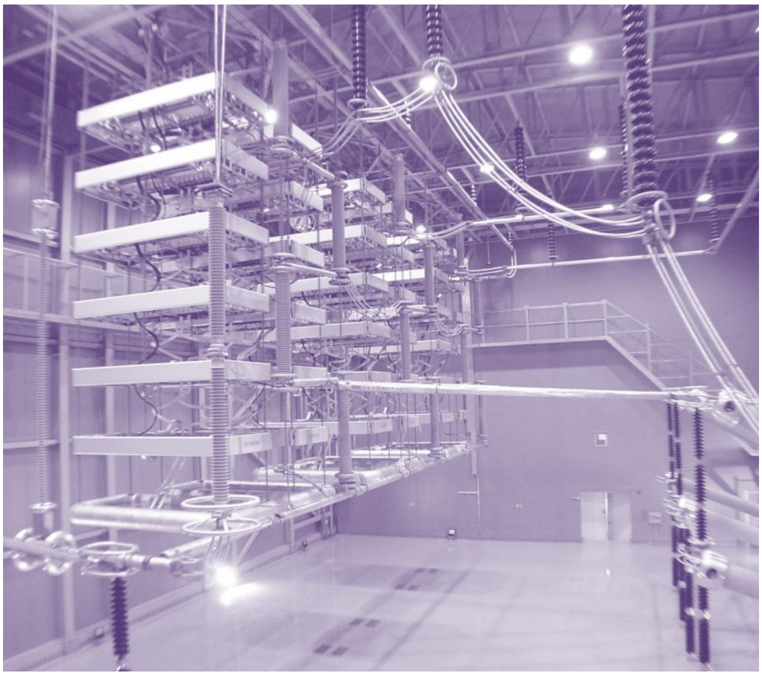
Independent Review of Funding Request for Western HVDC Link



STAGE 1: NEED CASE

- Final - Public version
- 1 August 2011

Commercially sensitive content has been removed for the public version of the report.

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Sinclair Knight Merz
13th Floor, Cale Cross House
156 Pilgrim Street
Newcastle upon Tyne
NE1 6SU
United Kingdom
Tel: +44 191 211 2400
Fax: +44 191 211 2401
Web: www.skmconsulting.com

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1. Executive Summary

Sinclair Knight Merz was jointly appointed[1] by NGET/SPT Upgrades Limited and Ofgem to act as independent reviewer of the joint NGET/SPTL funding submission to Ofgem in relation to the Western HVDC link between Hunterston in Scotland and Kelsterton in North Wales (Connah's Quay, Deeside). The Western HVDC link project comprises three components:

- An HVDC cable, of capacity circa 2GW and about 400km in length, together with converter stations at each end
- Onshore works around the northern connection point, near Hunterston 400kV substation in SPTL's area
- Onshore works around the southern connection point, near Deeside 400kV substation in NGET's transmission area

The current funding request relates specifically to item a) above, as the TOs are seeking to award a contract for this work in December 2011

Ofgem established a two stage process to cover various aspects of the funding request in March 2011[2]. This report covers the outcome of our analysis associated with Stage 1 of the review covering scope need and timing of the Western HVDC link project, and also an assessment of the planned process towards contract approach.

NGET/SPTL is currently undergoing a tender evaluation process for the proposed Western HVDC project. The tender documentation indicated a range of potential link capacities ranging from 1.8GW to 2.2 GW to facilitate competition between manufacturers and technologies. NGET/SPTL's construction programme indicates an expected delivery date of December 2015 assuming contracts can be formalised with the preferred bidder by the end of 2011.

The latest estimate cost of the project is [redacted] of which [redacted] relates to the HVDC cables and coverters costs with the remainder [redacted] [3] relating to additional onshore works in Hunterston and Deeside substations associated exclusively with the Western HVDC link. NGET indicates a cost tolerance at this stage of [redacted] for the cables and converters. Assuming a

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[1] SKM were appointed jointly by Ofgem and NGET/SPTL Upgrades Ltd to undertake an independent review of the TO submissions under an arrangement of "duty of care" to Ofgem

[2] Ofgem. "Transmission Investment Incentives. Supplementary document to decision letter of 21 January 2011", Ofgem website, 1 March 2011

[3] Based on information provided by the TOs which has not been reviewed by SKM at this stage but will be further considered in Stage 2.

similar range for the substation works it would indicate a potential project cost of up to [redacted].

In reviewing the evidence and information provided by the NGET/SPTL submission we have considered the following main areas:

- The evolution of the generation background as key driver to the reinforcements
- The requirements from the network planning standard.
- The analysis of net costs and benefits streams derived from the investment.
- The impact on key sensitivities on the results obtained using the above.
- Other non-monetised risks and benefits
- The process towards contract award

The main areas above are briefly described below.

1.1. Generation background

The most critical driver underpinning the 'need' for the Western HVDC link is the anticipated development of generation in Scotland, in particular the growth renewable generation. NGET/SPTL used three generation scenarios to assess the 'need' for the link (Slow Progression –SP-, Gone Green –GG- and Accelerated Growth –AG-). The GG scenario was originally developed through work with the ENSG and, updated, has subsequently formed the basis on NGET's Offshore Development Information Statement (ODIS)[4] alongside other scenarios (SP and AG) developed as variations to Gone Green. The scenarios have been subject to industry consultation for the purpose of ODIS and seek to capture a credible range of outcomes for growth of offshore generation across GB while reflecting different rates of progress to 2020 targets. We sought further information from NGET on the detailed composition of these scenarios in order to explore in more detail whether they reflect an appropriate range of variation in the specific drivers of the Western HVDC link for the purpose of this assessment."

During the course of the review NGET presented analysis for three different versions of these scenarios:

1) The April 11 submission used 2010 ODIS
2) Later updates used May11 scenarios as submitted for 2011 ODIS

[4] http://www.nationalgrid.com/uk/Electricity/ODIS/

3) June 11 scenarios developed as “reworked” versions of May11 scenarios based on bottom up analysis of generation development in Scotland as a key driver of this specific reinforcement

It should be noted that the June 11 scenarios are specific to this analysis and while developed from the May11 ODIS scenarios they are not the same as those consulted on by NGET for the 2011 ODIS.

SKM considers that the scenarios are defined by key characteristics:

- NGET’s ‘middle’ scenario (Gone Green-GG-) is driven solely by the requirement to meet the government’s 2020 renewable target and NGET’s assumptions of the contribution required in the electricity sector.
- NGET’s lowest scenario (Slow Progression –SP-) more accurately reflects outturn development over the period 2008/9 to 2011/12.
- The highest scenario (Accelerated Growth –AG-) shows an implausible rate of short term renewable growth in Scotland.

The generation scenarios that NGET/SPTL included in their initial submission for this review were based upon dated (2008/9) and some inaccurate information. An update of the data used in the scenarios showed that NGET/SPTL’s Gone Green scenario had anticipated a significantly higher rate of renewable growth than actual outturn development over the period 2008/9 to 2011/12. In our view NGET’s scenario (GG) represents a highly optimistic view of renewable development growth in Scotland.

By 2020, SP and GG scenarios show little divergence in their assumed installed onshore wind capacity in Scotland with the GG scenario being only 8% higher than the SP scenario. SKM considers that NGET’s scenarios do not fully take into account a wide range of uncertainties influencing renewable development that may plausibly result in a lower rate of renewable generation growth in Scotland. We note that some commentators and reports have indicated differing views and concerns about the low renewable growth towards 2020. Also the initial scenarios that NGET submitted had fairly conservative assumptions about the life extension of Hunterston nuclear power station which, given its high utilisation, has a significant impact on flows and hence boundary constraints (B6).

In addition to correcting some of the initially submitted scenarios using a bottom up approach that led to the June 2011 scenarios, SKM considered that the NGET/SPTL study needed to evaluate also the impact of assuming a lower renewable growth in Scotland to improve the robustness of the need case for the Western HVDC link. In order to evaluate the impact on the need case, and particularly on the timing of the Western link of the above issues, some additional sensitivity analyses were also requested to explore plausible ‘downside’ renewable development. The sensitivity analyses takes into account market uncertainties affecting renewable and thermal generation development in Scotland that may then require greater contributions from other sectors than assumed by NGET to meet the UK 2020 renewable target.

1.2. Network Planning Standard requirements

NGET/SPTL's submission included an assessment of the current capacity of the key boundaries and the impact of the three generation scenarios on transfers. The analysis also showed the increase in boundary capability resulting from the sequential addition of the Western and Eastern HVDC links. The boundaries presented included those covered by the Western HVDC link; B6, B7, B7a and B8 based on the current SQSS as applied by NGET/SPTL.

NGET/SPTL concluded that the first HVDC link is required by 2013 under all scenarios considered (noting that the earliest completion date for the Western HVDC link is Dec 2015) and a second HVDC link will be required by around 2018-2020 in the GG and AG scenarios. NGET/SPT also validated its results against current proposals for changes to the SQSS currently under review[5]. For all boundaries presented by NGET as relevant to the Western HVDC (B6, B7, B7a, B8), the proposed SQSS 'economy criterion' indicates a higher boundary transfer requirement than the present deterministic rules.

Under the evidence from NGET/SPTL's application of the SQSS, we concur with NGET/SPTL's assessment that there is a strong need for reinforcement under all scenarios applying the 'current' SQSS. Under high renewable generation growth in Scotland it is clear that both Western and Eastern links will be needed eventually. However we note that under lower wind generation scenarios the second HVDC link may not be justified before 2025. Under the 'proposed' SQSS the need case is stronger than under the 'current' SQSS.

Although the Eastern HVDC link does not cross boundaries B7 and B7a and so provides limited additional capacity on these boundaries compared to the Western HVDC link, the Eastern HVDC link bypasses several other network boundaries in Scotland where the Western HVDC link provides limited, if any, additional capacity. In assessing the merits of which link should be 'first' the benefit that each provides in terms of boundary reinforcement should be taken into account, together with additional reinforcement costs of those boundaries where the link is less effective. However the Western link provides additional capacity across the most limiting B7 and B7a boundaries and hence it is able to provide a much larger proportion of benefits.

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[5] GSR009 "Review of Required Boundary Transfer Capability with Significant Volumes of Intermittent Generation", April 2011, http://www.nationalgrid.com/NR/rdonlyres/BC265EEB-7415-4C58-8C56-0CF580581B8C/47751/GSR009ofgemreportv1_2_.pdf, National Grid website.

The Western link was initially identified by the TOs as the 'first' option on the basis of an initial limited assessment of project costs and benefits undertaken by the ENSG in 2009 and this assumption has continued in subsequent long term network development plans[6]. As a result the Western HVDC link is further developed than the Eastern HVDC link, which could only be delivered two years later than the Western HVDC link at the earliest (including also other reinforcements that would be required if the Eastern Link were to be built first). Even assuming the same commissioning date as the Western link, the CBA analysis undertaken by NGET has also indicated that superior net benefits are achieved by the Western link under a wide range of sensitivities.

We have also explored the issue of the reinforcements of B7a suggested by KEMA as a complementary investment to the Eastern HVDC Link (although the former cannot be delivered before October 2017). Our analysis indicated that the Western Link is superior to the alternative Eastern Link + B7a reinforcement by about 700 MW-800 MW. We conclude that the reinforcement raised by KEMA is not really an alternative to the Western HVDC Link as, even if coupled with the Eastern HVDC Link, it would not resolve the SQSS compliance issues of the B7a boundary to 2019 as it provides about 700 MW less boundary capacity compared to the Western HVDC Link.

We also noted that the boundary capability charts included in the June 2011 submission do not include the effect of the Teesside Power Station closure although it has been included in the CBA boundary capabilities for B7a. This has the effect of reducing the capacity of the B7a by about 1,000 MW due to the impact on the load sharing between circuits. NGET indicated that although boundary capability reduces, boundary requirements also reduce by about 1,500 MW (due to Teesside replacement generation being located south of the boundaries) which would make the B7/B7a boundaries closer to compliance by about 500 MW. The boundary capability charts will need to be updated under Stage 2 to reflect this and also the impact of changes in Scottish generation in line with the bottom up analysis leading to the June 11 scenarios.

1.3. Cost Benefit Analysis

The modelling tool and methodology used by NGET/SPTL in its CBA assessment is considered by SKM to be based on a broadly sound approach. SKM notes that short term constraint costs across specific boundaries are both difficult to model by NGET/SPTL and difficult to predict given the

[6] Although the TOs identified the Western HVDC link as their preferred first link, Ofgem reached no conclusion on the respective order and timing of the two links. Pre-construction funding was awarded to both links to allow them to be developed in more detail and then further reviewed at a later stage.

potential exploitative behaviour of generators behind the constrained boundary. As a result NGET/SPTL's assessment of short term constraint surrounding a particular boundary constraint may be underestimated. On the other hand NGET/SPTL continues to credit long term constraint cost relief to the project when, beyond 2030 it is likely that the constraint costs associated with onshore wind will decline as the subsidy awarded to onshore wind also declined.

The Western HVDC link demonstrates robust significant benefits under the three 'base' generation scenarios developed by NGET/SPTL over its lifetime under all credible sensitivities. SKM can conclude that there appears no credible risk of a stranded asset when assessed over the project life.

However, SKM also notes that the optimum commissioning year is sensitive to the generation profile used. While the reinforcement is required before 2015 under GG and AG, the reinforcement is not required by 2015 in the SP scenario.

NGET/SPTL's 'base' scenarios assume a number of onshore reinforcements in Scotland located upstream of the Western HVDC are delivered by 2015. Information in the public domain indicates that several of the reinforcements assumed to be commissioned by 2015 are currently being developed for commissioning between 2016-2019, dependent on local generation development. As a result the 'base' scenarios (SP, GG and AG) developed by NGET/SPTL should not have assumed such reinforcements occur as they may increase the apparent benefits from the Western HVDC.

Sensitivity analyses were undertaken at the request of SKM to evaluate the impact of the above issue. NGET/SPTL's analysis showed that, without reinforcements, the Western link is not needed until 2017/18 in SP. However the link remains required before 2015 in GG.

Although from the CBA it can be concluded that the Western HVDC link is robust against all credible scenarios and sensitivity assumptions, it cannot be concluded that the optimum timing for the reinforcement is 2015/16. It depends on the assumptions used. A range of between 2015/16 to 2018/19 is suggested.

1.4. Process towards contract award

Our review of the NGET/SPTL process towards contract award indicated that NGET/SPT have established a comprehensive tender evaluation process and procedure leading to contract award of the Construction contract. NGET /SPT have an Evaluation and Contract Award Plan and Programme with fully resourced teams for tender assessments which overall is currently on schedule. The procedure has an identifiable process and the programme has prescribed key dates for project and company boards governance approvals and sign offs.

NGET/SPT have a Risk Review Process including a maintained Risk Register which is regularly updated, includes risk mitigation actions and will form part of the modelling for Whole Life Cost which is one of the key assessment elements of the scoring criteria (represents [redacted])

The significant current level of questions to tenderers and associated clarifications and meetings with respect to each of the three tendered Lots under consideration that has to be resolved in a relatively short period of time has, in our view, the potential to negatively impact progress on each assessment stage. Management of this aspect of the process will be significant challenge to NGET/SPT to ensure progress is maintained to meet programme key dates for approvals and sign off and contract award in December 2011.

NGET/SPT within the tender evaluation and negotiation period have the ability to significantly manage, influence and control potential cost and time impacts but this will change as the process moves forward towards BAFO stage and contract award and also as other external influences such as other European transmission projects move into procurement and construction to affect equipment and cable supply and installation.

NGET/ SPT's Evaluation Plan provides a methodology for internal monitoring and managing progress with key tender evaluation work stream activities tracked by Evaluation Progress Indicators (% progress) highlighted on a Gantt Chart. In addition high level progress details on the tender evaluation process are provided as part of the regular reports to the NGET/SPT Project Board.

1.5. NGET/SPTL submission and Review Process

On 11 April 2011, NGET presented to Ofgem its initial submission for this review underpinning the needs case for the Western HVDC link, with a subsequent update on 4 May 2011. In its initial submission NGET concluded its analysis had confirmed both the 'needs' case for the Western HVDC link the need to commission the project for December 2015. NGET's analysis included an evaluation of delaying the project and also an assessment of the proposed Western HVDC as the next optimal reinforcement of transmission capability from Scotland to England.

Overall we consider that NGET/SPTL April 2011 submission document for this review was not sufficiently strong for a project of such magnitude, which has undergone several reviews since 2009 and where Ofgem had already indicated in the 1st March document the expectation of the information required and the need to augment previous submissions in several areas. Since the initial submission a number of areas were identified where further work, clarifications and corrections were required. Additional evidence and analysis was requested by SKM and Ofgem and provided by NGET/SPTL to help with the assessment.

The NGET conclusions above were confirmed in their revised submission of June 2011 which consolidated the additional information provided over the course of stage 1 of the review . The June 2011 submission also include an updated CBA which incorporated changes to the generation background scenarios, dispatch assumptions for some generation, changes to some constraint prices, additional sensitivity analysis and other refinements. Sections 4, 5 and 6 of this report discuss the above submissions in further detail. Areas of further analysis that will be covered under Stage 2 are discussed in Section 9.2.

1.6. Key conclusions and Recommendations

Notwithstanding the above comments with regards to the NGET/SPTL submission, SKM is satisfied that sufficient robust information and analysis has been provided by NGET/SPTL during the course of Stage 1 to allow the following conclusions and recommendations.

The Western HVDC link shows robust lifetime benefits under a wide range of credible scenarios and sensitivities of key input variables. In view of the long term renewable aspiration in the UK and Scotland in particular, it is considered that the risk of this investment becoming stranded is negligible.

The Western HVDC link is a superior alternative to the Eastern HVDC link as first ‘link’ reinforcement in the short term particularly noting the much earlier development state of the Eastern HVDC link, which could only be delivered two years later (2017/18) than the Western HVDC link, and also other reinforcements that would be required if the Eastern Link were to be built first. The Eastern HVDC link design is also subject to more uncertainties that will become clearer over the next few years. Even assuming the same commissioning date, 2015, as the Western link, the CBA analysis also indicated that superior benefits achieved by the Western link under a wide range of sensitivities.

The optimum timing for commissioning the Western HVDC link is dependent on the scenario used and varies from 2015 (earliest possible construction end date) for GG and AG scenarios, to 2017/18 in the case of the SP scenario. As there is great uncertainty about what renewable growth path will outturn, an assessment of the cost that would be incurred if the assumption made turns out to be wrong. The analysis based on the June 2011 scenarios indicated that if the Western link is commissioned in Dec 2015 and the renewable growth scenario turns out to be like SP the additional costs (via forwarding of capital cost) would amount to circa £33 million. If however the link is commissioned in 2017/18 (SP) and then the growth path looks like GG then the additional cost (via increased constraint costs) would amount to circa £165 million (i.e. about 5 times higher). If losses are considered, as calculated by NGET/SPTL, then the spread in the costs increases to £6 million and £200 million respectively. It can be concluded that the potential cost of being wrong by delivering the project early could be very small whereas the cost delivering the project late could be very high.

In addition, there are other difficult to quantify benefits that may result from investing earlier rather than later. Those primarily revolve around the likely supply chain risks as more cable is needed to connect offshore windfarms and also other related HVDC projects as we move closer to 2020 (potential for manufacturing delays and higher asset costs as demand increases). Also empirical evidence suggests that in the presence of significant network constraints with relatively few players behind the constraint could result in constraint costs much higher than calculated. There are other likely unmonetised benefits such as the potential reduction in risk premiums to developers due to the availability of transmission capacity, alleviation of cable market constraints (and prices) to offshore wind developers which ultimately may revert to consumers, earlier delivery of renewable projects with consequential CO_2 savings, provision of confidence message to industry etc. For all those reasons we consider that, in the presence of uncertainty, there should be a bias towards early delivery as late delivery of reinforcements is likely to result much more costly than calculated.

We conclude therefore that, although the need of the project by 2015 would depend on the scenario outcome, the proposed timing of the reinforcement is best possible in view of the costs of delivering the project behind of need vs. ahead of need.

- **Table 1 Summary of assessment of request for funding of construction works**

Scope	Need (by Dec2015)	Timing

Note: 'Need' is green by 2018 under all scenarios and sensitivities.

