Ironbridge circuits being loaded at 93% of their capability.

[73] Data from 2010 Seven Year Statement, Table E1.6

[74] NGET states that this represents the "Gone Green" scenario for 2020.

Power Station	Type	Capacity	Status
Dinorwig	Pumped storage	1096[75]	Existing
Gwynt y Mor	Offshore Wind	500[76]	Consented
Connah's Quay	CCGT	1380	Existing
Deeside	CCGT		Existing
Shotton Paper	CCGT/CHP	210	Existing
Wylfa	New Nuclear	3300	Proposed
Irish Sea Wind	Offshore Wind	1500	Proposed
Anglesey Aluminium Biomass	Biomass	299[77]	Proposed
EirGrid Link		500	Under construction
	Total	**8790**	
Hunterston – Deeside dc link		[redacted]	
	Grand Total	[redacted]	

Deeside (250 MW) assumed closed in GG scenario?

This is a total of [redacted] MW, i.e. if all the generation is 100% available there will be 2900 MW of constraints. For constraints to reduce to zero would require the generation to be running at 74% (and less in summer). At times of high wind output it is therefore likely that there would be significant constraints on the system.

KEMA is therefore concerned that, if the Western HVDC Link is built, this will trigger further transmission reinforcement across the North – Midlands boundary (Boundary B8), in future. This reinforcement could be the proposed Wylfa – Pembroke HVDC Link. Effectively NGET/SPTL would be building a Hunterston – Pembroke undersea link. If the Eastern HVDC Link was built then these costs would not be required (or at least, the requirement would be delayed). We therefore believe that these issues make the Eastern HVDC Link worthy of further consideration.

Accordingly, KEMA considers that there is a significant risk that constructing the Western HVDC Link will result in additional investment requirements on the NGET transmission system in England (or Wales), requirements which would be less likely to be required (or required significantly later) if the Eastern HVDC Link was to be built.

[75] 4 units assumed

[76] NGET Response 2010_NG_NG_A016_v1 gave a value of 500 MW. However, the correct value is thought to be 735 MW.

[77] Not in "Gone Green" scenario.

A.7.6 Headline Assessment

KEMA's headline assessment of the proposed Western HVDC link project is summarised within the two tables provided below:

Benefit/capability provided	Critical dependencies	Interaction with other projects
[redacted]MW extra capacity across boundaries B6 and B7a.	Project depends on assumed overall volume and operational performance of Scottish renewable generation connecting by 2020, counterbalanced by closure of existing plant. Key justification provided by cost benefit analysis (CBA) of project costs versus reduced constraints costs.	The Eastern HVDC link is an alternative project.

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● There is reasonable likelihood that B6 capacity will need to be expanded from 4.4 GW but some uncertainty remains concerning the date of any such requirement. The need case is dependent on the amount of new generation to be installed in Scotland (offset by generation closures), and CBA modelling assumptions.	● The scope is reasonable should additional capacity over and above 4.4 GW be required, and should the western link be preferred to an Eastern link.	● The commencement of construction for the Western HVDC Link in 2011/12 can be justified for a particular set of input CBA assumptions. However there also appears to be limited cost or delivery downside risk associated with conducting further analysis in 2011/2012 with a view to commencing construction in 2012/13.	● In absolute terms, this project is requires considerable network investment, costing [redacted] (inc Deeside) for an additional 2000 MW of transfer capacity. However, the unit cost baselined according to incremental capacity provided and geographic distance is not excessive. Some uncertainties remain regarding the accuracy of cost estimates which can be addressed through a tendering process.

Whilst KEMA can see the logic of the NGET/SPT proposals, uncertainty remains whether the Western HVDC Link is superior to the Eastern HVDC Link as the better option for creating additional export capacity across the Scottish border. The Western and Eastern HVDC Links are subject to different implementation issues (planning and routing complexities for example for the Western HVDC Link vs. project design option uncertainty for the Eastern HVDC Link).

The Western and Eastern HVDC Links also have differing relative merits with the Western HVDC Link potentially better addressing the pattern of renewables expected to connect earlier in the period out to 2020; whilst the Eastern HVDC Link better addresses the longer term pattern of renewables after 2020 and potentially provides a viable alternative (and greater) capacity expansion for Boundary B4 to that provided by the East Coast upgrade (see ENSG Report).