For the purposes of allowing the monitoring of progress toward contract award by Ofgem in Stage 2 it is considered that the progress tracking currently used by NGET/ SPT could be summarised in a report to Ofgem but at high level against key activities or key milestones either on a 'percentage progress achieved' or 'yes/no achieved' as appropriate. Further details are provided in the report. At this stage however it was not clear whether there is a specific criteria that each of the boards will apply in deciding whether to proceed with contract award. It is likely that each board will have its own set of conditions and markers and these will inevitably take into consideration the status of the contractual, commercial and technical negotiations, and the status of the major risks and risk mitigation measures taken.

2. Introduction

Sinclair Knight Merz was appointed to act as independent reviewer of the NGET/SPTL funding submission to Ofgem in relation to the Western HVDC link between Hunterston in Scotland and Kelsterton in North Wales (Connah's Quay, Deeside).

- **Figure 1 Western HVDC Link**

The Western HVDC link will have an estimated capacity of circa 2 GW and includes circa 400 km of cable (some 360 km submarine). The total capital cost for the HVDC converters and cables is estimated (May 2011) by NGET/SPTL at [redacted] with a [redacted] tolerance. A construction tender was prepared and issued in December 2010. The tender allowed bidders the provision of alternative designs between 1.8 GW and 2.2 GW in capacity in order to facilitate competition between manufacturers and technology options. Final capacities and costs are therefore subject to the outcome of the evaluation of tenders (received in May 2010) that is currently being undertaken by NGET/SPTL.

In January 2010 Ofgem confirmed its Transmission Investment Incentives (TII) framework for funding critical large-scale investments within TPCR4 and approved funding for an initial tranche of projects requiring funding from 2010/11.[7]. Approval included preconstruction costs for the

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[7] TPCR4 took effect on 1 April 2007 and is due to expire on 31 March 2012. The Authority decided to delay the next full transmission price control review by one year and to implement a one-year adapted rollover of TPCR4 (the TPCR4

Western HVDC[8] for 2010/11 and 2011/12 totalling £10.2m and £10.5m in the case of NGET and SPTL respectively. NGET also obtained approval for construction work in 2010/11 and 2011/12 at Deeside substation in relation to the Western HVDC link totalling £18.1m.

In August 2010 NGET and SPTL submitted additional requests to Ofgem under the Transmission Incentives Framework[9] (TII) for funding of construction costs on the Western HVDC link (HVDC converters and cables) that were planned to be incurred from 2011/12 in order to maintain a completion date of 2015. Ofgem appointed Kema to assist in the review of the funding request.

Ofgem's January 2011 decision letter identified the need for further assessment in certain areas prior to reaching a decision on the request for funding the Western HVDC link. The March 2011 document established in more detail:

- Ofgem's assessment of the Western HVDC link based on the information available in January 2011, including KEMA's review;
- the scope and timescales for further assessment, under a two-stage approach;
- the information requirements from NGET and SPTL to inform the work and the key dates (11 April and 30 June) for formal initial submissions for the first and second stages of the assessment; and
- expected process towards reaching a decision, subject to timely receipt of relevant information from the TOs.

2.1. Scope of the stages of the review

As indicated above, Ofgem established a two stage process to cover various aspects of the funding request. This report covers the outcome of our analysis associated with Stage 1 of the review. The specific scope associated with each of the stages is as follows:

Scope of Stage 1

- An assessment of need case, scope and timing of the Western HVDC link project as a whole (based on generic assumptions provided by NGET/SPTL, e.g. regarding cost and design), in

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rollover) from 1 April 2012 to ensure that Ofgem could reflect the final conclusions of the RPI-X@20 review (which was to implement the RIIO model for network regulation).

8 Ofgem granted funding for pre-construction work on the overall project for 2009/10 as part of earlier work.

9 The TII framework, initially applicable up to end 2011/12 when TPCR4 expired, was extended in June 2010 to 2012/13 under the one-year adapted rollover of TPCR4. Funding arrangements beyond 2012/13, including investments funded under the TII framework, will be addressed through the next full transmission price control review, RIIO-T1, in line with the new networks regulatory framework, the RIIO model.

line with the approach used in previous consultancy reviews under TII and summarised by the corresponding "traffic light" indicators

- Conclusions on (a) the case for delivering the link in 2015 and (b) the need to commit construction expenditure in 2011/12 in order to maintain achievability of the planned delivery date
- A review of NGET/SPTL's planned process towards contract award, to include recommendations on:
  - its feasibility and robustness, and any improvements that could be made; and
  - a methodology by which progress on this process may be monitored in the second stage assessment

Scope of Stage 2

- A review of whether the first stage assessment of need case, scope and timing of the Western HVDC link project as a whole, and conclusions based on that assessment, remains valid in light of the information available from the tender evaluation process.
- Recommendations on appropriate specific assumptions to use (e.g. total cost and design of the link and associated onshore works, expenditure profiles and specific activities planned to be undertaken prior to RIIO-T1), to assess funding requirements in 2011/12 and 2012/13 under TII
- An assessment of deliverability, design and cost of specific works (offshore and/or onshore, i.e. including convertor stations) on the Western HVDC link project for which funding is requested prior to RIIO-T1, in line with the approach used in previous consultancy reviews under TII and summarised by the corresponding "traffic light" indicators
- A report on NGET/SPTL's progress towards contract award, using the methodology developed in the first stage of the consultancy work
- Conclusions on readiness of NGET/SPTL to commit construction expenditure in 2011/12

2.2. Review structure

The key outstanding questions to be addressed in this Stage 1 of the review are:

- The need for delivering the Western HVDC link in 2015
- The need to commit construction expenditure in 2011/12 in order to maintain achievability of the 2015 delivery date.

Ofgem's March 2011 letter required NGET/SPTL to provide additional information in the subsequent submission on the following areas:

- Analysis of the net benefits (including non-quantitative impacts) of delivery of the proposed Western HVDC link in 2015, from an assumed baseline that all the proposed incremental onshore reinforcements proceed in line with current plans
- Sensitivity analysis of the impact on those net benefits if delivery of the proposed Western HVDC link is delayed by one or more years
- Details of assumptions and methodology used for the above analysis, identifying new information taken into account and providing supporting justification for the position taken on any outstanding areas of difference between NGET and KEMA
- Further evidence justifying the TOs' position that, irrespective of timing, the proposed Western HVDC link is the optimal next stage reinforcement for increasing the transfer capacity from Scotland to England, e.g. this should include comparative analysis of alternative options considered to date, against relevant criteria, and
- An update on expected process to progress the proposed Western HVDC link to contract award stage, giving details of key dependencies to achieving delivery in 2015 and approach to managing risks.

In addition the current (TII) and future (RIIO) regulatory framework that may be applicable to the proposed reinforcement, other background information and previous assessments undertaken by Ofgem and its consultants have also been taken into consideration in this review.

2.3. Stage 1 approach

In reviewing the evidence and information provided by the NGET/SPTL submission we have considered the following main areas:

- The evolution of the generation background as key driver to the reinforcements
- The requirements from the network planning standard.
- The analysis of net costs and benefits streams derived from the investment.
- The impact on key sensitivities on the results obtained using the above.
- Other non-monetised risks and benefits

The main areas above are briefly described below.

The National Electricity Transmission System Security and Quality of Supply Standards (NETS SQSS) specifies the transmission network planning requirements largely based around the provision of network capacity to secure peak annual demand. The SQSS is a deterministic standard (i.e. explicit compliance rules) to facilitate its application. The criteria included in the standard are based on a number of technical and economic assessments based on historic Cost Benefit Analysis (CBA) undertaken at a time when intermittent renewable sources, such as wind, were not considered attractive generation technologies. Following a major review of the standard, a number of specific changes to the SQSS have been proposed. Of particular relevance to this reinforcement are proposals for the treatment of intermittent generation sources such as wind, which are currently being considered by Ofgem (Section 5).

Given the uncertainties surrounding the appropriate modelling of intermittent generation in evaluating transmission investments driven by large intermittent renewable generation, the results of the analysis using the SQSS (including the approach to modelling wind used by the TOs) are normally complemented by Cost Benefit Analysis (CBA) to validate and complement the needs case identified.

The NGET/SPTL submission considers the need case of the HVDC Western interconnection using both the SQSS and CBA approaches applied to a number of future generation scenarios. There are also a number of uncertainties that indicate the need to undertake sensitivity analysis to assess the robustness of the investment and its timing. The NGET/SPTL submission considers a number of sensitivities and their impact is also considered in this report.

The analysis is based upon a methodology similar to that used in other CBAs evaluating renewable driven investments, in particular the quantification of specific costs and benefits, that have occurred since the original TIRG evaluation in 2004. Not all risks, costs and benefits can easily be monetised. Factors difficult to monetise may also be of significance and should be considered, particularly given uncertainty surrounding the optimum timing of the investment depending on the assumed sensitivities. This report will also explore these issues.

2.4. NGET's submissions and Key Findings

On 11 April 2011, NGET presented its initial submission for this review underpinning the needs case for the Western HVDC link to Ofgem, with a subsequent update on 4 May 2011. In its initial submission NGET concluded its analysis had confirmed both the 'needs' case for the Western HVDC link the need to commission the project for December 2015. NGET's analysis included an evaluation of delaying the project and also an assessment of the proposed Western HVDC as the next optimal reinforcement of transmission capability from Scotland to England.

Overall we consider that NGET/SPTL original submission document for this review in April was not sufficiently strong for a project of such magnitude, which has undergone several reviews since 2009 and where Ofgem had already indicated in the 1st March document the expectation of the information required and the need to augment previous submissions in several areas. A considerable amount of work went throughout the review process to correct several areas containing errors and to strengthen and clarify the need case in particular with the timing of the reinforcement. Both SKM and Ofgem sought further information to address gaps in the original submission, particularly regarding the details of the assumptions used and the basis of these, in order to identify what further analysis may be helpful for the need case assessment. NGET staff were cooperative during this very iterative process and the work undertaken contributed to clarify the key issues that allowed the evaluation for the objectives of this stage. There are also some areas however where the information provided has not been sufficiently detailed to bottom up the approach used (e.g. losses).

The final submission by NGET at the end of the Phase 1 review process in June contained new analysis (based on the June 2011 scenarios plus some updated input assumptions) as well as seeking to address the gaps in the original submission. The NGET conclusions above were confirmed in their revised submission of June 2011 which incorporated changes to the generation background scenarios, dispatch assumptions for some generation, changes to some constraint prices, additional sensitivity analysis and other refinements (Sections 4, 5 and 6 of this report discuss the above submissions in further detail). However the June 2011 submission still contained certain assumptions in the base case that required further clarifications and others that are considered to be inappropriate (particularly with respect to the timing assumptions of certain onshore reinforcements in Scotland, or even the headline project cost).

The sensitivity analysis undertaken became instrumental in the submission to overcome some of the deficiencies in the base case and also to assess the robustness of the case against variations of key drivers particularly for the timing of the investment. However the need to constantly compensate for these deficiencies when reading the NGET/SPTL report makes it unnecessarily complicated and does not provide confidence about their internal investment assessment process and quality assurance. It is recommended that in Stage 2 the submission updated with the information from the tendering process takes the issues above and other specific comments made in this report in addition to those made by Ofgem into consideration.

3. Generation Background

Key messages

- The most critical driver underpinning the 'need' for the Western HVDC link is the anticipated development of generation in Scotland, in particular the growth renewable generation
- NGET presented three generation scenarios to assess the 'need' for the link. NGET's 'middle' scenario Gone Green is driven solely by the requirement to meet the government's 2020 renewable target. SKM considers GG to represent a highly optimistic view of renewable development in Scotland
- NGET's initial scenarios were based upon dated (2008/9) information. An update of the data used in the scenarios showed that NGET's Gone Green scenario anticipated a significantly higher rate of renewable growth than actual outturn development over the period 2008/9 to 2011/12.
- NGET revised the generation scenarios for their June 2011 submission incorporating the results of a bottom-up reconciliation of the development status of specific generation projects following discussions with SKM and Ofgem. Although these scenarios are still labelled as per the ODIS names on which they were based (SP, GG, AG) it should be noted that they are not the same.
- NGET's lowest scenario (Slow Progression) more accurately reflects outturn development over the period 2008/9 to 2011/12. The highest scenario (Accelerated Growth) shows an implausible rate of short term renewable growth in Scotland.
- By 2020, SP and GG scenarios show little divergence in their assumed installed onshore wind capacity in Scotland with the GG scenario being only 8% higher than the SP scenario. SKM considers that NGET's scenario analysis does not fully take into account a wide range of uncertainties influencing renewable development that may plausibly result in a lower level of renewable generation in the longer term.
- Additional sensitivity analyses were requested to explore a plausible 'downside' scenario that takes into account market uncertainties affecting renewable and thermal generation developments

3.1. The three NGET/SPTL generation scenarios

A key determinant of the 'need' for the proposed Western HVDC link is the volume of generation in Scotland, in particular the growth rate of renewable generation. Significant uncertainty surrounds the development drivers of renewable and conventional generation in Scotland. NGET developed three long term scenarios of UK generation for the Offshore Development Information Statement (ODIS)– Accelerated Growth (AG), Gone Green (GG) and Slow Progression (SP). The scenarios were used as the basis for the need-case analysis in NGET's April 2011 submission and further modified in their June 2011 submission.

The three scenarios developed by NGET cover the period 2010 to 2025 – NGET stated that the drivers underpinning the scenarios are the UK's carbon and renewable targets – with GG meeting the 2020 renewable target on time, AG meeting the target early and SP failing to meet the 2020 target.

Our review of the detailed generation databases underpinning each scenario highlighted that the 2010/11 starting point for the scenarios was not an accurate reflection of the existing GB generation mix.

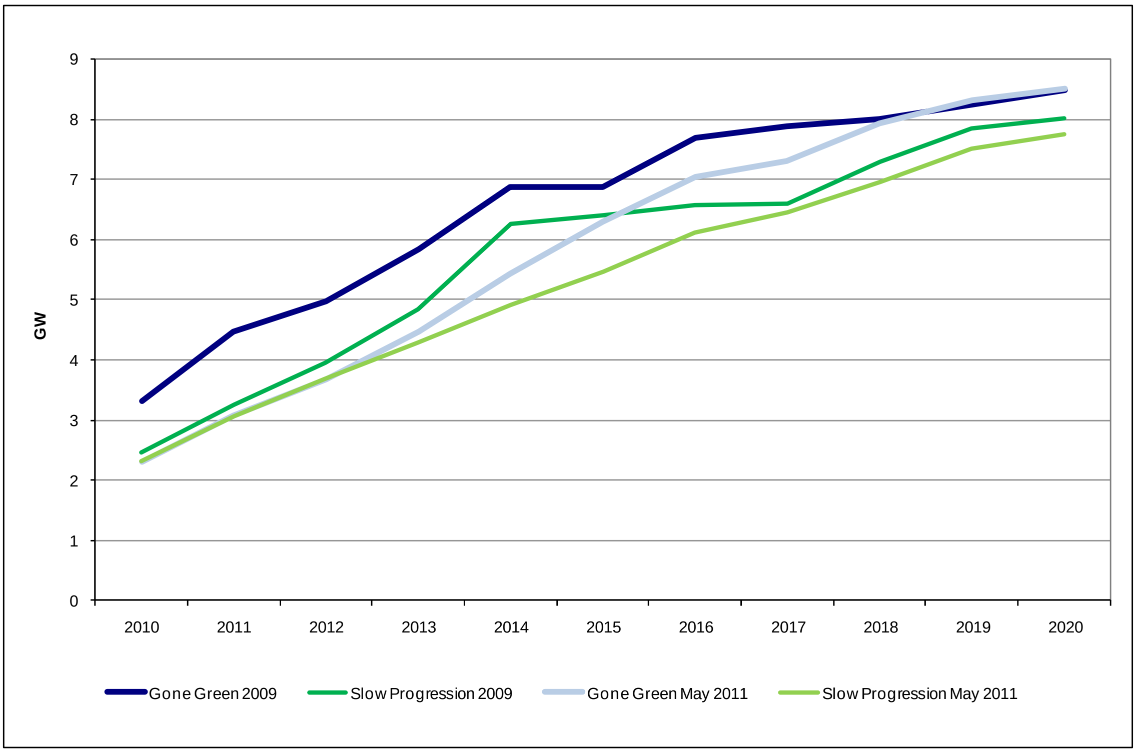
In simple terms GG and AG had significantly over estimated the volume of renewable generation in 2011 and failed to take into account some thermal plant closures/mothballing. Further investigation identified that the data used in the scenarios were based upon information developed in late 2008/early 2009. As a result the initial scenarios did not fully take into account the impact of market developments since 2008/9, in particular the post credit crunch impact on renewable development, uncertainty surrounding future renewable subsidy support schemes and the rise in the GB generation margin resulting from a low electricity demand growth.

As a result the April 2011 CBA submission was based on an over optimistic assessment of renewable development in 2010/11 and an inaccurate generation base. Given the inaccurate starting point, the subsequent future development of the scenarios could not be considered robust.

NGET subsequently submitted updated generation scenarios to Ofgem in May 2011 as part of the the ODIS 2011 and these reflect a more accurate 2010/11 position.

The ODIS 2011 scenarios were further refined during the course of this review and became part of NGET's June 2011 submission. Figure 2 shows the revised scenarios and compare with the original 2009 scenarios – the updated scenarios are shown as GG and SP May 2011.

■ **Figure 2 Onshore wind generation in Scotland. Comparison of April 2011 Scenarios[10] and May 2011 update**

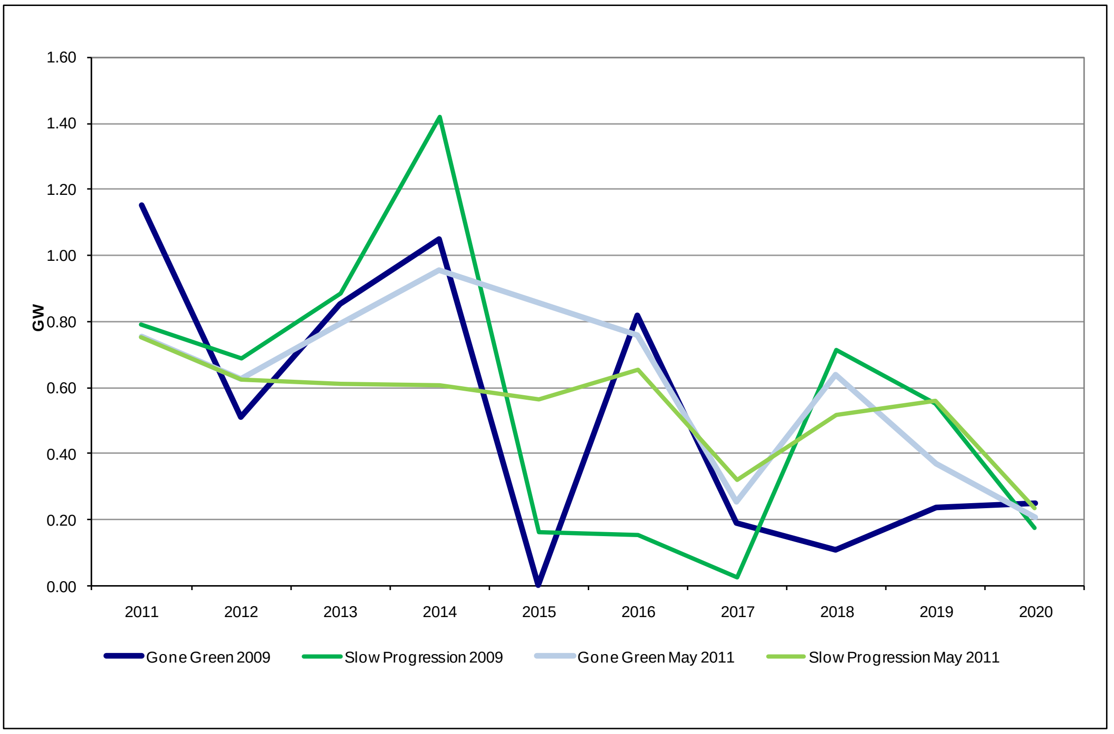


The May 2011 updated scenario comparison highlights some key issues:

- The 2009 GG scenario significantly over-anticipated the growth of renewable generation in Scotland over the period from 2008/9-2011/12
- The 2009 SP scenario represented a more accurate outturn assessment of renewable generation development
- Little significant divergence exists between GG and SP
- The rate of renewable development over the period to 2020 is 'front loaded' – occurring faster in the earlier years than the latter years (Figure 3)

[10] Although used in the ODIS 2010, these scenarios were labelled as 2009 by NGET and we use the same name convention in this and subsequent charts.