Doubt remains around the optimum timing of this project. The CBA is sensitive to a number of key assumptions, and KEMA is concerned that the assumptions adopted overstate the project benefits (see section 5 above). Based on a particular set of input assumptions, the Western HVDC Link can be justified to commence construction in 2011/12, there also appears to be limited project delivery and renewable deployment downside risk associated with conducting further analysis in 2011/2012 with a view to commencing construction in 2012/13.

During 2011/2012 NGET/SPTL plan to complete a tendering process to appoint vendors for the construction of the Western HVDC Link. This tendering exercise is scheduled to complete in late 2011. Therefore, it appears that construction funding for the Western HVDC Link relates to the latter months of the 2011/12 financial year. KEMA believes that initiating this tendering process in 2011 represents a sensible means of reducing project cost uncertainty and therefore should progress as planned.

KEMA therefore considers that:-

a. If there is a requirement to provide more than 4.4 GW capacity across Boundary B6, then an undersea link is appropriate;
b. Based upon variations to key input assumptions, this requirement to complete the Link before 2015 may not be justified.

In KEMA's view there is sufficient evidence that an alternative view of key input assumptions reduces the urgency to commence construction of the Western HVDC Link in 2011/12. KEMA considers that NGET a period of further review of the various scheme options, assumptions and costs will be beneficial; and that the implications for transmission out of Deeside identified by KEMA can be adequately addressed and is necessary before Ofgem should allow the construction expenditure to proceed.

KEMA concludes that whilst the commencement of construction for the Western HVDC Link in 2011/12 can be justified for a particular set of input assumptions, there also appears to be limited project delivery and renewable generation deployment risk associated with conducting further analysis in 2011/2012.

A.8 Anglo-Scottish Schemes - East-West Upgrade (SPT)

A.8.1 Project details

The driver of this project is the predicted volume of new renewable generation in Scotland and the consequent power flows through the Scottish network. The purpose of this project is to minimise series and shunt compensation requirements in the related SPT project "SPT - NGET interconnection" and NGET project "Anglo-Scottish incremental works". Taken together, these investments will enable the Scottish Interconnector circuits to provide 4.4 GW transfer capacity between Scotland and England – an increase of 1.1 GW.

The project consists of:

(i) Upgrading the northern side of the Strathaven-Wishaw-Kaimes-Smeaton double circuit overhead line route from 275kV to 400kV;

(ii) Installing a new 400 kV substation at Wishaw;

(iii) Rearranging the overhead line configuration at Kaimes; and

(iv) Installing a second 400kV cable (per phase) on each of the Torness-Eccles 400kV circuits.

The total cost is circa [redacted] outlined in our 2009 report.

The purpose of the East-West upgrade is to complement the design of the proposed series and shunt compensation projects so that, together, they increase the capacity of the Scottish Interconnector circuits from 3,300 MW to 4,400 MW. SPT has also indicated that the Torness-Eccles route represents a key constraint to potential transfers across the B6 boundary and regardless of the two Series Compensation projects would restrict capacity to 3.4 GW, i.e. only 100 MW above the 3.3 GW currently being implemented.

Again, the key dependency is the volume of new renewable generation forecast to locate in Scotland and the performance of such generation, counterbalanced by closures of existing generation in Scotland driving increased powers flows south through the Scottish network towards England.

Prior to 2009 Ofgem approved the full pre-construction works for the period 2009/10-11/12 for additional funding. Construction work on the project is due to begin in 2011/12 with completion in 2015/16.

This is summarised in the table below.[78]

[Table removed]

A.8.2 Cost Issues

KEMA's initial review of the cost data for this project suggested that the costs were, in a number of places, higher than would be expected. [redacted]

Overall, KEMA has concerns that the cost of the Wishaw GIS substation investment appears high and therefore proposes a reduction of [redacted] for this project unless further information can be sourced from SPT.

[78] Details provided by SPT on 9th January 2011. (Alan Michie email).

A.8.3 Headline Assessment

KEMA's headline assessment of the proposed East-West upgrade project is summarised within the two tables provided below:

Benefit/capability provided	Critical dependencies	Interaction with other projects
In isolation it is indicated to provide 200 MW extra capability. However there is an interaction with the SPTL and NGET series and shunt compensation projects which means this project should be considered as a package of investments delivering 1.1 GW expansion of B6 capability.	Project depends on assumed overall volume of Scottish renewable generation connecting by 2015, less the conventional and nuclear plant closed (or becoming out of merit). The key justification for this project is provided by the NGET Cost-Benefit Analysis	The project design interacts with the NGET/SPTL series and shunt compensation projects.

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● There is reasonable certainty that B6 capacity will need to be expanded beyond 3.3 GW by 2015.	● The scope appears reasonable although it should be noted that in order to deliver the full range of benefits, this scheme must be considered with the other Anglo Scottish interconnection and incremental schemes.	● Given the dependence on key assumptions within the CBA relating to generation and its performance; as well as constraint costs which influence project scheduling, there is limited uncertainty regarding the timing of this project.	●● Whilst some cost items for this scheme appear expensive (e.g. Wishaw substation), the scheme interacts with other B6 upgrade schemes suggests it should be considered within an overall package of schemes to deliver 1.1 GW at a cost of c. £316/kW.

NGET has confirmed that the East-West upgrade project in the SPT region is part of a package of measures associated with upgrading the capacity of the Scottish interconnector circuits to 4400 MW, and represent the most cost-effective way of achieving this capacity.

It appears that there is a need to increase transfer capacity across the B6 boundary from 3.3 GW and that this project, together with the NGET/SPTL interconnector project (see below) is justified. On this basis, the general scope and timing of this project appears reasonable.

A.9 Anglo-Scottish Schemes - SPT-NGET interconnection (SPT) and Anglo-Scottish Incremental (NGET)

A.9.1 Project details

These two projects are considered together given their level of interaction.

Prior to 2009 Ofgem approved the full pre-construction works for the period 2009/10-11/12 for additional funding. Construction work on the project is due to begin in 2010/11 with completion in 2015//16.

The project consists of three parts:-

(i) Installation of 2 series capacitors on the Harker - Hutton - Quernmore 400kV circuits in north west England, and 6 series capacitors in Scotland: 4 on the western route at Strathaven (2 x 120MVar), Gretna (1 x 290MVar) and Moffat (1 x 290MVar) and 2 on the eastern route at Eccles (2 x 290MVar). The size and location of the capacitors has changed slightly from that planned in 2009, the result of design optimisation;

(ii) Installation of shunt capacitors at Harker, Hutton and Stella West in England, and at Cockenzie in Scotland; and

(iii) Reconductoring of each of the Harker to Hutton and Hutton to Quernmore Tee 400kV circuits.

Additional funding in 2011/12 is requested for part (i) only.

The costs are summarised below:

Project (at 2010/11 prices)	2009/10		2010/11	Pre-construction 2009/10 on	Total Construction cost	Total Cost
	Requested	Approved	Requested			
	£M	£M	£M	£M	£M	£M
SPT Capacitors (series and shunt)	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NGET shunt capacitors	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
NGET Series Capacitors	1.5	1.5	0	1.5	36.1	37.6
Reconduct of Harker – Hutton - Quernmore	1.5	1.5	0	2.4	102.0	104.4
Total				5.5	316.5	322.0

The construction expenditure is spread over the years 2011/12 to 2015/16.

The driver/purpose of this project is to enable the full thermal capacity of the Anglo-Scottish Interconnectors (4,400 MW) to be realised by relieving the existing substantial stability constraints which otherwise limit the export capacity to circa 3,300 MW and thus deliver circa 1,100 MW extra export capacity between Scotland and England.

The key dependency is the capacity and operating performance of new generation projected to connect in Scotland and the anticipated generation patterns within Scotland, offset by planned closures.

This project is also linked with the SPT East-West upgrade project (see the previous section - A.8): both are needed to obtain the full capacity out of the system. In terms of timing, these interconnector upgrade works are scheduled to precede the proposed offshore HVDC Link discussed in Section A.7 earlier.

A.9.2 Sub-Synchronous Resonance

A concern arising from the use of series capacitors is that there is a risk that sub-synchronous resonance (SSR) can occur. The installation of the shunt capacitors is not affected by SSR issues.

NGET have stated that, in the event that the studies to be commissioned in 2011 indicate a potential problem, the solution could be:-

- Installing more, smaller series capacitor units;
- Introducing a thyristor control system.