▪ **Figure 3 Onshore wind generation in Scotland. Build rate1987031**



Given that the updated scenarios highlighted the impact of uncertainty over the rate of short term renewable development in Scotland, SKM suggested that the three scenarios developed by NGET are useful long term scenarios providing a 'what if' assessment of generation development that might occur in GB over the next 15 years. However, in order to determine the more specific needs assessment for the Western HVDC link, in particular the need for the project to be delivered in 2015, a narrower shorter term forecast of generation is required based upon existing market fundamentals, rather than a 'what if' longer term assessment.

NGET's analysis of renewable development in Scotland for the ODIS 2009 and 2011 scenarios was based largely upon generation contracted with NGET. SKM considered that this view of renewable development was insufficient and may lead to an overestimate of renewable capacity development as it failed to take into account 'real world' market developments that often resulted in lower levels of generation developed. As a result SKM was concerned that none of the scenarios represented a rigorous short term forecast upon which to base a long term scenario to support the timing of the construction of the HVDC link. SKM was also concerned that limited detailed rationale underpinned the renewable generation assumptions for the period to 2015/16 that were used to base the timing of the Western HVDC link – other than meeting the 2020 renewable target on time, ahead of time or failing to meet the target.

3.2. Update of short term project information

In order to improve the immediate robustness of the scenarios SKM suggested NGET undertake a short term forecast of renewable generation development based upon existing market fundamentals – a so called ‘bottom up’ approach that identified each project and assessed its actual size and development probability over the next 5 years. SKM highlighted its view that not all projects with consent will proceed, and that even fewer projects in planning will proceed. As a result an element of judgement is required in determining the volume of plant not already under construction that will proceed.

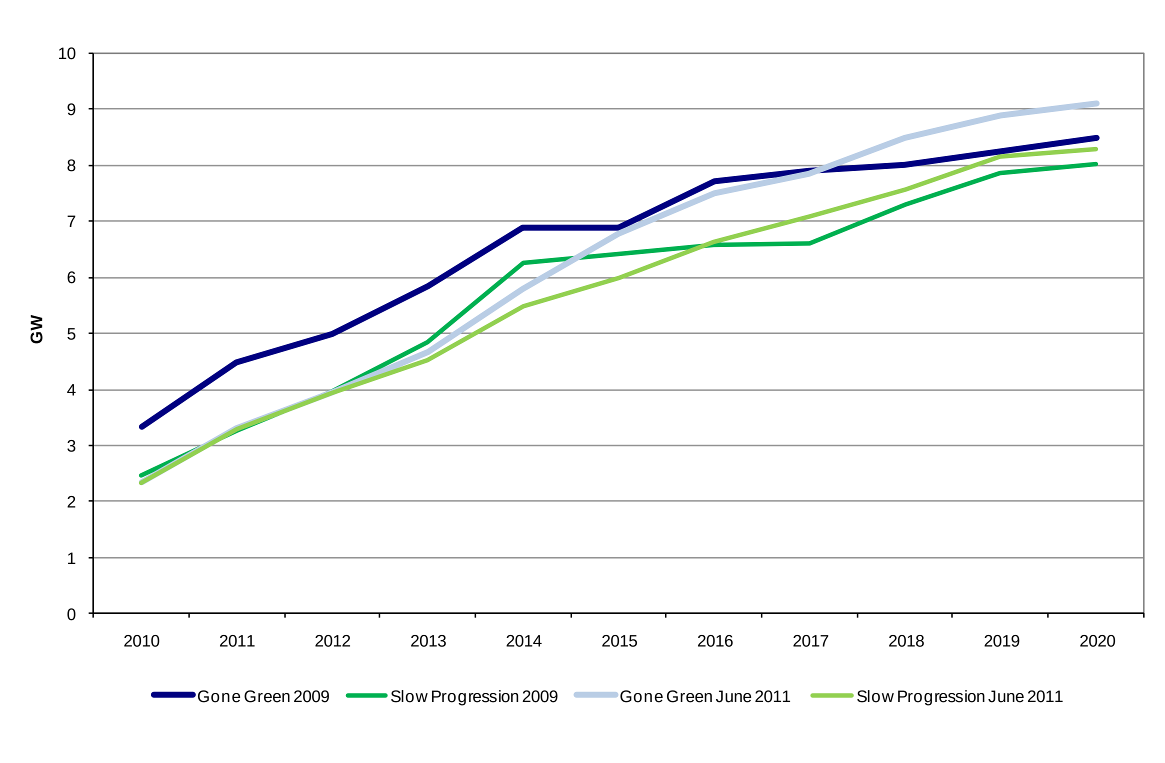
NGET focused upon the GG scenario of generation development as it both met the 2020 renewable target and represented the ‘middle’ scenario between AG and SP. SKM expressed concern that AG was not a credible short term scenario – showing a pattern of renewable development over the next 5-10 years that SKM considers unachievable. It was agreed to discount the AG scenario in the assessment of the required timing of the project for the CBA as the AG scenario was above GG and GG was already indicating a need case by 2015 or before.

NGET reworked GG and SP (June 2011 scenarios) using a ‘bottom up’ project by project assessment and its judgement determining what plant with and without consent would proceed. NGET’s analysis resulted in:

- A number of onshore wind projects were delayed or advanced in the analysis based on NGET’s improved market intelligence
- The capacity of a number of projects was revised downwards based on NGET’s improved market intelligence
- NGET had hitherto failed to fully take into account small scale embedded renewable generation in its analysis and so subsequently revised upwards the volume of embedded generation included

The chart below (Figure 4) shows the results of the June 2011 update and compares with the original 2009 scenarios.

▪ **Figure 4 Scottish Renewables. Updated generation scenarios**



The chart highlights a number of points:

- SP has been more representative of actual renewable growth since 2008/9 than GG, emphasising the underlying optimism that characterises GG.
- The revised June 2011 GG and June 2011 SP scenarios are almost identical to 2013/14. SKM considers the similarity between the two updated scenarios inevitable in the short term given the timing of plant construction.
- Beyond 2015 the two scenarios display a very limited degree of divergence, by 2020 only about 800 MW separates the two scenarios. SKM is concerned by the limited divergence between the two scenarios in the longer term, where the range of development uncertainties underpinning renewable development will inevitably widen. As a result SKM is concerned that neither GG nor SP adequately represents a credible 'downside' view of renewable development in Scotland. While both SP and GG represent plausible scenarios, SKM considers that GG represents a credible 'upside' view, but that SP does not adequately represent a credible 'downside' view.

As a result we consider that the June 2011 generation scenarios underpinning the latest CBA submission present only an optimistic view of renewable development in Scotland.

3.3. Market uncertainties influencing renewable generation

A range of uncertainties are currently affecting the development of renewable generation in the UK and so will significantly influence the short and longer term rate of renewable growth, including:

- Access to finance. Of those 5.9 GW of onshore wind projects in Scotland identified with consent or planning but not yet built, around half are 'independent' developers. Independent developers are challenged in many areas, but in particular access to finance. SKM believes it is overly optimistic to expect the majority of 'independent' projects to be developed in the short to medium term.
- Market uncertainty – uncertainty surrounds the proposed Electricity Market Reforms and ongoing levels of subsidy support for renewable generation. Such uncertainty has led the UK to slip down the league table of clean energy investments[11]
- Potential changes to transmission costs allocation.– There a number of initiatives from GB and Europe that may result in short term and long term changes over the allocation and magnitude of transmission charges amongst transmission users (e.g. Electricity Market Reform, Transmit, European markets coupling etc.). It is likely that a certain amount of 'wait and see' could be influencing the development of Scottish renewable generation given the potentially significant financial impact on generation projects in Scotland.
- Network reinforcements in Scotland – a number of large renewable projects that are developed in both SP and GG are dependent upon significant network reinforcement work, including the construction of HVDC links. Uncertainty surrounds the timing of these reinforcements.

As a result SKM believes that and that a 'downside' view should reflect the range of uncertainties affecting the potential development of generation in Scotland – a downside that is not adequately explored in SP. SKM considers both GG and SP present an optimistic view of renewable development in Scotland, with SP relatively optimistic and GG very optimistic. While SKM acknowledges that GG is driven by government targets, government targets alone will not ensure the development of renewable generation.

A number of commentators and reports have also considered lower renewable growths towards 2020 and/ or expressed concerns about the feasibility of achieving the Renewable targets by 2020. In this respect we note for example reports from PWC[12], DECC pathways analysis[13], Ofgem project

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[11] WHO'S WINNING THE CLEAN ENERGY RACE?, 2010 edition, The Pew Charitable Trusts
[12] http://www.pwc.co.uk/eng/publications/meeting_the_2020_renewable_energy_targets.html
[13] http://www.decc.gov.uk/assets/decc/What%2520we%2520do/A%2520low%2520carbon%2520UK/2050/216-2050-pathways-analysis-report.pdf

discovery[14], UK ERC[15] etc as well as confidential reports by Cambridge Econometrics. These demonstrate the need to consider the robustness against lower renewable growth scenarios than those considered by NGET/SPT.

3.4. Alternative sensitivity analyses

In order to explore the impact of a 'downside' generation scenario in Scotland SKM requested NGET undertake a further series of sensitivity analyses using the June 2011 scenarios. These included:

- Delay 1 GW of onshore wind development by three years from 2016 to 2019 in SP. SKM considers such a sensitivity will explore the impact of delays to the large schemes involving HVDC connections in the SHETL area and may also be used for looking at the impact of delays in upstream onshore reinforcement
- Delay 1 GW of onshore wind development by three years from 2015 to 2018 in GG
- Reduce total onshore wind by 2 GW by 2020 in SP, but also extend the life of Hunterston nuclear power station by a further five years to 2021. Reducing the total volume of renewable generation would reflect a 'downside' renewable development – supported by the scenarios published by DECC/Arup in June 2011 showing only 5.5 GW of onshore wind in Scotland by 2020.[16]

SKM considers the sensitivity analyses requested adequately explores a suitable range of scenarios on which to explore the CBA and are further discussed in Section 6.

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14 http://www.ofgem.gov.uk/Markets/WhlMkts/Discovery/Documents1/Discovery_Scenarios_ConDoc_FINAL.pdf
15 http://www.law.monash.edu.au/regstudies/scenarios-sensitivities-on-long-term-carbon-reductions-using-the-uk-markal-and-markalmacro-energy-system-models.pdf
16 http://www.decc.gov.uk/publications/basket.aspx?filetype=4&filepath=What+we+do%2fUK+energy+supply%2fEnergy+mix%2fRenewable+energy%2fpolicy%2frenew_obs%2f1834-review-costs-potential-renewable-tech.pdf#basket

4. Project Cost Estimate

[This section of the report provides an overview of the total project costs. Details about the break down of these costs are commercially sensitive and hence this section has been redacted from the public version of the report. The range of costs considered in the CBA (see section 6, below) is consistent with the TOs' latest cost estimates. The cost is subject to change as a result of the ongoing tender process.]

5. SQSS need case

Key messages:

- A strong need for reinforcement under all scenarios applying 'current' and 'proposed' SQSS
- Low risk of stranded asset. Both Eastern and Western HDC links to be required in the long term assuming continuous growth of renewable generation in Scotland.
- Under lower wind generation scenarios (SP) the Eastern HVDC link may not be justified before 2025.
- The Western HVDC link provides the same increase in boundary capacity across the B6 boundary to the Eastern HVDC link, the latter provides however reduced benefits across B7 and B7a but increased benefits from B2 to B4.
- The Western HVDC link provides more additional boundary capability across B7a than the Eastern HVDC link with a B7a reinforcement previously identified by KEMA.
- NGET/SPTL need to update their submission on boundary capability charts under Stage 2 to reflect the impact of Teesside closure and also the impact of changes in Scotttish generation in line with the bottom up analysis leading to the June 11 scenarios. The CBA submitted in June already had however included the effect of this closure in the boundary capability assumptions.

5.1. Current SQSS

Under the current SQSS applied by NGET/SPTL, the required transfers across the key boundaries that will be covered by the proposed Western HVDC link – B6, B7, B7a and B8 – were analysed by NGET/SPTL. The analysis was undertaken for each of the three generation scenarios described in Section 3.1.

The boundary transfer requirements charts in the April 2011 submission were subsequently updated using the May 2011 scenarios as submitted for the 2011 ODIS (Table 2). The June 2011 submission did not update the boundary capability charts although it included significant changes to the some generation assumptions. The impact of these changes to the conclusions obtained from the examination of the May 2011 results, which are discussed below, is further considered in Section 5.5.

- **Table 2 NGET Boundaries transfer requirements under SP, GG and AG (May 2011 scenarios)**

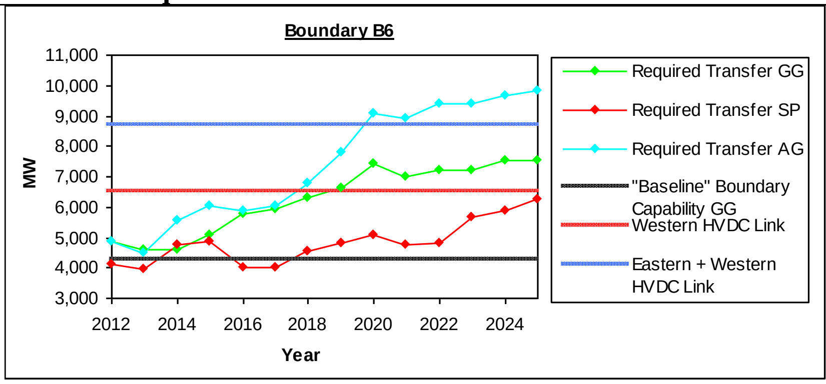
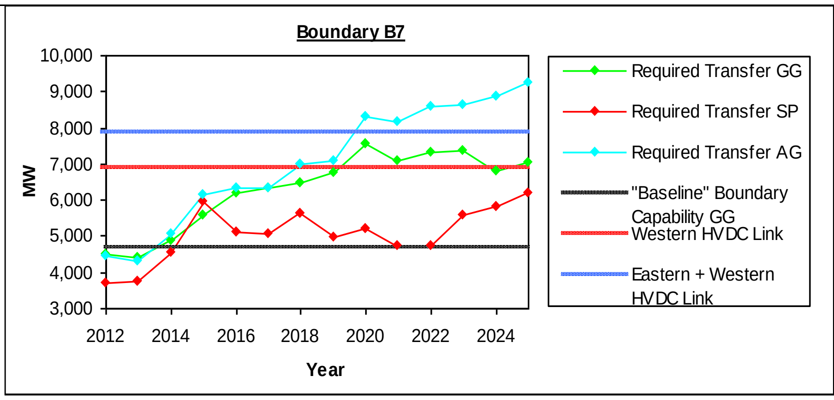
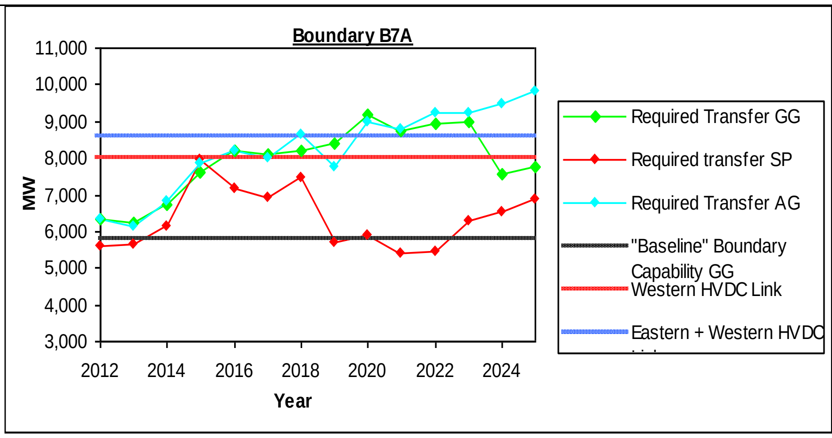
Boundary	Transfer Requirements
Boundary 6: SPT to NGET (Cheviot) Non compliant in all scenarios from 2013 Second link required by 2018 and 2020 in GG and AG respectively SP compliant throughout period with Western Link only	
Boundary 7: Upper North Non compliant in GG & AG from 2014. GG non-compliant between 2018 and 2023 with only Western HVDC Link SP non compliant from 2015. Compliance restored throughout period with Western Link	
Boundary 7a: Upper North south of Penwortham Non compliant in GG & AG from 2016. Compliance restored with Western Link. By 2018 Eastern link also needed for compliance In GG, compliance is restored from 2024 without the additional Eastern link. SP compliant throughout period with Western Link only	

Table 2 outlines a summary of the boundary transfers analysis undertaken by NGET/SPTL. The figures within the table show transfers across each boundary for the three generation scenarios over the period to 2025. The figures also indicate when a boundary becomes non-compliant under the current SQSS for each generation scenario. It is also important to note that although the deterministic SQSS provides a starting point for identifying when investments are required, the economic justification of a specific investment to overcome a capacity deficit may indicate a different timing.

Some of the sharp drops in transfer requirements in the charts shown in Table 2 correspond to closure of large power stations particularly Nuclear (e.g. Heysham, Hartlepool, Hunterston). Further to note that under' Connect and Manage' generation north of B6 may be able to connect prior to completion of the reinforcement

The charts above indicate that, based on the current SQSS, a need for reinforcement across some of the boundaries is required from as early as 2012 under all scenarios. The most limited boundary is B7a – NGET/SPTL's analysis indicates an additional reinforcement (the Eastern Link) is required to the Western Link from 2016 (although the extent of non compliance across this boundary is marginal until about 2018). Furthermore, even with both Western and Eastern HVDC links, Boundary B7a becomes non-compliant from 2020 under GG and AP. However, in GG compliance is restored with only the Western link beyond 2024.

For the SP scenario, the system is compliant throughout the period to 2025 with the Western HVDC link only.

NGET/SPTL conclude that the first HVDC link is required by 2013 under all the scenarios considered. NGET/SPTL also note that the earliest completion date for the Western HVDC link is Dec 2015. Furthermore NGET/SPTL conclude that a second HVDC link will be required by around 2018-2020 in the Gone Green and Accelerated Growth scenarios.

5.2. Potential impact of proposed changes to SQSS

NGET/SPT also assessed the boundary transfers against proposed changes to the SQSS currently under review. The proposed changes to the SQSS require the transfer capability to be determined with zero wind output (the 'security criterion') and a 'pseudo CBA.' The 'pseudo CBA (the 'economy criterion') utilises deterministic rules at peak demand to assess equivalent capacity required by undertaking a detailed CBA analysis. The proposed SQSS would then require network capacity to meet the higher of the security and the economy requirements[17].

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[17] The economy criterion is proposed in GSR009 "Review of Required Boundary Transfer Capability with Significant Volumes of Intermittent Generation" – this proposal was submitted to the Authority on 1 April 2011 (http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/fundamental/Wind+Integration/)

NGET/SPTL's analysis indicates that, for all three key boundaries, the SQSS 'economy' criterion triggers a higher requirement than the present deterministic rules.

The results of NGET/SPTL's analysis suggest that the boundary transfer analysis is robust against the proposed changes to the SQSS (including GSR008)[18]. The SQSS changes proposed in GSR009 could indicate that some boundaries become non-compliant ahead of the dates the indicated above.

5.3. Western vs Eastern HVDC

5.3.1. Background

NGET undertook an analysis of the merits of the Western HVDC link compared to the Eastern HVDC link in terms of SQSS compliance. For the assessment the Eastern HVDC link was assumed as a single point to point connection with a capacity of 2.2 GW between Peterhead and Hawthorn Pit commissioned by 2015, facilitating comparison between the two links. However, although the analysis assumes completion by 2015, the Eastern HVDC link is much less developed project than the Western HVDC link and NGET do not expected that the project could be delivered before 2017/18.