Thyristor control units could be retrofitted accordingly.

In the event that an SSR problem is detected, and it cannot be solved with thyristor control systems, there is a risk that the installation of the series capacitors will need to be revisited. KEMA's view is that the project can go ahead provided that any equipment contracts take this risk into account.

A.9.3 Detailed Design Issues

The project includes a 275 kV shunt capacitor at Cockenzie, which is needed to provide voltage support according to SPT.

The south Edinburgh 275 kV system was originally designed around Cockenzie Power Station, with the intention of providing power from Cockenzie to the city. There are three sub-stations (Currie, Kaimes and Smeaton) within 10 miles. With the closure of Cockenzie Power Station the sub-station at Cockenzie becomes much less important, and KEMA sees an opportunity to rationalise this network, with further upgrading of parts of the system to 400 kV. KEMA is concerned that installation of new capacitor equipment at 275 kV will militate against future rationalisation (by perpetuating the 275 kV network), or alternatively will result in stranded assets. It is likely that installation of the capacitor at Cockenzie is the cheapest option in terms of first cost, but may not be optimal in the long term.

Ideally, KEMA would therefore like to see some more detailed analysis – including a long-term strategic plan for the South Edinburgh network - to provide sufficient persuasion that the Cockenzie capacitor is, in fact the best solution.

KEMA understand that, in the light of our comments, SPTL are re-evaluating the position but it is likely that any change in design would have an adverse effect on the overall project delivery timescales, resulting in additional constraint costs and outweigh any long-term savings.

KEMA would, however, like to emphasise that we consider this to be a detail design issue, and debate about this does not invalidate the overall project.

A.9.4 Headline Assessment

KEMA's assessment of these proposed SPT-NGET interconnection projects is summarised in the two tables below:

Benefit/capability provided	Critical dependencies	Interaction with other projects
This project provides 1.1 GW further transfer capability across boundary B6, removing any stability limitations and ensuring that the maximum use is made of the existing infrastructure. However, there is an interaction with the East-West project which means this capacity increment would not be achievable if this project were to proceed in isolation.	Project requirements depend on assumed (i) overall volume of Scottish generation connecting by 2015, and (ii) impact on conventional generators. The key justification for this project is provided through the CBA undertaken by NGET.	This project interacts with the SPTL East-West Project.

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● There is reasonable certainty that B6 capacity needs to be expanded from 3.3GW by 2015.	● In 2009, both NGET and SPTL indicated that there remained some scope/project design refinement to be undertaken. Nearly all these issues have been resolved, resulting in minor cost savings. The scope appears reasonable and relevant interactions have been properly considered.	● Given the dependence on key assumptions within the CBA relating to generation and its performance there is some uncertainty over the timing of this project. KEMA also notes that the proposed 2011/12 works are timed to coincide with another local outage to seek to avoid potential high (£20m) constraints costs.	● (SPT) / ● (NGET) The interaction with other B6 upgrade schemes suggests it should be combined with the SPTL East-West project to deliver 1.1GW at a cost of c. £316/kW.

There will probably be a need to increase transfer capacity across the B6 boundary from 3.3 GW and this project, together with the SPT East-West project is therefore justified. On this basis the scope and timing of this project appears reasonable.

A.10 Beauly-Mossford (SHETL)

A.10.1 Project details

Two single circuit 132 kV transmission lines run north-west from Beauly up Strathconon to Garve and Grudie Bridge. Their current purpose is to connect up a number of hydro stations in the Conon system (Grudie Bridge, Achanalt, Mossford, Luichart, Orrin and Torr Achilty, a total of 118 MW). The thermal capacity of each line is 106 MVA(summer), 117MVA (spring/Autumn), and 132 MVA (winter). In addition the line serves customers in a large part of North-West Scotland, but the demand is low (about 2MW).

Recently Fairbairn Wind (42 MW at Orrin), has been connected to the system, and this has resulted in this part of the system becoming non-firm, i.e. it does not (by agreement with the Generators) comply with the GB SQSS.

There are a number of additional generation plants planned for the area, but the two most significant are Loch Luichart Wind (66 MW at Loch Luichart) and Corriemoillie Wind (22 MW at Mossford). The first of these has consent (and the developers are reported to be keen to

proceed) while the second is subject to consent (a revised application was made on 6 October 2010). However, with the existing generation the transmission system does not meet the GB SQSS, and any additional generation will exacerbate the problem.