The case of the Eastern vs. Western link as a first reinforcement was examined in the ENSG in 2009. At the time the CBA did not demonstrate conclusively that any particular two reinforcements offered significant benefit over any other combination against the scenarios considered then. However when considering generation sensitivities, particularly extending the life of the Hartlepool and Heysham 1 Nuclear power stations beyond 2017/18 then the Western HVDC link provided the most robust solution.

More recent work on this issue include the KEMA's report of Dec 2009 and Jan 2011 and the discussion of these in Ofgem's March 2011 document.

This section compares the links from a SQSS perspective, a comparison on a CBA basis is discussed in Section 6.

While the issues covered by the above proposal were originally considered as part of "fundamental review" they are addressed in a separate change proposal (GSR009), the remaining aspects of the review are considered via GSR008 "Fundamental Review".

[18] GSR008 was also identified as relevant to the Western HVDC link. The overall proposal includes a number of changes, the most relevant here is the proposal that for some circuits the N-2 criterion is relaxed. In practice this would increase the boundary capability of B7A by 200-400MW, according to NGET. But NGET consider this insignificant compared to the level of non-compliance on B7a (2000-3000MW)
GSR008 has not yet been submitted to the Authority, but NGET has issued two consultations (Apr10 and Mar11).
http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/Fundamental+SQSS+Review/

5.3.2. Analysis

NGET/SPTL presented a comparison of both reinforcement alternatives based on SQSS requirements and a CBA. Both links provide the same benefits across Boundary B6. However, given the starting and landing point of the Eastern link, it does not bypass boundaries B7 and B7a and so has limited benefits across these boundaries (shown by the figures within Table 2). As a result the analysis concluded that the Western HVDC link is superior to the Eastern link in terms of provision of additional boundary capacity to B7 and B7a and benefits provided.

Some of the detailed conclusions that can be extracted from the examination of the boundary flows across B7 and B7a against the boundary capacities provided by NGET/SPTL are:

- If the Eastern HVDC link was undertaken as the first reinforcement, non-compliance across B7 and B7a to 2025 under the higher renewable scenarios (AG and GG) would result.
- Under SP, if the Eastern HVDC link was the first reinforcement, the system will remain compliant across B7. However, the system will be non-compliant across B7a until 2019, when compliance is restored, but then becomes non-compliant again by 2024.

From NGET/SPTL's analysis it can be concluded that, for the Eastern HVDC link to provide the same SQSS compliance as the Western HVDC link as the first reinforcement, lower generation in Scotland would be required and possibly additional reinforcement across B7a. The costs of additional and unspecified reinforcement across B7a would need to be added to the cost of the Eastern HVDC. The additional cost reinforcement cost would then seem to ensures that the Western Link is the optimum first link. This conclusion is however not necessarily true as the comparison between the Western and Eastern as first HVDC link on an equal basis requires also consideration of the to costs of other reinforcements in Scotland which are not included in above analysis. This is further discussed below and in Section 6.5.6

Although the Eastern HVDC link does not cross boundaries B7 and B7a in Northern England and so provides limited ability to relieve these boundaries compared to the Western HVDC link, the Eastern HVDC link has an alternative benefit. The Eastern link effectively bypasses several other network boundaries in Scotland were the Western HVDC link provides limited, if any, additional capacity. The potential boundary relief benefits provided by the Eastern HVDC link in Scotland are not accounted in NGET/SPTL's analysis. Some of the additional benefits the Eastern link may provide, that would depend on the generation scenario, include:

- Increase in boundary capacities in Scotland from B2 to B5
- Additional benefit, in terms of constraint reductions, if the assumed delivery of planned onshore network reinforcements in Scotland are delayed
- Potentially delay the need for some of the onshore network reinforcements in Scotland.

NGET/SPTL acknowledged that the Eastern HVDC link has an advantage over the Western HVDC in case of delays to onshore transmission reinforcements in Scotland[19]

Further consideration of the Western vs Eastern Link, from a CBA perspective, is provided in Section 6.

5.4. B7a: KEMA remarks

KEMA concluded that the incremental onshore reinforcements (i.e. those contributing to 4.4GW capacity across B6 by 2015) should go ahead first, KEMA then argued that most of the benefits of also going ahead with the Western HVDC link in 2015 arise, in the short term, from the elimination of constraints across B7a as opposed to B6. KEMA suggested that a reinforcement on boundary B7a (uprating the Penwortham to Kirkby route from 275 to 400 kV) would be more effective at mitigating constraints across boundary B7a in 2015 than the Western HVDC link. The reinforcement option, with an NGET estimated cost of £120m, was considered in further detail in NGET/SPT's June 2011 submission and concluded that the reinforcement could lead to an increase in B7a boundary capacity of circa 600 MW (NGET estimate) vs. the circa 2GW increase in capability with the Western link. In addition, NGET/SPT raised a number of objections to KEMA's conclusion, including:

- The reinforcement does not reinforce B6 and so B6 remains non-compliant
- The reinforcement cannot be delivered before October 2017 given that:
- Construction outages cannot be secured until 2013/14
- Consent for line diversions would require approach to the IPC

We agree with NGET/SPTL's and KEMA's assessment that the B7a reinforcement could provide some positive benefit in 2015 of and additional 600MW of boundary capacity. We also concur with NGET/SPTL that the reinforcement cannot be an effective <u>alternative</u> reinforcement to be considered to the Western HVDC link for delivery by 2015. In short, due to the time required to secure outages and line diversions, the reinforcements could not be delivered by 2015. However, we believe that, if a full consideration of the reinforcement alternative had been made when NGET/SPTL was assessing transmission investment options, then deliverability by 2015 would

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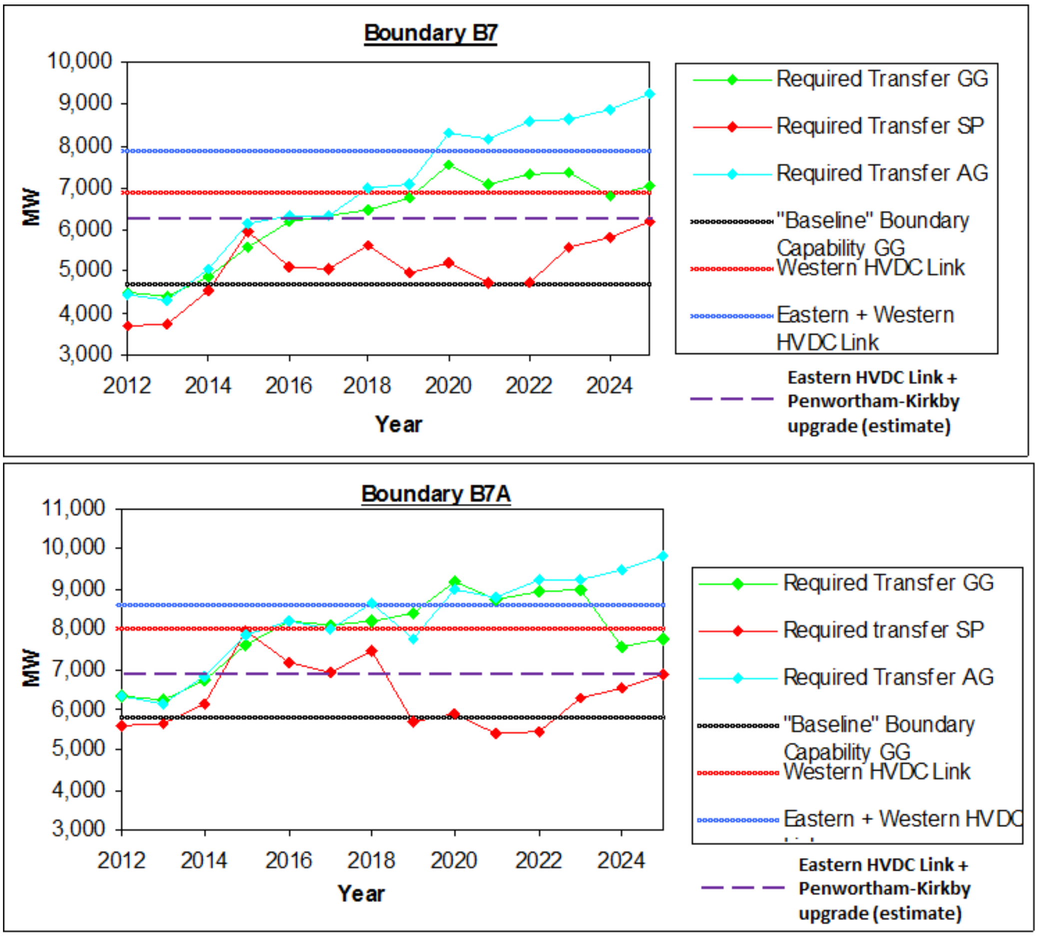
[19] NG_059: *"Were we to carry out studies where not all Scottish reinforcements were completed, we would observe reduced boundary capability within Scotland. This would definitely skew the value of the Eastern HVDC link over the Western HVDC link due to the fact that the Eastern link increases B4 boundary capability.*
NGET: "We strongly believe that such studies would give a distorted comparison of the Eastern HVDC over the Western HVDC. As the onshore reinforcements are cheaper it is reasonable to assume that they should be progressed first. Therefore it would not be credible to examine the benefits of the Western and Eastern HVDC links under an unrealistic scenario that is weighted in favour of the Eastern link."

have been possible and a full consideration of its lack of effectiveness in providing additional capacity across B6 would also have been undertaken. NGET however has not indicated under what scenarios would be cost effective to continue development of this reinforcement, even if the Western HVDC link is commissioned by Dec 2015, so that it can be delivered by 2017/18 if required. This is expected to be covered under Stage 2.

Notwithstanding the comments above we consider that the reinforcement option outlined above (or other onshore reinforcement) could be considered as a complementary reinforcement to the Eastern HVDC link in the comparison of Western vs. Eastern links discussed in Section 5.3. However, given the small incremental increase of boundary capacity across B7a of this reinforcement compared to the Western link, it seems unlikely that a combination of the Eastern HVDC with the uprating of the Penwortham to Kirkby route would resolve the boundary compliance issues as indicated by inspection of the B7a required transfers in Table 2.

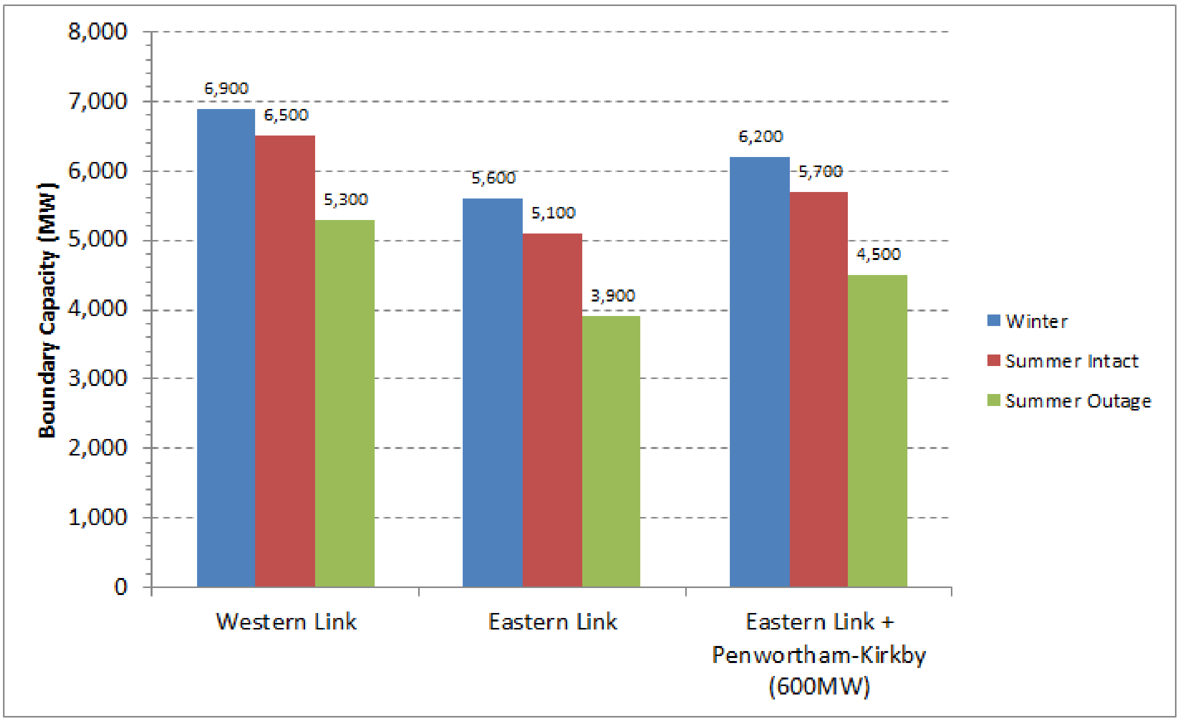
Figure 5 shows an estimate of the boundary capability across B7 and B7a with the Eastern HVDC link and Penwortham-Kirkby upgrade using the charts in Table 2. The capability has been estimated from the difference between the Eastern and Western HVDC lines in the charts in Table 2 added to the baseline capability and also adding 600 MW for the link. The results (shown in a dashed line) indicate that in the case of B7, the boundary remains compliant until 2018 under all scenarios, and compliant all over the period to 2025 under SP only. However in the case of B7a and over the period to 2018 the reinforcement does not seem to provide sufficient capacity for any scenario noting that under SP some years the violations seem small. The boundary is non-SQSS compliant over the period for GG and AG.

- **Figure 5 Estimate of boundary capability with Eastern HVDC link and Penwortham-Kirkby upgrade**



Similar but more precise results can be drawn from examination of the seasonal boundary capacities indicated in the CBA report for B7a and presented in Figure 6 below. We have also estimated the effect of adding the Penworthan to Kirkby reinforcement as a 600MW increase of capacity (not seasonally adjusted due to lack of further information). The charts show that the Western Link is superior to the alternative Eastern Link + B7a reinforcement by about 700 MW-800 MW.

▪ **Figure 6 B7a seasonal boundary capacity with alternative reinforcements**



We conclude therefore that the reinforcement raised by KEMA is not really an alternative to the Western HVDC Link as, even if coupled with the Eastern HVDC Link, it would not resolve the SQSS compliance issues of the B7a boundary to 2019 as it provides about 700 MW less boundary capacity compared to the Western HVDC Link.

5.5. Boundary Charts update

It should be noted however that the boundary capacities for 2020 presented in Figure 6 for the Western HVDC Link are significantly below the boundary capacity for B7a in the boundary capability charts in of NGET/SPTL June 2011 submission (based on the ODIS 2011 submission) by about 1000MW. The June2011 CBA submission justifies this reduction as the effect of closing Teesside Power closed in all scenarios that, according to NGET, "…affects the load-sharing across the western and eastern circuits comprising B7a profoundly". This also indicates that the capability requirements indicated in the boundary capability charts B7a included in NGET/SPTL June 2011 submission are out of sync[20] with the assumptions used in the accompanying CBA of June 2011 and will require to be updated in the submission under Stage 2.

NGET indicated that although boundary capability reduces, boundary requirements also reduce by about 1,500 MW (due to Teesside replacement generation being located south of the boundaries) which would make the B7/B7a boundaries closer to compliance by about 500 MW. The boundary capability charts will need to be updated under Stage 2 to reflect this and also the impact of changes in Scottish generation in line with the bottom up analysis leading to the June 11 scenarios.

[20] As indicated above the boundary capability charts are based on the May 2011 scenarios which correspond to the ODIS 2011 submission. These charts were not updated in the June 2011 submission.

6. CBA based need case

Key Messages:

- Tool and methodology used in the assessment and generation costs assumptions are considered to be based on a sound approach
- Western HVDC link demonstrates robust significant benefits under all scenarios over its lifetime under all credible sensitivities. No credible risk of stranded asset when assessed over project life.
- However, the optimum commissioning year is sensitive to the generation profile used. In SP a start date of 2017 is indicated, but 2015 for GG the results indicate 2015 is appropriate (constrained by construction).
- Other sensitivities may advance or delay the optimum date by a number of years although those considered seemed to have a small effect (less than a year)
- CBA indicates a range of optimum commissioning dates depending on scenario assumptions and sensitivities.
- Although from the CBA it can be concluded that the Western HVDC link is robust against all credible scenarios and sensitivity assumptions, it cannot be concluded that the optimum start date is 2015/16. It depends on the assumptions used. A range of between 2015 to 2017 is suggested.
- If the Western link is commissioned in Dec 2015 and the renewable growth scenario turns out to be like SP, the additional costs would amount to circa £33 million. If however the link is commissioned in 2017/18 (SP optimum) and then the growth path looks like GG then the additional cost would amount to circa £165 million (i.e. about 5 times higher).

6.1. Modelling approach

The modelling approach adopted by NGET in the CBA is based on the discounted sum of the capital cost stream and the cost of any construction outages (negligible in the case of the HVDC links), less the stream benefits resulting[21] (assessed as reduced constraint costs and losses). The capital cost of the transmission reinforcement (assumed as [redacted] in the CBA) is distributed equally over the assumed four year construction period of the reinforcement.

In terms of modelling approach, NGET undertakes a comparative analysis. The cost and benefits of the proposed Western HVDC link are compared to those determined in a 'base case.' Significantly the base case comparator assumes that a number of, transmission reinforcements are completed by

[21] Hence negative net values indicate a positive benefit using NGET sign convention.

2015. These projects are currently being developed for commissioning between 2016-2019, dependent on local generation development, and do not currently have regulatory funding for construction works. The impact of these assumed additional upstream reinforcements on the CBA is discussed in section 6.5 below. The 'base case' is intended to illustrate the operation of an indicative transmission network without the Western HVDC link and determine the resulting constraints occurring on the network.

The results of the CBA modelling approach are assessed by NGET over the lifetime of the proposed investment. As we consider in Section 6.4 below, while the lifetime approach taken by NGET is appropriate to assess the merits of the reinforcement and robustness of the reinforcement (stranded asset risk), the lifetime approach can not directly indicate the optimum year in which the reinforcement is required.

6.2. Modelling tool and assumptions

In order to undertake the CBA comparison NGET uses two Excel based models. The key model is the constraints forecast model, the results of which are used to feed the simpler CBA model. The constraints model undertakes a snapshot analysis for 2015, 2020 and 2025 using a specific generation dataset for each year. The three scenarios, SP, GG and AG, use differing generation datasets as a starting point. The generation datasets make specific assumptions regarding plant closures, commissioning and plant location for each of the snapshot years. The constraint model utilises the generation dataset and the network state to determine flows and resulting constraints. In order to determine the cost of these resulting constraints, the model also requires the prices of balancing actions, a generation plant merit order, demand assumptions, definition of seasons and sets of boundary capabilities.

KEMA indicated some concerns about the treatment of depreciation and discounting in the CBA analysis undertaken by NGET/SPTL. Having reviewed the approach used by NGET/SPTL for the discounting of the costs and benefits in the assessment we consider it correct.

6.2.1. Generation dataset

When assessing NGET's generation scenarios SKM reviewed the generation datasets used in SP, GG and AG. While SKM considers the overall growth of renewable generation optimistic in the scenarios (Section 3), notwithstanding the renewable assumptions, SKM concurs with NGET's resulting assessment of the supporting generation dataset. However further clarifications need to be provided in Stage 2 about the changes made to Teesside and the generation merit order

6.2.2. Constraint costs

A particularly important input into the model, along with the generation dataset, are the assumed bid and offer prices used to determine constraint costs. NGET has based its assessment on average prices experienced over 2005–2009 across the operation of the Balancing Mechanism (BM) by plant type. The model attempts to mimic the operation of the BM, so constrained-on and constrained-off plant are those submitting the lowest Offer and highest Bid prices respectively.

NGET assumes wind, marine and nuclear plant cannot be ‘constrained on,’ and that the cost of ‘constraining off’ these plant types is relatively high. NGET reviewed its assessment of the Bid Prices of nuclear, marine and wind generation, revising the Bid price of these technologies up – as shown in Table 3 below.

- **Table 3 April 2011 and June 2011 – Bid and Offer Prices used**

Fuel Type	Bid Price (£/MWh)	Offer Price (£/MWh)
Nuclear	-100	n/a
Marine	-60	n/a
Wind_Off	-50	n/a
Wind_On	-25	n/a
Base_Gas	25	60
Base_Coal	30	75
France	32	80
Biomass	33	83
Hydro	34	85
Marg_Gas	35	90
Marg_Coal	40	105
PumpStor	60	150
Britned / Imera	80	200
Oil	100	300
Aux GT / Main GT	150	400

Fuel Type	Bid price £/MWh	Offer price £/MWh
Nuclear	-200	
Marine	-160	
Wind_Off	-150	
Wind_On	-75	
Base_Gas	25	60
Base_Coal	30	75
France	32	80
Biomass	33	83
Hydro	34	85
Marg_Gas	35	90
Marg_Coal	40	105
PumpStor	60	150
Britned / Imera	80	200
Oil	100	300
Aux GT / Main GT	150	400

NGET/SPTL explained that the upward revision in Bid Prices for wind, from -£25 / -£50 £/MWh (onshore / offshore) in their April 2010 submission based on 2009 Bid/Offer prices to -£75/£150 £/MWh reflects ROC prices of £50 /MWh foregone, plus a 50% Bid pricing premium. NGET/SPTL considers the bid premium assumed to be less than the 200-500% premium currently observed.

SKM concurs that the bid/offer prices indicated by NGET for thermal plant are based on empirical evidence from the BM, where the system buy price (SBP) is considerably higher than the system sell price (SSP). SKM also concurs that the revised June 2011 Bid Price for wind is more representative of current market conditions. SKM notes that NGET/SPTL have provided no explanation of why it has changed the Bid Price for nuclear generation from -£100 to -£200.

SKM also notes that the constraint cost of onshore wind is likely to fall over the lifetime assessment of the Western HVDC link. Wind generation is awarded a subsidy for 20 years, after this period the subsidy will end – but the project may continue to generate beyond 20 years without a subsidy, leading to a likely reduction in its Bid Price after a 20 year period. If the project repowers after 20 years, it is highly unlikely that any subsidy awarded to an onshore windfarm will remain at the current relatively high levels. As a result constraint costs over the life of the proposed Western HVDC link are highly unlikely to remain at the constant levels assumed by NGET/SPTL for the period 2026-2050. The result will be a lower lifetime constraint reduction benefit, particularly as NGET/SPTL note that many of its constraint model runs show around half of the total constrained-off volume to be onshore wind with a constraint price of £90 – (-£75) = £165/MWh (assuming the constrained on plant is marginal gas). In simplistic terms given the subsidy to onshore wind will decrease it may be reasonable to assume, beyond 2030, a reduction in constraint benefits of up to one third.

6.2.3. Modelling constraint costs

SKM notes that the wide differential experienced in the current Balancing Mechanism between the SBP and SSP is due, in part, to the ability of plant operators to predict imbalance and offer their plant accordingly to exploit the imbalance. SKM notes that, if a constraint is perceived to have a finite life based on anticipated reinforcement investment, then the constraint is very likely to be exploited at a resulting high short term cost – as empirical evidence suggests. As a result short term bid prices based on locational considerations may be considerably higher than those assumed by NGET. SKM considers that NGET's bid price assumptions are likely to result in more modest constraint costs than those that might occur on specific, short term constrained boundaries in the real world.

The constraint costs model used in the NGET /SPTL assessment was validated by NGET/SPTL using 2007/8 data and comparing the results from the model against the real outcome. The results of the calibration show that NGET/SPTL's model overestimated constraint costs for 2007/8 by some 27 per cent. NGET/SPTL has not validated the model using other years, but suggests that if calibrated using 2008/9 data, then the model would underestimate actual constraint costs.

The results of NGET/SPTL's constraint model suggest that replicating real world operation of balancing actions taken to relieve constraints is complex – with the cost of alleviating planned and relatively short term constraints difficult to model due to the behaviour of market participants. NGET's model does not allocate constraint costs to specific boundaries – given that empirical evidence suggests that constraints across specific boundaries are indeed exploited (such as the 2008/9 Cheviot boundary), then it is likely that the model will underestimate constraint costs driven by relatively short term boundary limitations.

In assessing rising constraints costs, Ofgem has identified that, on occasion at times of constraint, output from some or all of the generation plant in Scotland was considerably more expensive than comparable generation in England and Wales. Ofgem considered that the relatively high price of generation plant in Scotland behind the Cheviot constraint could indicate the existence of market power. As a result, under the current electricity market arrangements, it remains likely that short term boundary constraints cost will continue to be above those used in the model.

6.3. Losses

In NGET/SPTL's April 2011 submission it concluded that determining the losses benefit is complex, sensitive to the exact location of plant in Scotland, and that reductions in losses resulting from a boundary reinforcement would be partly offset by increases in losses when the reinforcement permits unconstrained flows higher than the previous flow limit. As a result NGET/SPTL assumed in its initial CBA that losses benefits are zero.

However, it was considered that assigning losses a zero value was too simplistic and NGET/SPTL was asked to further explore the inclusion of losses. Considerable interaction had previously occurred between NGET/SPTL, KEMA and Ofgem surrounding the issue of losses that remained unresolved.

In determining losses for the CBA NGET/SPTL highlighted that losses will be driven by the generation and demand background and the network configuration. In assessing the losses NGET/SPTL used the GG scenario, but noted that losses are unlikely to be significantly different between GG with a 4.4 GW transfer and the broadly similar network configuration in SP. NGET/SPTL determined that the maximum power transfer capability of the existing B6 AC interconnector circuits is 4.4 GW (post all Anglo – Scottish upgrades). At such a transfer level total system losses were calculated to be 1302 MW.

Adding the Western HVDC link to the network leads to a redirection of power flows. NGET/SPTL determined that if the link operates at 2 GW, then the transfer across the B6 AC circuits is reduced to 2.4 GW. As a result total system losses were reduced to 1,140 MW.

NGET/SPTL also concluded that a B6 transfer greater than 4.4 GW is not possible without the addition of the Western HVDC link. With the link added the maximum B6 transfer capability will rise to 6.4 GW. As transfer levels increase, system losses also increase, and will eventually exceed the 1302 MW determined above. NGET/SPTL concluded that B6 transfers of 5.4 GW or more will result in higher system losses than transferring 4.4 GW across the AC system only.

However, NGET/SPTL also observed that, if the HVDC link was not in place, the increasing volumes of generation in Scotland must be constrained to stay below the 4.4 GW B6 transfer limit.

NGET/SPTL concluded that any increase in the cost of losses would be offset by savings made by not incurring constraint costs in Scotland.

The resultant cost saving determined by NGET/SPTL was calculated by assessing the number of hours in a year that the B6 boundary transfer will be at each level and multiplying by the cost of losses. Table 4 summarises the system losses calculated by NGET/SPTL for the GG scenario at different transfer levels with and without the Western HVDC link. The energy losses are associated with the duration of the transfer level across B6 that has been used as indexing parameter. Losses on the HVDC converters are assumed to be at 45 MW, reducing at transfers below 2GW and assumed to be disconnected at transfer levels below about 1GW.

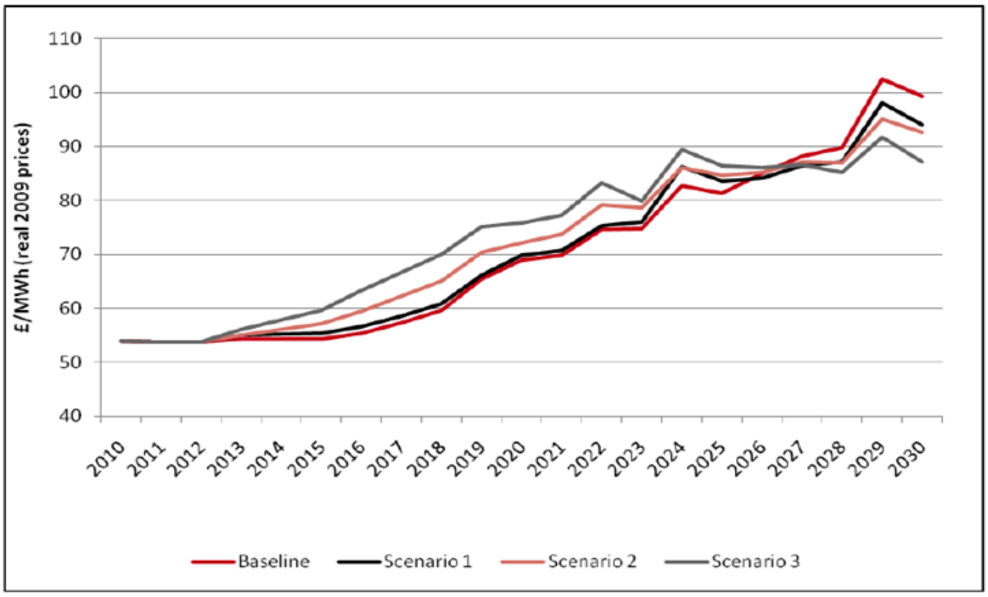
The overall conclusion is that the HVDC link offers a positive cost benefit in terms of reducing system losses. For Gone Green NGET/SPTL indicates a potential losses saving resulting from the Western HVDC link of £16.6m, £15m for SP and £17 m for AG.

- **Table 4 NGET Losses assumptions and calculations**

B6 Transfer Level (MW)	Total System Loss (No Link) MW	Total System Loss (With Link), MW	Loss on HVDC Link (MW)	Delta Loss (MW)	Cost Of Losses (£/MWh)	Transfer Duration (Hrs)	Costs (£m)
6200		1398	45	141	60	0	£0.00
5800		1331	45	74	60	73.5	£0.33
5400		1267	45	10	60	146	£0.09
4800		1184	45	-73	60	345.5	-£1.51
4400	1302	1140	45	-117	60	480	-£3.37
4000	1229	1092	45	-92	60	577.5	-£3.19
3600	1162	1046	45	-71	60	551.5	-£2.35
3200	1113	1021	45	-47	60	634	-£1.79
2800	1063	995	45	-23	60	733	-£1.01
2400	1020	967	45	-8	60	522	-£0.25
2000	981	934	18	-29	60	719	-£1.25
1600	946	898	18	-30	60	1060.5	-£1.91
1200	913	897	9	-7	60	972.5	-£0.41
800	889	889	0	0	60	778	£0.00
400	867	867	0	0	60	778	£0.00
0	854	854	0	0	60	389	£0.00
						8760	-£16.62

SKM concur with NGET/SPTL's assessment of the unit cost of losses. We note that the cost of losses is below DECC's central wholesale electricity price projection for 2016, but is within the range of wholesale price projections made in supporting documents to the government's Electricity Market Reforms proposal (Figure 7).

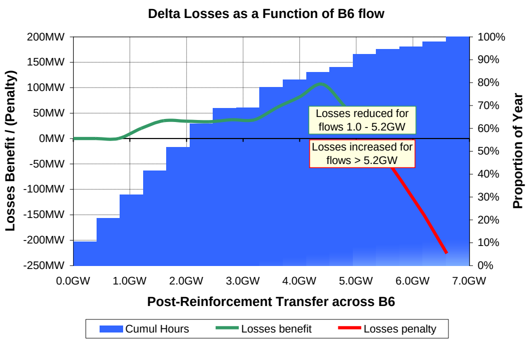
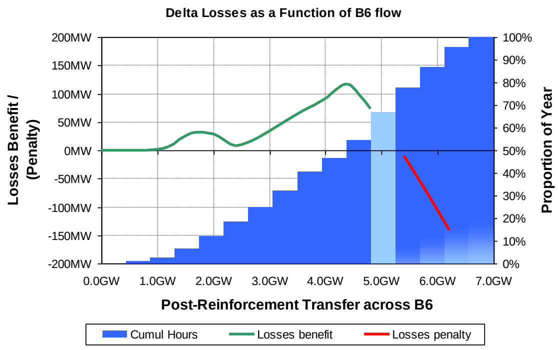
- **Figure 7 DECC assumptions for losses under EMR**



SKM notes the difference between the losses benefit determined by NGET/SPTL in April 2011 and the subsequent re-evaluation in June 2011.

Figure 8 below show the difference in NGET/SPTL's assessment of losses. NGET/SPTL was asked to explain the differences in its assessment of losses, and has not formally done so. However, it has been suggested that the losses benefit differs between the two charts as each represents a different analysis of flows undertaken to minimise losses. In short the actions taken to minimise losses in modelling underpinning the April 2011chart is different to the action taken in June 2011. NGET/SPTL were unable to explain the reasons for the change in 'shape' of the cumulative hours between the charts other than due to model improvements, but noted that different results will be provided by different scenarios and generation backgrounds. Also it is likely that the duration curve will change over time and with increased renewable generation in Scotland. It is unclear how this is captured in NGET analysis.

■ **Figure 8 Changes in NGET losses modelling**

April 2011 Submission	June 2011 Submission
	

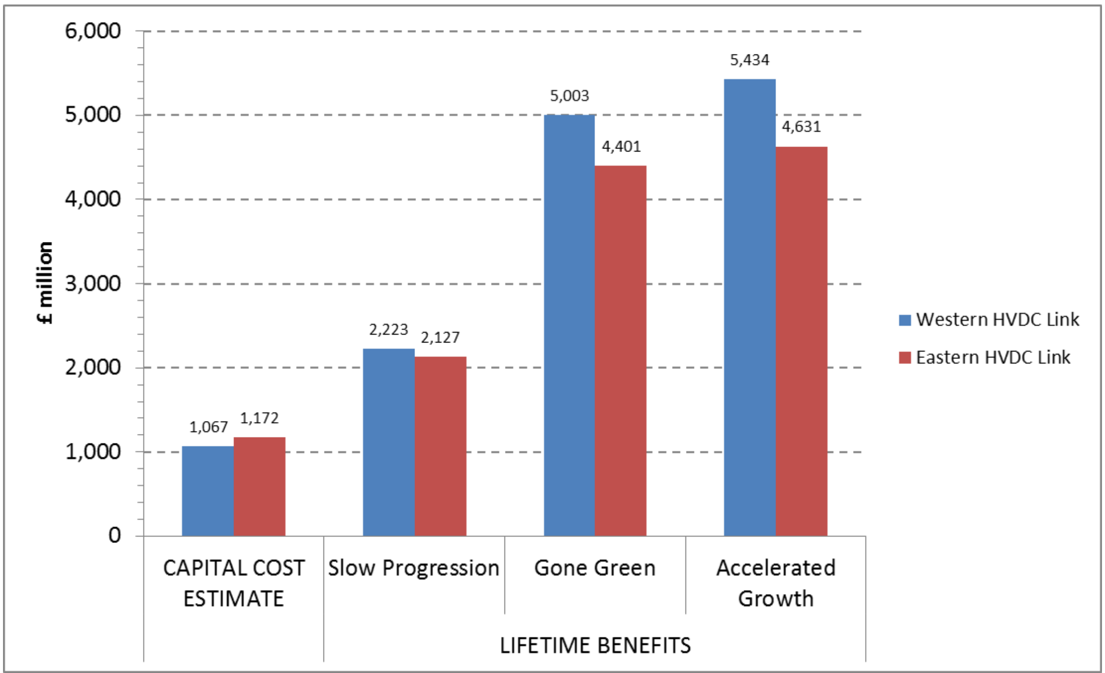
NGET/SPTL's analysis suggests that a positive loss benefit will result from the Western HVDC link for flows up to 5.2 GW across the B6 boundary. At higher transfers, greater system losses will result than without the Western HVDC link – shown in charts where the green line becomes red. However NGET/SPTL conclude that the cost of additional losses will be offset by the reduced constraint costs incurred.

SKM notes the limited explanation and inconsistent results underpinning NGET/SPTL's assessment of losses. SKM concurs that the proposed Western HVDC link will remain a lower loss route to transmit power than the AC system up to 5.2 GW across the B6 boundary. At higher transfer levels the losses benefit becomes negative – representing a cost. SKM concurs that it is likely that reduced constraint costs will be greater than the increase in the cost of losses and hence it represents a second order benefit. However we consider that this issue should be investigated further and the analysis improved in Stage 2.

6.4. Lifetime CBA assessment

The lifetime CBA assessment of the Western HVDC calculated by NGET/SPTL shows lifetime benefits in excess of costs under all scenarios. Figure 9 shows the lifetime benefits assessed under each scenario by NGET/SPTL and compares to the cost of the project – it is clear that, even under the lower renewable scenario, lifetime costs are considerably lower than benefits.

- **Figure 9 Lifetime CBA assessment of Western and Eastern HVDC link**



The key driver underpinning the benefits assessed of the Western HVDC link is the relief of constraint costs that results from the reinforcement in the medium and long term.

In determining the lifetime CBA assessment, NGET/SPTL have discounted the costs and benefits over a 35 year period. Under TII the applicable depreciation period is 20 years, whereas under RIIO the depreciation period is 45 years. SKM concludes that the 35 year depreciation period used by NGET/SPTL is a reasonable proxy for the expected profiling of capital expenditure of the Western HVDC link between TII and RIIO-T1.

SKM also notes that the constraint costs upon which the lifetime benefits are calculated are likely to be overstated given that the subsidy currently awarded to onshore wind is likely to fall over the period to 2050. SKM considers that, as a result, the constraint benefit determined beyond 2030/2035 may be one third less than NGET/SPTL assumes.

NGET did undertake a sensitivity analysis assuming zero constraint benefit beyond 2030 – while the lifetime benefit of the project clearly reduces, it remains above the cost of the project.

6.4.1. Eastern HVDC Link

The lifetime benefits of the Eastern HVDC Link indicate very similar benefits under the SP scenario with lower benefits than the Western HVDC Link in the GG and AG scenarios. Considering the comments above about reduction of constraint cost of onshore wind over time, it can be concluded that, consistent with findings in earlier studies, the lifetime benefits of the Eastern and Western HVDC links are likely to be very similar particularly on the scenarios with lower levels of renewable growth. The Western HVDC link shows higher benefits under those scenarios with higher renewable growth.

6.4.2. Robustness analysis

NGET/SPTL have carried out a range of sensitivity analysis underpinning its CBA, in addition to the implicit sensitivity of the three generation background scenarios. The additional sensitivity analysis undertaken is designed to demonstrate the robustness of the reinforcement over the lifetime CBA assessment. The sensitivities explored included:

- Changes in project capital costs – with project capex 40 per cent greater and 30 per cent lower than total estimated capital costs (see also comments in Section **Error! Reference source not ound.** and 6.5.4)
- Lower constraints – both the cost and volume of constraints – leading to constraint costs up to 30 per cent lower than the base case
- Higher constraints – both costs and volume – leading to overall constraint costs up to 40 per cent above the base case
- Cost of capital – using alternative discount rates of 0%, 5.05%, 6.25% and 10%
- Constraint benefit ending in 2030

For most of the sensitivity analyses conducted, NGET has used a 'consolidated' scenario, an average of GG, SP and AG. Consolidating the scenarios does not assist the transparency of the assessment and SKM asked for the information to be available on a dissagregated basis in the June 2011 submission. For all sensitivity cases analysed the CBA results indicate that the lifetime CBA of the Western HVDC link remains robust. The only exception noted by NGET/SPTL is using a 10% discount rate will result in a negative lifetime CBA in SP.

In terms of constraints, constraint volumes may be lower if the volume of generation in Scotland is less than anticipated by NGET in its three scenarios. Alternatively, short term constraint costs may be higher if market participants exploit a perceived short term boundary limitation.

SKM notes that NGET/SPTL's sensitivity analyses to higher project costs and lower constraint costs and volumes was undertaken only on the GG scenario, or with a 'consolidated' scenario approach – where AG, GG and SP are consolidated. While SKM acknowledges that a 5 per cent reduction in wind output in GG is an approximation of a lower level of renewable growth, even with this reduction renewable output in GG remains above SP. As a result, SKM does not consider a sufficient sensitivity on lower levels of renewable growth was considered by NGET/SPTL and requested additional sensitivity analyses from NGET (Section 3.4).

The CBA also used an expenditure profile based on constant amounts over a four year period. NGET/SPTL submission contained a profile of investment over a five year period. We have also looked at the difference between assuming one or the other in the CBA and amounts to less than 5% increase in costs compared to using the actual profile (i.e. the NGET/SPTL profile in the CBA increases costs slightly).