The system is not compliant with the GB SQSS in two areas:

(i) There is insufficient capacity between Mossford and Beauly,
(ii) The system design is too complex, with many isolation facilities on separate sites (most generation is simply connected to the overhead line by a simple tee connection).

Issue (i) is to be resolved by rebuilding the existing overhead lines.

Issue (ii) requires the two 132 kV circuits to be bussed up, and by doing this at Mossford SHETL can both provide a connection site for Loch Luichart windfarm, and also resolve the circuit complexity issue with a single solution.

The proposal, therefore, is to replace the existing two single circuit light duty 132 kV overhead lines with a single heavy duty 132kV double circuit overhead line, of length about 30 km.

The estimated cost is £13.1M (2010 prices). However this only represents the costs associated with the new substation at Mossford, and omits the costs of rebuilding the circuits to Beauly (costing a further £34.8M, making £47.9M in total). This expenditure is summarised in the Table below.

Project (at 2010/11 prices)	2009/10		2010/11	Pre-construction 2009/10 on	Total Construction cost	Total Cost
	Requested	Approved	Requested			
	£M	£M	£M	£M	£M	£M
Mossford Substation	-	-	13.1	-	13.1	13.1
OHL Rebuild					34.8	34.8

SHETL state that they have examined a number of alternatives, but they are all more expensive.

A.10.2 KEMA Assessment

The system is already operating non-firm (i.e. outside the GB SQSS) and the position will not improve as additional generation is connected to the system. The need for the project is proven. With the Beauly – Denny project achieving consent, there is little risk, in the long term, that the generation will be constrained by transmission restrictions further south.

There is a potential interaction with the proposed HVDC cable connection to the Western Isles. The route of this cable closely follows the existing (and proposed) overhead line. There would therefore be potential cost savings if the Beauly – Mossford route was rebuilt at 275 kV. Any connection to Lewis could then terminate at Mossford with associated savings. It would be necessary to replace transformers at Orrin and Luichart substations. In the event that the Lewis link did not go ahead the cost would be greater, but with the Lewis link the overall cost would be reduced.

However, the route runs through the Highlands and a 275 kV overhead line is larger and more bulky than a heavy duty 132 kV overhead line; there may be significant objections to a 275 kV overhead line. There may also be objections to constructing a converter station at Mossford.

If this option was to be adopted, then most of the 132kV substation would still be required, so this would be unlikely to result in significant stranded assets.

Benefit/capability provided	Critical dependencies	Interaction with other projects
Enables connection of Loch Luichart wind farm (and possibly other wind farms). Ensures system complies with GB SQSS.	Loch Luichart windfarm proceeding. Also some dependency on obtaining consent to rebuild the overhead lines	None – stand alone

Certainty of need	Reasonableness of scope	Certainty of timing	Cost effectiveness
● The line is already at full capacity and outside of SQSS so need is clear. Extra generation will increase requirement for this investment.	● Scope seems appropriate for the requirement.	●● Planned timing is appropriate. No reasons to delay. However, consents for substation still required.	● Considered to be least cost approach to comply with SQSS.

This project is being proposed under the "Connect and Manage" regime. This requires Transmission Operators to connect generators to the system as soon as practicable, even if the associated infrastructure cannot be completed to the same timescales.

There are two minor items of concern: firstly, SHETL is seeking permission to spend £13M on the substation without consent for rebuilding the overhead lines, with the risk that the substation assets would become stranded. However it is understood that the sub-station provides stand alone benefits in respect of switching the connected hydro stations and therefore the linkage to the overhead line (for which funding for 2011/12 has not been requested) can be discounted. The second is that SHETL believe that the new substation would require the line entries from the Grudie Bridge circuits to be cabled (at a cost of £1.26M); this requirement has not yet been justified and it is possible that an overhead line connection could be achieved.

SHETL have put forward a cost-benefit argument to show that the substation is economic. However, this CBA only examines the local constraints, and ignores wider system constraints: these could be considerable until the Beauly – Denny project is completed in 2014. As a consequence KEMA discounts the cost-benefit arguments advanced to support the project, but considers that the SQSS drivers are sufficient**.**

APPENDIX B UNDERSEA DC CABLE TECHNOLOGY AND COSTS

The TO's have submitted two projects for undersea DC cables. This Appendix provides additional summary information regarding the economics and performance of this technology to further inform Ofgem.