6.5. Sensitivity to the commissioning date

While a lifetime assessment of the proposed Western HVDC link indicates a positive CBA result under all generation scenarios and sensitivities, the CBA analyses also highlighted that 2015 was potentially not a consistent start date across all scenarios and sensitivities.

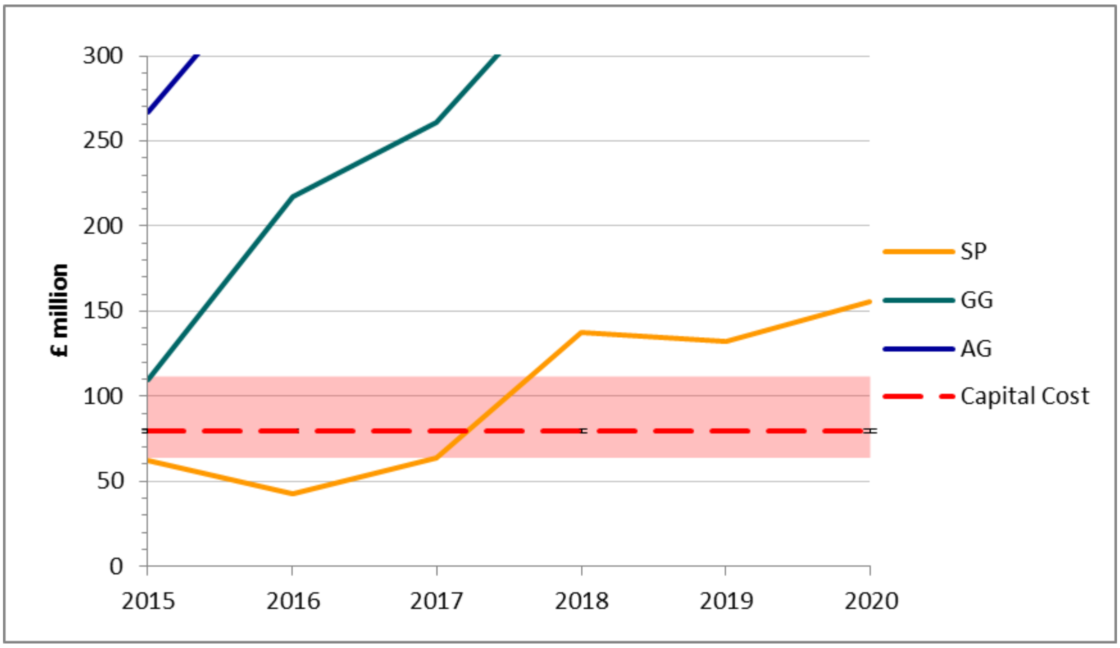
Earlier submissions from NGET/SPTL considered the sensitivity to the commissioning date using an examination of the costs of delaying the project by one year using a composite scenario that utilised equal weightings between the three basic scenarios. The results indicated a strong case to commission the project by 2015.

SKM suggested an alternative presentation based on the annualised cost of the investment and annualised stream of net benefits derived from the reinforcement. Such a presentation would allow a clearer identification of the year in which project benefits were greater than project costs. When the annualised approach was used it showed that:

- the optimum start date for the Western HVDC link under the SP scenario was not 2015
- the robustness of the optimum starting date under the various sensitivity analyses was considerably reduced compared to the results of the lifetime assessment

Figure 10 shows the annualised costs and benefits of the project. The results indicate that the annualised benefit of the project remains consistently above the annualised costs under GG and AG. However, under SP the annualised costs are higher than the annualised benefits until 2019 – based on NGET's initial submission. Taking into account the benefit of losses of around £15m in SP would result in a required start date for the project of 2017/18.

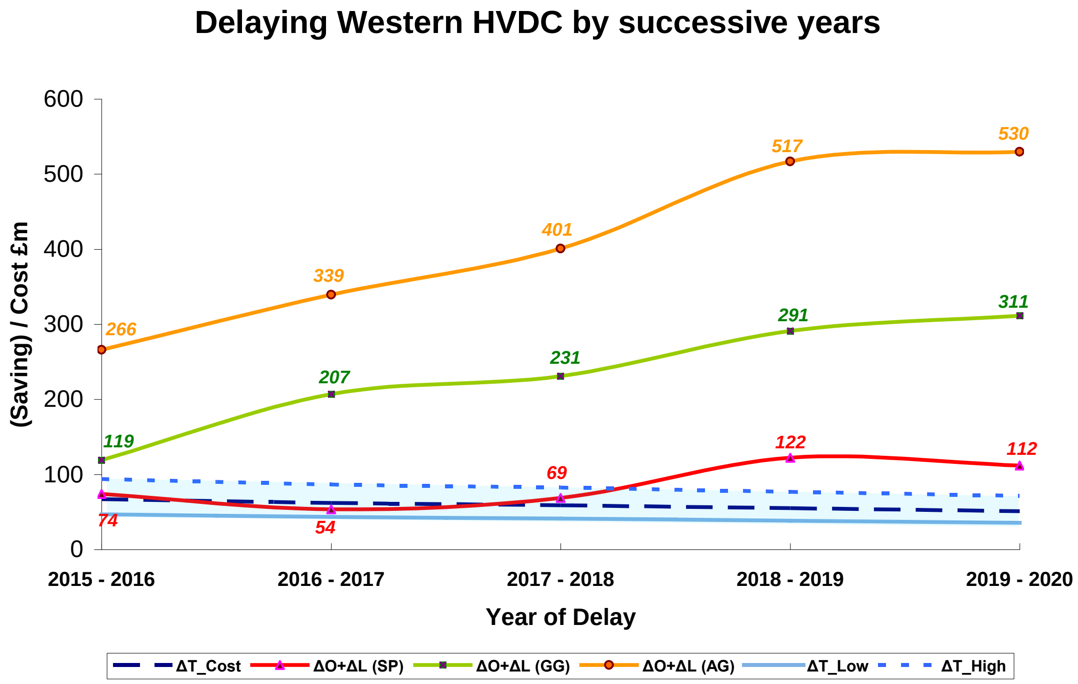
▪ **Figure 10 Optimum start date under SP,GG and AG**



As a result SKM considers that, under the SP scenario, the Western HVDC link does not seem to be justified until 2017/18 but under the GG and AG scenarios the earliest possible commissioning date of Dec 2015 seems justified.

NGET/SPTL's preferred methodology for assessing a delayed start date is to calculate the lifetime costs and benefits with a one year delay in the start date. The analysis made in the case of the Western HVDC is reproduced in Figure 11. The chart shows the constraints costs(including losses)for each of the three scenarios (orange, green and red lines) for successive delays by a year against the capital cost saving (dark blue dashed line) with a tolerance (blue shaded area) that gradually reduces due to discounting. The conclusions are the same as above.

▪ **Figure 11 NGET Western HVDC timing analysis**



6.5.1. Impact of upstream reinforcements

NGET based its initial CBA on the assumption that a number of potential reinforcements identified by the TOs are all assumed to be commissioned by 2015. These include:

- All TIRG and TIRG related upgrades of the Strathaven – Harker and Eccles – Stella West routes. **2010 – 2012**
- Up-rate the Stella West – Norton route to 400kV. **2012**
- Re-conductoring of the Harker – Hutton – Quernmore route and the Heysham 400kV ring. **2013**
- Installation of quad boosters at Penwortham: **1st QB 2012, 2nd QB 2013**
- Beauly – Denny single 400kV circuit. **2014**
- Beauly – Blackhillock uprate. **2014**
- SHETL east coast scheme which establishes a 400kV double-circuit route from Blackhillock via Kintore and Tealing to Kincardine. **2015**
- A corresponding reinforcement to the above reinforcement within SPT to the B5 boundary. It is not clear to us at what exact date SPT intend to complete this reinforcement. For the purposes of the CBA, we have assumed 2015.

- The incremental reinforcements to the B6 boundary; principally series compensation in both SPT and NGET but also the SPT East-West scheme. **2015**
- A new SHETL undersea cable from Mybster in Caithness to Blackhillock in Aberdeenshire and other works to reinforce boundary B1. **2015**

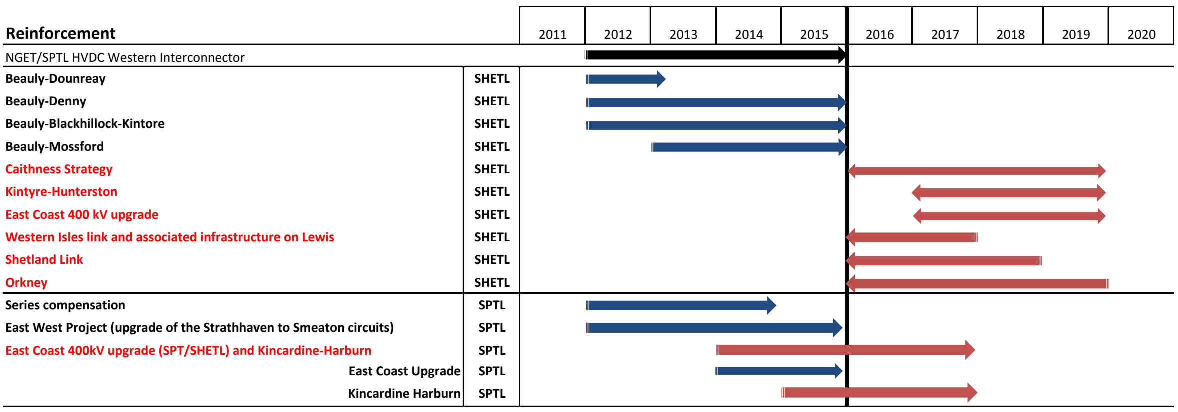
NGET stated that the assumed dates above come from National Grid's business plan (for NGET schemes) or from the latest information we have been given by the Scottish TOs (SHETL or SPT schemes).

NGET explained that the rationale for adopting the reinforcements above was to allow the constraints model to consider flows from within Scotland as unconstrained as possible, and so maximise the benefits of HVDC links. If the model was run without the reinforcements, constraints within-Scotland would occur, particularly in later years with increased onshore wind in North Scotland. As a result the benefit of HVDC links would reduce. NGET also suggested that studies without the reinforcements listed above would 'skew' the value of the Eastern over the Western link as the Eastern link increases B4 capability, whereas the Western link does not. NGET strongly believes such studies would give a distorted comparison of Eastern over Western, since it is unfair to benefit Eastern for absence of onshore reinforcements that are cheaper and should be progressed first.

As a result NGET considered its CBA assumption, that the reinforcements described above are in place in the base case, is the most appropriate.

SKM has reviewed the reinforcements that are assumed to be undertaken by 2015 by SPTL and SHETL using documents available in the public domain and made available by Ofgem for the purposes of this review. SKM considers that NGET is not reflecting in its assessment the available information about the timing of the reinforcements in Scotland.

- **Figure 12 Timeline for onshore reinforcements in Scotland**



The chart above attempts to show the proposed timing of the reinforcements by SHETL and SPTL. The right arrows indicate the latest expected completion date of the reinforcements highlights, and the left arrows indicate that the reinforcements that cannot be delivered earlier than indicated.

A key number of reinforcements in the SHETL area are scheduled to be completed beyond 2015, including the East Coast upgrade, Caithness Strategy and Kintyre-Hunterston HVDC.[22] As a result the potential constraints resulting from renewable generation dependent upon these reinforcements cannot be considered to be relieved by the Western HVDC link

Two significant "developer led" reinforcements (the HVDC links to Shetland and the Western Isles) have no user commitment and SHETL does not expect these projects can be completed before 2015.[23] If the reinforcements to Shetland, Western Isles and Kintyre are not undertaken by 2015, then the renewable generation associated with these developments (potentially up to 1.4 GW) will be unable to proceed.

The benefits of the WHVDC may be further reduced if the Caithness Strategy and East Coast upgrade are delivered later than 2015.

In summary SKM considers that:

- The Western HVDC will not be as effective in removing constraints by 2015 as indicated in NGET's analysis as it offers little relief to the network constraints upstream of the Western HVDC link.
- Several significant generation projects associated with major reinforcements are unlikely to be developed by 2015, the date assumed by NGET in its CBA.
- NGET base case should have reflected in the CBA the information in the public domain about the development of these projects and expected timing for commissioning as indicated by the Scottish TOs (see also Stage 2 submission recommendations in Section 9.2)

As a result SKM believes that the NGET CBA is overstating the benefits that will be derived from the project.

In order to capture the uncertainty over the timing of the assumed reinforcements and the unlikelihood of the reinforcements being in place by 2015, SKM requested a sensitivity analysis to investigate the impact on the timing of the Western HVDC link of considering the impact of considering the expected timing of onshore reinforcements in Scotland rather than assuming that all

[22] SHETL Green Book http://www.ssepd.co.uk/uploadedFiles/TPCR5_Green_Paper.pdf/
[23] SHETL White Paper http://www.ssepd.co.uk/uploadedFiles/Content/14_Investors/WhitePaper.pdf

of those will be commissioned by 2015. Specifically NGET considered removing the following reinforcements form their base case:

- Mybster to Blackhillock ('Caithness') DC circuit
- 'SHETL East Coast' Kintore to Tealing 275 to 400kV upgrade
- Associated SPTL reinforcements to B5.

The results of the sensitivity analyses (see Section 6.5.7) indicated a positive CBA result for the lifetime of the project under both SP and GG scenarios. However, the sensitivity analysis also showed that, under SP with the delayed reinforcements, the project would not be required until 2017/2018.

Given that the reinforcements cannot be delivered by 2015, SKM considers the sensitivity analysis with delayed reinforcements in Scotland should have been considered the 'Base Case' for GG, SP and AG. This should be further considered in the revised submission under Stage 2.

6.5.2. Lower Wind profile

While NGET/SPTL believe that most weight should be given to the Gone Green scenario, as outlined in Section 3, SKM considers a lower rate of renewable generation growth in Scotland a more feasible outcome than the rate of growth outlined in GG. However, SKM does not consider the rate of growth outlined in SP differs sufficiently from GG, with onshore wind only 8% lower in SP than GG by 2020. In addition SKM does not consider NGET/SPTL's sensitivity analysis on GG of a 5% reduction in wind output was a sufficiently robust assessment of lower wind growth. As a result SKM considered no 'downside' assessment of onshore renewable generation had been made.

SKM requested NGET/SPTL undertake three additional sensitivity analyses:

- Delay 1 GW of onshore wind development by three years from 2016 to 2019 in SP. SKM considers such a sensitivity will explore the impact of delays to the large schemes involving HVDC connections in the SHETL area and may also be used for looking at the impact of on the timing of considering the actual expected delivery date of the upstream onshore reinforcements in Scotland. The details of the assumptions made to consider the onshore reinforcements were discussed in Section 6.5.1 above.
- Delay 1 GW of onshore wind development by three years from 2015 to 2018 in GG
- Reduce total onshore wind by 2 GW by 2020 in SP, but also extend the life of Hunterston nuclear power station by a further five years to 2021. Reducing the total volume of renewable generation would reflect a 'downside' renewable development – supported by the scenarios

published by DECC/Arup in June 2011 showing only 5.5 GW of onshore wind in Scotland by 2020.[24]

- Re model the impact of including embedded generation into SP and GG scenarios. This is to correct an error in the NGET modelling in the previous submission and this assumption was include in the CBA analysis presented in the June 2010 submission
- Refer to Section 6.5.7 for an overview of the results which not affect the overall timing conclusions above
-

6.5.3. 2 GW less wind by 2020 with Hunterston life extended

As indicated above the sensitivity conducted assessed the impact of 2 GW less onshore wind generation by 2020 than SP, but with the life of Hunterston nuclear power station extended to 2021. The results of the sensitivity analysis suggest that, assessed over the lifetime of the project the project indicated a positive result.

However, the results also showed that, under this feasible scenario, the reinforcement is not required until 2017/18. Refer to Section 6.5.7 for an overview of the results.

6.5.4. Capital costs

NGET/SPTL considered the impact of a 40 per cent increase in project costs, together with a 30 per cent reduction. While a cost reduction will clearly have a substantial benefit on the CBA results, a 40 per cent cost increase will reduce the positive outcome of the CBA. [redacted].

The sensitivity analysis of 40 per cent greater capital costs is a reasonable assessment of the potential upper level of project costs. The results indicated a positive CBA result over the lifetime of the project under all scenarios.

In terms of the potential impact on the required timing of the project – increasing the capital cost of the project has little impact under the GG scenario. In SP increasing project capex by 40 per cent does not affect the timing of the project – with 2017/18 remaining the required commissioning date under the 'Base Case' without all reinforcements by 2015.

These results will be updated in Stage 2 with the latest capital cost estimates.

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[24] http://www.decc.gov.uk/publications/basket.aspx?filetype=4&filepath=What+we+do%2fUK+energy+supply%2fEnergy+mix%2fRenewable+energy%2fpolicy%2frenew_obs%2f1834-review-costs-potential-renewable-tech.pdf#basket

6.5.5. Link Capacity

This sensitivity considers the impact on the optimum start date for the Western HVDC link of reducing the link capacity to 1.8GW (minimum allowed in the tender). NEGT/SPTL has not considered the impact of reducing the capacity of the link to 1.8 GW on the CBA model. However NGET provided an estimate of the changes assuming a worse case scenario that the 1.8GW results in a 86% (1.8/2.2) reduction in removed constraints and assuming the same capital cost.

The results indicated that the changes from such reduction in removed constraints did not affect did not materially affect the conclusions with respect to lifetime benefits or timing.

These results will be updated in Stage 2 with the link capacity estimates from the tender evaluation.

6.5.6. Eastern vs Western Link

In order to establish which of the HVDC links is the optimum ‘first’ reinforcement from a CBA perspective, a full assessment of the costs (constraints and capital) and savings (constraints and capital) across all boundaries should be made (B2 to B7a, or any other boundaries where it may have an impact). Each reinforcement option provides benefits across particular boundaries, for example the Eastern HVDC link will mainly provide benefits across boundaries B2 to B6. The benefits provided should be credited against the additional reinforcement costs that need to be incurred to reinforce those boundaries where the option is less effective, for example the Eastern HVDC link provides little benefit across boundary B7a.

In conclusion, SKM considers that the Western link was initially identified as the ‘first’ option on the basis of a very limited assessment of project costs and this bias has continued in subsequent analysis. Furthermore not all the costs of the Western link are taken into account in the CBA, including substation costs and onshore reinforcement costs. It appears that no full CBA of *all* the costs and benefits associated with both the Western link, Eastern link, other onshore reinforcements and constraints was conducted back in 2009, or has been conducted since.

Under the higher renewable scenarios, an HVDC link may be required by 2015/16. The Eastern link cannot be delivered until at least 2017/18, but that the Western link is a more advanced project and can be delivered. As a result, under the higher renewable scenarios and notwithstanding the results discussed in Section 5, SKM can only conclude that the Western link is the optimum ‘first’ reinforcement.

NGET has however provided CBA results that compare the benefits from the Eastern compared to the Western, assuming both are commissioned at the same time for a range of years from 2015 to 2019. The results indicate that the Western HVDC delivers higher benefits than the Easter HVDC under a range of sensitivities particularly for the higher renewable growth scenarios.

6.5.7. Summary of key sensitivity results

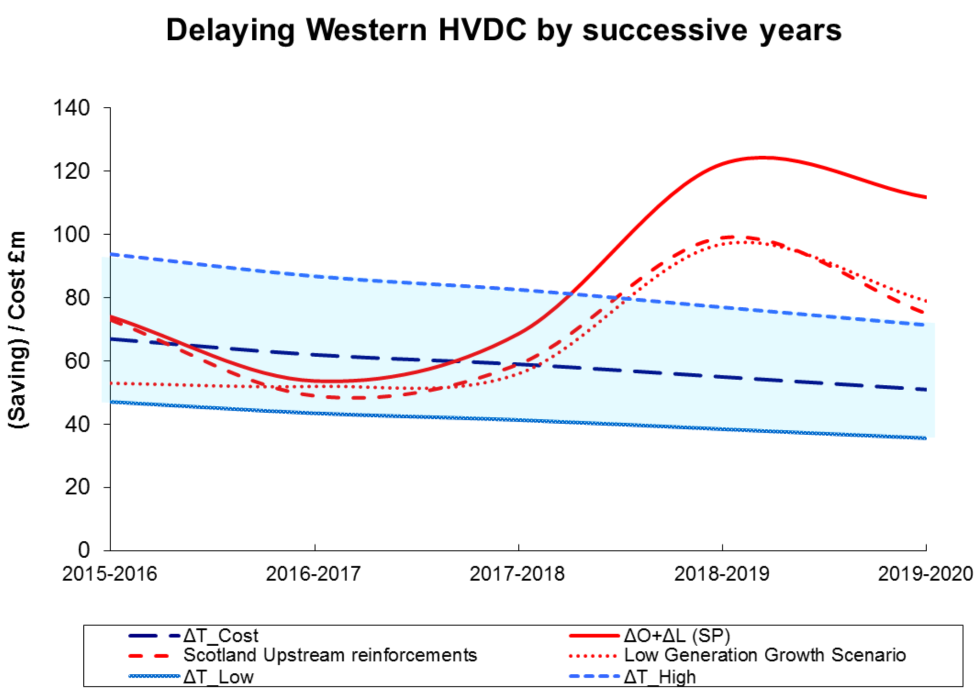
Figure 13 summarises the CBA results obtained for the SP scenario, which is the critical one when it comes to timing of the reinforcement. The red line is that used by NGET in their submission for SP (Figure 11).

The red dashed line shows the sensitivity of the benefits to the upstream reinforcements in Scotland in the short term. The red dotted line shows the sensitivity of the benefits to a scenario with much reduced generation in Scotland (about 6.5GW by 2020) and life extension to Hunterston. Both cases are similar and do not alter the key conclusions obtained.

Results do not change significantly as the majority of the constraints removed by the Western HVDC are across B6 and B7a and hence the results seem relatively insensitive to an increase in constraints in Scotland. In the case of the scenario with reduced renewable growth in Scotland a similar result is obtained. In this case however the inclusion of an extension to Hunterston limits the benefit of the reduction in renewable growth in terms of constraints.

In both cases the results hardly change and indicate an optimum delivery date of 2017/18 under the SP scenario. The constrain costs (red lines) are above the capital savings achieved from the delay from 2017 to 2018 (although within the high tolerance) and well above thereafter.

- **Figure 13 Summary of key sensitivity studies. SP**

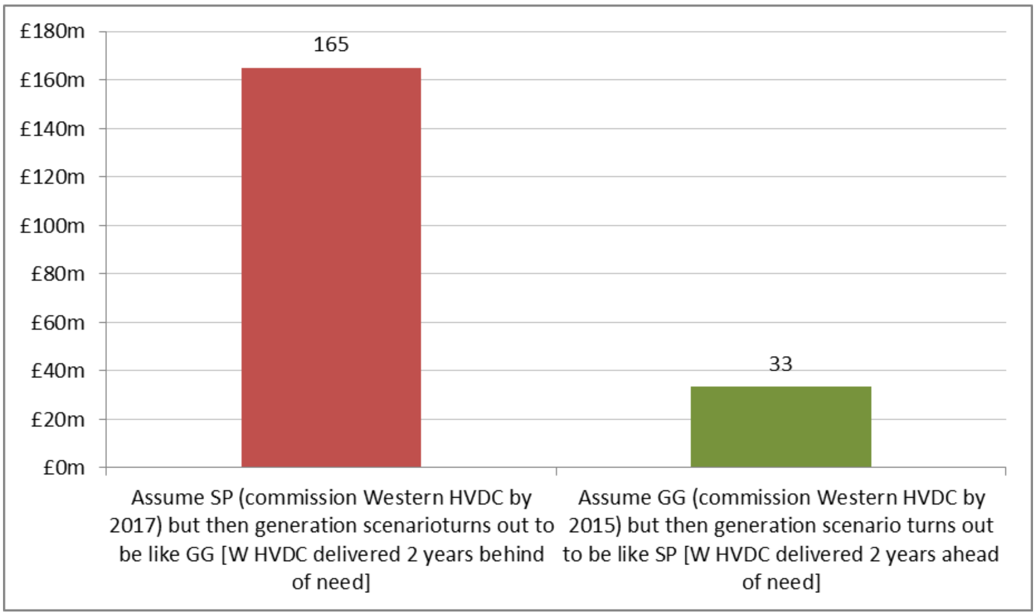


6.6. Timing decision and Risk

The optimum timing for commissioning the Western HVDC link is dependent on the scenario used and varies from 2015 (earliest possible construction end date) for GG and AG scenarios, to 2017/18 in the case of the SP scenario. As there is great uncertainty about what renewable growth path will outturn, an assessment of the cost that would be incurred if the assumption made turns out to be wrong.

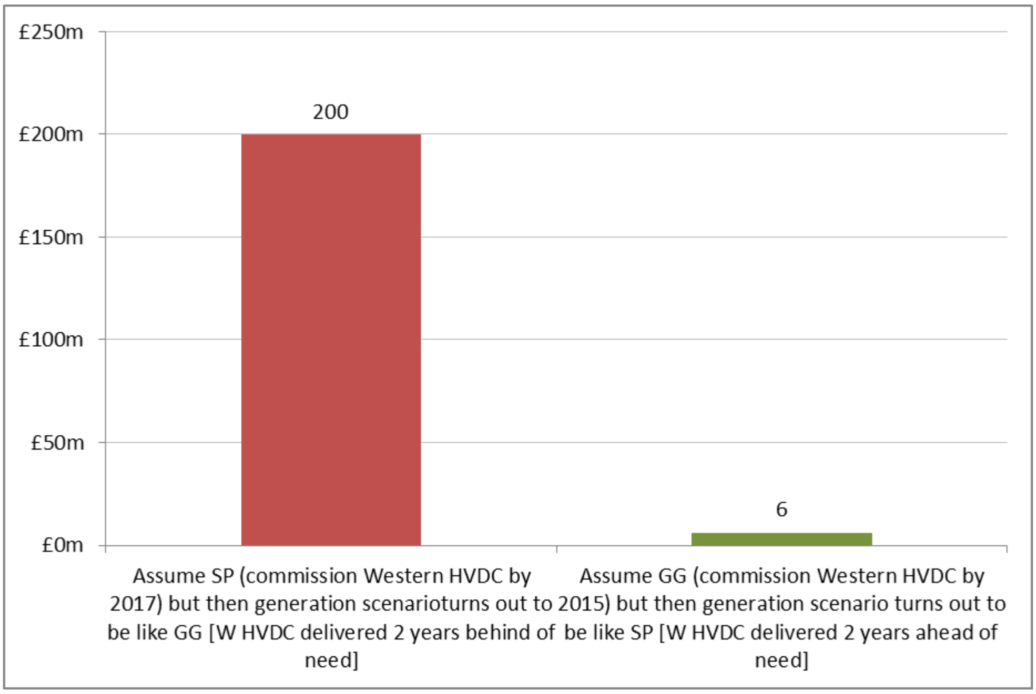
The analysis indicates (Figure 14) that if the Western link is commissioned in Dec 2015 and the renewable growth scenario turns out to be like SP the additional costs (via forwarding of capital cost) would amount to circa £33 million. If however the link is commissioned in 2017/18 (SP) and then the growth path looks like GG then the additional cost (via increased constraint costs) would amount to circa £165 million (i.e. about 5 times higher).

- **Figure 14 Cost of getting the timing wrong, Red: Late – Green:Early (2 years)**



If losses are considered, as calculated by NGET/SPTL, then the spread in the costs increases to £6 million and £200 million respectively (Figure 15). It can be concluded that the potential cost of being wrong by delivering the project early could be very small whereas the cost delivering the project late could be very high.

- **Figure 15 Cost of getting the timing wrong, Red: Late – Green:Early (2 years) including effect of electrical losses.**



We also considered the impact on the above conclusion of delaying the project by 1 year (i.e. commissioning 2016). The 'cost of being wrong' for the SP and GG assumption as per above reduce to £36m and £29m respectively (without losses) which compares to the values in Figure 14 above. When losses are included the costs are £53m and £14m for the SP and GG respectively which compares to the values in Figure 15. This indicates that the option with lowest cost of being wrong (£6m) is to commission the Western HVDC by Dec 2015.

7. Other Unmonetised Risks and Benefits

Key messages:

- Clearly delaying the project will increase the robustness of ‘need’, but...:
- Investing early and ‘being wrong’ will lead to a smaller penalty than investing late (using the GG vs SP)
- Empirical evidence tells us that constraints are likely to be much larger than suggested in the CBA as players exploit the opportunity presented
- So the cost of ‘being wrong’ by investing late is likely to be above model calculations
- Even if the project is delivered ahead of need (uncertainty about future developments) there will be other non monetised benefits such as
  - Removal of uncertainties for project developers
  - Lower financing risk premiums
  - Resulting in earlier delivery of renewable projects and CO2 reductions
  - Alleviation of cable manufacturing constraints for other R3 projects
  - Others – signal to the market of UK’s intent to invest in renewables?
- Leads to a ‘bias’ in favour of constructing earlier rather than later
- Uncertainty is key – most investments face a degree of uncertainty that the investor must bear
- For the Western link it is the customer, not the TOs, that bear the cost of getting the investment timing ‘wrong’ by delivering the project early or late
- Absolute certainty over the exact required timing of the link is impossible to determine (i.e. although all scenarios have the same initial 3-5 years as they are largely based on firm commitments, it is uncertain which scenario will apply beyond that)
- Different “optimum timing” may apply to each generation scenarios. We could end up with a range (i.e. optimum between 2015 and 2018 depending on scenario)
- The costs to the consumer will be lower if the project is delivered one year early rather than one year late
- Bias towards earlier investment given the market uncertainties and ultimate cost to the consumer

7.1. Uncertainty

A key issue with the analysis undertaken to support the CBA is uncertainty – in particular the level of renewable generation commissioning in Scotland over the period to 2020. While national and Scottish targets suggest considerable volumes of onshore wind generation will be required in

Scotland, targets alone will not ensure this capacity is delivered. SKM considers NGET's assessment of renewable growth in Scotland optimistic and considers a lower trajectory of growth more plausible. However, neither view can be considered certain and both are likely to be wrong to some extent. As a result an optimum investment decision must be taken on the basis that the decision represents the 'least wrong' for the consumer.

While uncertainty surrounds the future generation mix in Scotland, in particular the rate of renewable growth, the results of the CBA suggest that investing early may be less costly to the consumer than potentially investing late.

Furthermore, while a lower trajectory of renewable development in Scotland suggests the HVDC link between Scotland and England will not be needed before 2017, a range of other non-monetised issues must also be taken into account when assessing the results of deferring the investment until 2017.

7.2. Real constraint costs

The first is the potential real cost of constraints over the period to 2017 if construction of the Western HVDC link is deferred.

SKM considers that, on balance, investing ahead of need may lead to lower costs to the consumer than the potential for significant exploitation of constraints.

7.3. Construction risk

Another issue to be considered in the case of investing ahead of need is the assumed construction period of the project. The project is due to be commissioned in December 2005, although NGET has built contingency periods within its construction timetable, the risk of weather delays is real. One or more weather events may delay the commissioning of the link into 2016.

7.4. Cost risk

Cost creep is another risk. The cable market is one of limited competition, with cable costs difficult to forecast. The cable market is driven less by changes in the commodity prices underpinning cable construction costs than by the perceived supply and demand for the cables. Demand for HVDC cables is set to increase if the anticipated growth in offshore generation in Europe and other HVDC cable demands, such as additional HVDC reinforcements also earmarked for Scotland before 2020, all materialise. If cable demand does indeed increase significantly over the next five years, then delaying the project may lead to an increase in cable costs.

On the other hand if the development of offshore wind is less robust, then there may be less pressure on the cable market and subsequent costs. Again, uncertainty surrounds key market drivers. In terms of mitigating the risk to NGET, then it may be contractually feasible to defer the project for a year although this would need to be confirmed

7.5. Message to market

Another issue difficult to quantify is the message that construction commitment will send to the market. A commitment to the infrastructure underpinning renewable generation will be a positive policy message for project developers, financers and other stakeholders. Such a message may also play a role in reducing perceived project risk. On the upside, such a positive message may lead to more renewable generation, with subsequent benefits in terms of CO_2 reductions.

8. Contract award process review

Key messages

- NGET/SPT have established a comprehensive tender evaluation process and procedure leading to contract award of the Construction contract.
- NGET /SPT have an Evaluation and Contract Award Plan and Programme with fully resourced teams for tender assessments which overall is currently on schedule.
- The procedure has an identifiable process and the programme has prescribed key dates for project and company boards governance approvals and sign offs, however these seem to be under review and unapproved by shareholders at this stage,
- NGET/SPT have a Risk Review Process including a maintained Risk Register which is regularly updated, includes risk mitigation actions and will form part of the modelling for Whole Life Cost which is one of the key assessment elements of the scoring criteria (represents [redacted])
- Current level of TQ's and associated clarifications and meetings with respect to each of the three tendered Lots under consideration has the potential to negatively impact progress on each assessment stage. [redacted].

8.1. Construction Procurement

NGET/ SPT have in place an overall procurement plan with associated procedures for the Construction element of the Western HVDC Link project for the Convertors and Cable.

Following the DAWS and Development Agreement phases including finalisation of design options which were completed in 2010, and following period of consultation with interested parties including main equipment/materials suppliers, a Construction ITT strategy was established for the Construction stage tenders to be submitted in Lots as follows:

- Lot 1 – Convertors only
- Lot 2 – Cable only
- Lot 3 – Convertors and Cable

ITT documents were issued in December 2010 and Tenderers submissions were received by NGET/SPT in May 2011 – technical proposals including drawings were submitted on 3rd May with full tender response including commercial submission on 10th May.

[redacted]

- [redacted]

Generally NGET/ SPT appear to be on schedule with the Construction contract procurement and award programme and are currently in the Tender Evaluation stage, which is scheduled to continue through to end of August 2011.

Following their Evaluation Assessment Stage 3 NGET/ SPTL anticipate being in a position to move to final negotiations with issue of BAFO[25] notice to selected tenderer(s) in October and BAFO submission by early November 2011.

The final stage [redacted] assessment is due to be completed by end of November to allow NGET/ SPT Board approvals and Contract Award scheduled for December 2011.

The overall evaluation and contract award programme is achievable

8.2. Internal Governance and approvals

NGET/ SPT program and procedures from tender evaluation stage through negotiation and BAFO leading to contract award has clear and specific time (dates) and governance related gated approvals. These approvals process will require NGET's and SPT's respective boards approval and sign off in addition to the NGET/SPT Upgrades Ltd Company Board approval.

NGET and SPT have their own prescribed arrangements for delegated authority and main board sign off which will requires harmonisation within the overall contract award programme. NGET/SPT indicate the following minimum requirements:

- A robust plan for obtaining outline planning permission for both converter sites by mid-December 2011
- A robust plan to ensure Land is procured (or firm contractual options) in place for both converter sites at time of contract award
- A robust plan in place which will ensure that Land and sea corridor consents or firm contractual options will be in place at time of contract award
- Confirmation that the approved ITT and contracting process has been executed

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[25] See also note in Table 5

- A position agreed (within a range) with preferred bidders on all major risks
- A risk assessed construction outturn cost (within a range)
- A detailed plan for the conclusion of any outstanding issues
- Confirmation of regulatory funding for 2011/12 and 2012/13 and confirmation of licence changes

We note however that NGET indicates in their submission that the Procurement Governance process is currently being reviewed by shareholders. The timely approval of the Governance process is highlighted as a 'Medium' risk with very high impact on the schedule. However, the supplied info indicates just one project board meeting between early July and the end of November. We expect that NGET will provide further information on the progress of this important issue in their Stage 2 submission.

8.3. Tender Evaluation

NGET/ SPT have in place a substantive Tender Evaluation process and associated procedures, including prescribed scoring and contact award criteria, and a fully resourced Tender Evaluation Plan.

The Tender Evaluation teams are effectively split into two main groups subdivided into principal work stream team activities:

- Commercial – Legal and Costs
- Technical - Systems, Convertors, Cables, Environmental /Planning, Safety/Quality

The work stream teams carry out their evaluation work independently on their respective activities, in eight separate locations co-ordinated and managed through a LiveLink system. Some personnel are listed as being involved in more than one work stream activity. The work stream team leaders meet on a weekly basis to share information on progress and specific areas of concern or items for clarification and co-ordinate the tender evaluation scoring of the bids.

The NGET/ SPT tender evaluation process has four Assessment stages:

- Assessment 1 -May and June 2011– preliminary evaluation phase which identify initial queries and clarifications arising from the tender submissions and provides a first stage scoring
- Assessment 2 – July 2011- further clarification /queries and includes preliminary negotiations and second stage scoring
- Assessment 3 – August to October 2011- further submissions, negotiations, proposals and scoring in advance of BAFO notice to be issued in September

- Assessment 4 – November 2011 – final assessment following receipt of BAFO, with final scoring and recommendations for contract award.

NGET/ SPT have advised overall progress on tender evaluation was considered to be on schedule although from the information provided to SKM it was noted some items in Assessment 1 stage were shown to be behind schedule. NGET/SPT were confident any activities currently running behind schedule would be pulled back by the beginning of July, with additional resource if necessary drawn from NGET or SPT's own staff through the JV company agreement or from external services support available to NGET and SPT.

The tender evaluation process in Assessment 1 stage has generated a considerable number of TQ's [redacted].

NGET/ SPT anticipated completing on programme the first stage of assessment and preliminary evaluation and scoring by 01 July 2011. The Evaluation scoring process, criteria and templates form part of the Tender Evaluation Procedure and appear to be substantive in content covering the main areas of assessment.

A paper to NGET/SPT Project Board will be prepared and submitted at the end of June which will set out the initial findings of the tender evaluation processes and the NGET/SPT proposed negotiating strategy.

SKM note that although initial tender clarification meetings had already commenced, and an initial pass review had been undertaken on some of the contractual items arising out of the tender submissions, no meetings had yet taken place involving main equipment/cable suppliers – NGET/SPT indicated this would be part of the further technical evaluation and clarification in Assessment 2 and 3 stages to take place in July/August.

NGET/ SPT provided in the ITT documents for alternative bids (technical and commercial variants) in addition to a compliant bid. Some alternative proposals had been received principally relating to cable suppliers and cable ratings. NGEL/ SPT acknowledged they had not received any significant alternative bids or proposals in respect of innovative alternatives. Options are only considered if technically acceptable.

NGET/SPT acknowledged current main challenge at this stage of evaluation of tenders is managing the tender assessment and negotiation process, including dealing with the volume of TQ's, to be in a position to meet the programmed completion dates for each stage of assessment and NGET/SPT scheduled formal governance meetings of the both the NGET/SPT Project Board and the NGET/SPT Company Board.

8.4. Risks

NGET/SPT have in place a Risk Review process and have prepared a Project Risk Register which is regularly reviewed and updated with respect to both current risks and emerging risks. The Risk Register records the individual risk item , cause, consequence, stage of project affected, current assessment, risk mitigation actions, and residual assessment with an independent consultancy G&T running risk workshops and risk modelling using @RISK for both cost and time.

The output from the risk assessment is part of the Whole Life Cost model which will form part of the first cut in the tender evaluation process and completed prior to formal governance approval and sign off.

The Consents and access progress is as follows:

- Onshore Cable routing – [redacted]. NGET/SPT have appointed experienced Land Agent consultancy to deal with consent matters.
- Offshore Cable routing - NG SPT working with Crown Estates and Isle of Man authorities – no significant issues identified to date.
- Converter stations - NGET/SPT working with relevant Local Authorities in respect of planning consents.

NGET/ SPT advised that within the Project team they were utilising the services and experience of one of their senior engineers who had been involved in the recent Britned project, that was delivered on time and budget, and whose experience and lessons learned from that project would be a valuable input at this stage in the project in tender evaluation, assessment, negotiation and input to risk mitigation.

Contingency plans for Construction contract award being delayed until after December 2011- NGET/SPT are aware future events may prevent or prejudice award of the Construction contract in December and such events affecting award have been detailed in the Project Risk Register with their respective mitigation actions and responses set out.