Long underwater AC cable projects are not technically feasible. A DC undersea cable with a capacity of around 2000 MW costs (according to NGET) around [redacted]. By comparison an overhead line with a capacity of 4000 - 5000 MW costs around £0.8M/km[79], i.e. the undersea cable is about [redacted] the unit cost of an overhead line. By comparison, an underground AC cable with a capacity of 2000MW costs around £7M/km[80], or about 9 times the unit cost of an overhead line.

The undersea cable is therefore considerably cheaper than an underground cable of an equivalent capacity. The reasons for this are as follows:

- DC cables are cheaper than AC cables (for the same capacity);
- the length of each individual section of underground cable is limited by the amount of cable that can be transported by lorry, and this is around 1 km for a 2000MW capacity cable: this means that expensive (and potentially unreliable) cable joints are needed every 1km. Undersea cables are transported on purpose-built cable-laying ships, which can transport individual section of length several tens of km;
- Underground there are many obstacles to be crossed (roads, railways, rivers, other utilities); there are fewer obstacles undersea;
- Care needs to be taken over the installation of an underground cable, as it is important that the backfill material has a high thermal conductivity even in drought conditions: undersea the backfill material is permanently wet, so such considerations are much less important; and

[79] Value taken from Report "A Generic Comparison of the use of ac underground cable as an alternative to overhead line" by PB Power. Evidence given at the Beauly – Denny Inquiry (reference APL 5/14).

[80] Value taken from Report "A Generic Comparison of the use of ac underground cable as an alternative to overhead line" by PB Power. Evidence given at the Beauly – Denny Inquiry (reference APL 5/14).

- The ground needs to be reinstated for an underground cable (e.g. topsoil replaced): this is not necessary for an undersea cable (although the undersea cable does usually need to be trenched to prevent damage from dragging anchors or fishing trawls).

However, although the undersea cable itself is only around [redacted] as expensive as an overhead line (for the same capacity), additional costs are involved in installing AC/DC converter stations which are required at both ends of the cable. As these are fixed costs, this militates against short lengths of undersea DC cable.

APPENDIX C ALTERNATIVES TO THE WESTERN HVDC LINK

The 2009 ENSG report identified two alternative reinforcements to provide transfer capacity beyond 4.4 GW, namely a west coast undersea route from Hunterston to Deeside, and an East Coast Route for Peterhead to Hawthorn Pit. This ENSG report indicated qualitatively that the west coast route was regarded as better in the early years but the east coast route has advantages later. Whilst the overall argument to construct a HVDC link was persuasive, the selection of the west coast route in preference to the east coast route was finely balanced.

At the end of 2009 KEMA assessed the investment drivers for the west coast route. At that time KEMA concluded that whilst the concept of an undersea route was supported, we were not fully convinced that the west coast route was preferable to the east coast route. KEMA identified a third option, from Torness to Hawthorn Pit, that might also be a cost effective option, also enhancing the capacity across Boundary B6.

NGET's 2010 analysis has focussed upon the West Coast route. Broader analysis could have investigated land-based ac options to confirm practicability. Considering the size of the overall investment, KEMA believes it to be important for NGET to evaluate all options to confirm that the Western option represents the optimal solution.

KEMA's concerns over the west coast route are twofold. Firstly, it may be possible that a shorter, east-coast option is available by locating the converter stations at Torness and Hawthorn Pit, and we believe that NGET should evaluate this option further.

Secondly, KEMA considers that construction of the Western HVDC link would entail a significant risk that it would "move the bottleneck" south and will require additional investment in North Wales or North-West England in the following 10-15 years to provide additional capacity south of the Wylfa/Trawsfynydd/Deeside/Legacy group. This additional capacity could potentially be represented by the proposed Wylfa – Pembroke undersea HVDC link. This requirement would arise if significant generation capacity is connected in North Wales or North-West England: this could be either new nuclear generation on Anglesey, or offshore wind in Liverpool Bay (or a combination of the two). However, KEMA considers that an east-coast route could potentially avoid requirements for such additional transmission investment.