The action and response and resultant effect on Construction cost and time will in each case depend on the materiality of the cause and its potential to affect contract award. The impact on the construction programme could range from an immaterial delay to a significant delay for example:

Contract award in December being maintained or slightly delayed but awarded on the basis of Limited Notice to Proceed e.g. delay in wayleave access requiring extended negotiations with landowner(s) or compulsory purchase;

Significant delay to award (number of months) with completion date of Construction contract being put back into 2016 and possibly as late as Q4 2016 for significant impact events e.g. delay in Ofgem's process towards reaching a decision on the funding request, or matters affecting securing the cable manufacturing and supply in timescale to meet the programme, particularly subsea cable laying.

NGET/SPT within the tender evaluation and negotiation period have the ability to significantly manage, influence and control potential cost and time impacts but this will change as the process moves forward towards BAFO stage and contract award and also as other external influences such as other European transmission projects move into procurement and construction to affect equipment and cable supply and installation.

8.5. Monitoring Methodology

NGET/ SPT's Evaluation Plan provides a methodology for internal monitoring and managing progress with key tender evaluation work stream activities tracked by Evaluation Progress Indicators (% progress) highlighted on a Gantt Chart.

In addition high level progress details on the tender evaluation process are provided as part of the regular reports to the NGET/SPT Project Board.

For the purposes of providing visibility to Ofgem and to allow the monitoring of progress in the second stage assessment it is considered the progress tracking used by NGET/ SPT could be extended in report to Ofgem but at high level against key activities or key milestones either on a 'percentage progress achieved' or 'yes/no achieved'.

Appendix A contains a snapshot of a Gantt chart provided by NGET to monitor the progress towards contract award. NGET may suggest an alternative progress reporting to Ofgem but it is suggested that the following key milestones[26] are included:

[26] Dates based on NGET/SPT. HVDC Western Link Plan 110629 v1.54 Gantt Chart

■ **Table 5 Suggested key Contract award process milestones to monitor under Stage 2**

Milestone	Start date	End Date
Access and consent – Onshore cable	ongoing	TBA[27]
Access and consent – Offshore cable	ongoing	TBA
Access and consent – Converter stations	ongoing	TBA
Assessment Round 2[28]	04/07/11	12/08/11
Assessment Round 3	15/08/11	23/09/11
Assessment Round 4	26/09/11	25/11/11
BAFO[29]	26/10/11	25/11/11
[redacted]	[redacted]	[redacted]
Stand Still	09/12/11	23/12/11
Construction contracts Governance approval and contract award	17/10/11	23/12/11

At this stage however it was not clear whether there is a specific criteria that each of the boards will apply in deciding whether to proceed with contract award. It is likely that each board will have its own set of conditions and markers and these will inevitably take into consideration the status of the contractual, commercial and technical negotiations, and the status of the major risks and risk mitigation measures taken.

8.6. Conclusions

From the information provided by NGET/ SPT to SKM it is considered the procedures and processes being used by NGET/ SPT are robust, comprehensive and appropriate for the Western HVDC Link project and take into account and allow in the programme for company governance approval and sign off.

Progress towards Construction contract award generally appears to be on schedule [redacted].

[27] Gantt chart indicated 01/07/11. Updated end dates for planning and consents to be confirmed by NGET
[28] Assessment Round 1 has an end date of 01/07/11.
[29] We note that in the stylised Gantt chart of the 22 June the periods for the BAFO and Final Internal review have been delayed to 07/11/11-01/12/11 and 05/12/11-09/12/11 respectively.

With more detailed and potentially complex areas of both commercial and technical evaluation and negotiation yet to take place over the next two months in the next stages of assessment it will be important NGET/ SPT recognise the need to ensure any area of delay potentially affecting the critical path of the evaluation and award programme will need to be addressed promptly and effectively if the planned Construction contract award in December 2011 is to be achieved.

9. Conclusions and Recommendations

9.1. Summary

SKM is satisfied that sufficient robust information and analysis has been provided by NGET/SPTL during the course of Stage 1 to allow the following conclusions and recommendations.

The Western HVDC link shows robust lifetime benefits under a wide range of credible scenarios and sensitivities of key input variables. In view of the long term renewable aspiration in the UK and Scotland in particular, it is considered that the risk of this investment becoming stranded is negligible.

The Western HVDC link is a superior alternative to the Eastern HVDC link as first 'link' reinforcement in the short term particularly noting the much earlier development state of the Eastern HVDC link, which could only be delivered two years later than the Western HVDC link, and also other reinforcements that would be required if the Eastern Link were to be built first. The Eastern HVDC link design is also subject to more uncertainties that will become clearer over the next few years. Even assuming the same commissioning date as the Western link, the CBA analysis also indicated that superior benefits achieved by the Western link under a wide range of sensitivities.

The optimum timing for commissioning the Western HVDC link is dependent on the scenario used and varies from 2015 (earliest possible construction end date) for GG and AG scenarios, to 2017/18 in the case of the SP scenario. As there is great uncertainty about what renewable growth path will outturn, an assessment of the cost that would be incurred if the assumption made turns out to be wrong. The analysis based on the June 2011 scenarios indicated that if the Western link is commissioned in Dec 2015 and the renewable growth scenario turns out to be like SP the additional costs (via forwarding of capital cost) would amount to circa £33 million. If however the link is commissioned in 2017/18 (SP) and then the growth path looks like GG then the additional cost (via increased constraint costs) would amount to circa £165 million (i.e. about 5 times higher). If losses are considered, as calculated by NGET/SPTL, then the spread in the costs increases to £6 million and £200 million respectively. It can be concluded that the potential cost of being wrong by delivering the project early could be very small whereas the cost delivering the project late could be very high.

In addition, there are other difficult to quantify benefits that may result from investing earlier rather than later. Those primarily revolve around the likely supply chain risks as more cable is needed to connect offshore windfarms and also other related HVDC projects as we move closer to 2020 (potential for manufacturing delays and higher asset costs as demand increases). Also empirical evidence suggests that in the presence of significant network constraints with relatively few players behind the constraint could result in constraint costs much higher than calculated. There are other likely unmonetised benefits such as the potential reduction in risk premiums to developers due to the availability of transmission capacity, alleviation of cable market constraints (and prices) to offshore wind developers which ultimately may revert to consumers, earlier delivery of renewable projects with consequential CO_2 savings, provision of confidence message to industry etc. For all those reasons we consider that, in the presence of uncertainty, there should be a bias towards early delivery as late delivery of reinforcements is likely to result much more costly than calculated.

We conclude therefore that, although the need of the project by 2015 would depend on the scenario outcome, the proposed timing of the reinforcement is best possible in view of the costs of delivering the project behind of need vs. ahead of need.

- **Table 6 Summary of assessment of request for funding of construction works**

Scope	Need (by Dec2015)	Timing

Note: 'Need' is green by 2018 under all scenarios and sensitivities.

9.2. Stage 2 Needs case update

Overall we consider that NGET/SPTL original submission document for this review in April was not sufficiently strong for a project of such magnitude, which has undergone several reviews since 2009 and where Ofgem had already indicated in the 1st March document the expectation of the information required and the need to augment previous submissions in several areas. A considerable amount of work went throughout the review process to A considerable amount of work went throughout the review process to correct several areas containing errors and to strengthen and clarify the need case in particular with the timing of the reinforcement. However, the June 2011 submission although considerably improved still contained some deficiencies and required further clarifications that should be incorporated in the needs case update submission in Stage 2.

The stage 2 submission may consider incorporating the following:

Re-work the CBA 'base' case

- Include upper capital cost estimate Include substation costs at Hunterston and Deeside in capex using latest information from the tender evaluation
- Stream the capex in accordance with expected capital outflows during the construction process

- Scottish reinforcements: Include the actual expected timeline of these reinforcements in the base case.
- Include the tapering of the renewable subsidy in the long term in the NPV and lifetime benefits evaluation to reflect subsidy support dropping after 20 years as onshore wind becomes an 'established' technology.
- Include losses and improve the explanation and rationale behind its calculation and how the duration curve is derived and changes over time.

Sensitivity analysis

Re-run the sensitivities under the new base case as described above :

- 2 GW less wind in SP by 2020 with Hunterston extension (Our additional cases 1 GW less wind in SP and 1 GW less wind in GG are somewhat covered by the result from above)
- Capex cost increases
- Impact of Teesside reopens
- Impact of developer led reinforcements connected via HVDC Western Isles, Shetland, Kintire.

Additional information

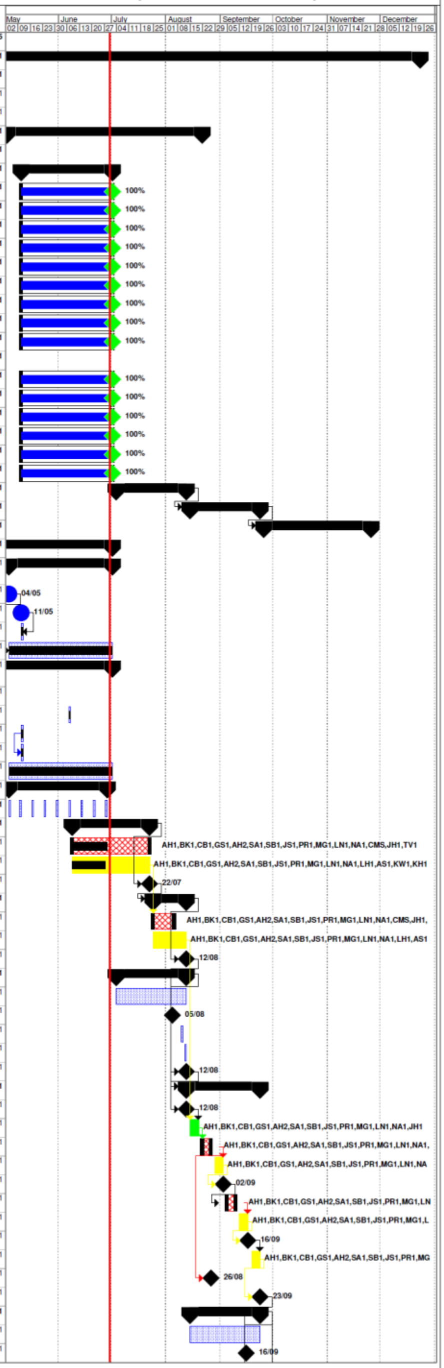
- Teesside closure
  - Re-issue the boundary capability charts as affected by Teesside closure
  - B7a Explain how a potential reopening of Teesside would affect the conclusions
  - Explain how the utilisation of Teesside would affect the boundary capability and how that is captured in the analysis
  - Are the boundaries capabilities sensitive to the operation of any other non-base load power station?
  - Explain plan to manage apparent boundary capacity shortfall in the short term even with the Western HVDC interconnector
  - Explain how the conclusions about the Penwortham-Kirkby reinforcement need case is affected by the Teesside closure.
  - Teesside closure
- Merit order Explain the rationale for the change in assumptions about Peterhead Longannet,
- B7a under what assumptions would be beneficial to proceed with the additional B7a reinforcement

SKM will liaise with NGET and Ofgem in scoping the specific issues that will be included in the work undertaken under Stage 2.

Appendix A NGET Western Link Gantt Chart

HVDC Western Link Plan 110629 v1.54 Gantt Chart (Evaluation Plan)

ID	Task Name	Dur	Start	Finish
1	**Western HVDC Link Programme**	1704 d	01/06/09	25/12/15
28	**Construction ITT Evaluation and Negotiation**	216 d	18/02/11	23/12/11
29	**Evaluation of Interim Legal Submissions**	20 d	18/02/11	17/03/11
30	Interim Legal submissions received from tenderers	0 d	18/02/11	18/02/11
31	Review of Interim Legal Submissions	20 d	18/02/11	17/03/11
32	**Inputs to Tender**	78 d	03/05/11	22/08/11
47	**Evaluation Progress Indicators**	142 d	11/05/11	25/11/11
48	**Assessment 1**	37 d	11/05/11	01/07/11
49	**Commercial - Legal Team Progress**	37 d	11/05/11	01/07/11
51	**Commercial - Costs Team Progress**	37 d	11/05/11	01/07/11
53	**System Design and Integration Team Progress**	37 d	11/05/11	01/07/11
55	**Converters - Civils Team Progress**	37 d	11/05/11	01/07/11
57	**Converters Main Plant & Electrical Layout Team Progres**	37 d	11/05/11	01/07/11
59	**Converters Transformers Team Progress**	37 d	11/05/11	01/07/11
61	**Converters Protection and Control Team Progress**	37 d	11/05/11	01/07/11
63	**Converters - Maintenance Team Progress**	37 d	11/05/11	01/07/11
65	**Cables - Design and Rating Team Progress**	37 d	11/05/11	01/07/11
67	**Cables - Installation and Logistics Team Progress**	37 d	11/05/11	01/07/11
69	- Onshore South	37 d	11/05/11	01/07/11
71	- Onshore North	37 d	11/05/11	01/07/11
73	- Offshore	37 d	11/05/11	01/07/11
75	**Environment Planning Access and Consent Team Progr**	37 d	11/05/11	01/07/11
77	**Project Management and Constructability Team Progres**	37 d	11/05/11	01/07/11
79	**SHES \ Quality Team Progress**	37 d	11/05/11	01/07/11
81	**Assessment 2**	30 d	04/07/11	12/08/11
82	**Assessment 3**	30 d	15/08/11	23/09/11
83	**Assessment 4**	45 d	26/09/11	25/11/11
84	**Assessment Round 1**	47 d	21/04/11	01/07/11
85	**Technical Preliminary Evaluation [Assessment 1- Prior to clarification Meeting Rounds]**	42 d	04/05/11	01/07/11
86	Layouts and routing information available in all project room	0 d	04/05/11	04/05/11
87	Full Tenders Available in Project Rooms 0900 on 11th May	0 d	11/05/11	11/05/11
88	Teams Assembled \ Work Allocation confirmation	1 d	11/05/11	11/05/11
89	Technical Preliminary Evaluation (Assessment 1)	42 d	04/05/11	01/07/11
90	**Commercial Preliminary Evaluation (Legal and procurement) [Assessment 1 Prior to Clarification Meeting**	47 d	21/04/11	01/07/11
91	Risk Workshop (G&T) Full Day	1 d	21/04/11	21/04/11
92	Risk Workshop - Costs Focus (G&T) Full Day	1 d	07/06/11	07/06/11
93	Tenders Available in Project Rooms 0900 on 11th May	1 d	11/05/11	11/05/11
94	Team Assembled \ Work Allocation confirmation	1 d	11/05/11	11/05/11
95	Commercial Initial Review process [Comments\Questions to	42 d	04/05/11	01/07/11
96	**Legal Review Activities (Assessment 1)**	39 d	04/05/11	28/06/11
97	**Legal team Meetings [Every Tuesday]**	39 d	04/05/11	28/06/11
119	**Initial Clarification Telconferences\Meetings**	32 d	09/06/11	22/07/11
120	Tender Clarification Meetings teleconferences	32 d	09/06/11	22/07/11
121	Review Tenderer Responses clarification questions	32 d	09/06/11	22/07/11
122	Initial Round of Clarification Meetings Complete	0 d	22/07/11	22/07/11
123	**Further round of Clarification Teleconferences\Meetings**	15 d	25/07/11	12/08/11
124	Tender Clarification Meetings Round 2	10 d	25/07/11	05/08/11
125	Review Tenderer R2 responses	15 d	25/07/11	12/08/11
126	Clarification Meetings Round 2 Complete	0 d	12/08/11	12/08/11
127	**Assesment Round 2**	30 d	04/07/11	12/08/11
128	Scoring Assessment Round 2	30 d	04/07/11	12/08/11
129	Technical Team Report and Scores Available	0 d	05/08/11	05/08/11
130	Technical workstream leads review meeting	1 d	10/08/11	10/08/11
131	Workstream Leads overall review meeting	1 d	12/08/11	12/08/11
132	Assessment Round 2 Scoring Complete	0 d	12/08/11	12/08/11
133	**Negotiation Meeting Activities**	30 d	12/08/11	23/09/11
134	Negotiation Meeting Agenda Confirmed	0 d	12/08/11	12/08/11
135	Prepare for Negotiation Meetings	5 d	15/08/11	19/08/11
136	Negotiation Meetings Round 1	5 d	22/08/11	26/08/11
137	Progress Round 1 Actions	5 d	29/08/11	02/09/11
138	Round 1 Actions Complete	0 d	02/09/11	02/09/11
139	Negotiation Meetings Round 2	5 d	05/09/11	09/09/11
140	Progress Round 2 Actions	5 d	12/09/11	16/09/11
141	Round 2 Actions Complete	0 d	16/09/11	16/09/11
142	Review outcome of R2 meetings	5 d	19/09/11	23/09/11
143	Negotiation Meetings Round 1 Complete	0 d	26/08/11	26/08/11
144	Negotiation Meetings Round 2 Complete	0 d	23/09/11	23/09/11
145	**Assessment Round 3**	30 d	15/08/11	23/09/11
146	Scoring Assessment Round 3	30 d	15/08/11	23/09/11
147	Technical Team Report and Scores Available	0 d	16/09/11	16/09/11



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HVDC Western Link Plan 110629 v1.54 Gantt Chart (Evaluation Plan)

ID	Task Name	Dur	Start	Finish
148	Technical workstream leads review meeting	1 d	21/09/11	21/09/11
149	Workstream Leads overall review meeting	1 d	23/09/11	23/09/11
150	Assessment Round 3 Scoring Complete	0 d	23/09/11	23/09/11
151	**Detailed discussions (Ts and Cs, technical etc)**	**24 d**	**26/09/11**	**27/10/11**
152	Detailed discussions (Ts and Cs, technical etc)	24 d	26/09/11	27/10/11
153	**BAFO**	**21 d**	**28/10/11**	**25/11/11**
154	Issue BAFO	1 d	28/10/11	28/10/11
155	Tenderers prepare BAFO	10 d	31/10/11	11/11/11
156	BAFO Responses Received	0 d	11/11/11	11/11/11
157	Evaluate BAFOs	10 d	14/11/11	25/11/11
158	BAFO evaluated and preferred bidders identified	0 d	25/11/11	25/11/11
159	BAFO Notice Issued	0 d	28/10/11	28/10/11
160	BAFO returns received	0 d	11/11/11	11/11/11
161	**Assessment Round 4**	**45 d**	**26/09/11**	**25/11/11**
162	Scoring Assessment Round 4	45 d	26/09/11	25/11/11
163	Technical Team Report and Scores Available	0 d	21/11/11	21/11/11
164	Technical workstream leads review meeting	1 d	23/11/11	23/11/11
165	Workstream Leads overall review meeting	1 d	25/11/11	25/11/11
166	Assessment Round 4 Scoring Complete	0 d	25/11/11	25/11/11
167	**Final Internal Review**	**10 d**	**25/11/11**	**08/12/11**
168	Final Internal Review	10 d	25/11/11	08/12/11
169	Final Internal Review Complete	0 d	08/12/11	08/12/11
170	**Stand Still**	**11 d**	**09/12/11**	**23/12/11**
171	Issue Standstill Notice	1 d	09/12/11	09/12/11
172	Standstill notice issued	0 d	09/12/11	09/12/11
173	Construction Contract Standstill Period	2 wks	12/12/11	23/12/11
174	Stand Still Notice Issued (latest)	0 d	09/12/11	09/12/11
175	Stand Still Period Complete	0 d	23/12/11	23/12/11
176	**Construction Contract(s) Governance Approval and Contract Aw**	**50 d**	**17/10/11**	**23/12/11**
177	NGET Governance Process	6 wks	31/10/11	09/12/11
178	SPT Governance Process	8 wks	17/10/11	12/12/11
179	Construction Contract(s) Awarded	0 d	23/12/11	23/12/11
180	Key Pre-requisite: Ofgem Funding in Place [for input to Governance process prior to October Board]	0 d	30/09/11	30/09/11
181	Board Approval in principle in place to enter into construction contr	0 d	20/10/11	20/10/11
182	Final Board Approval to Award Contract	0 d	09/12/11	09/12/11
183	HVDC Converter\Cable Construction Contract(s) Awarded	0 d	23/12/11	23/12/11