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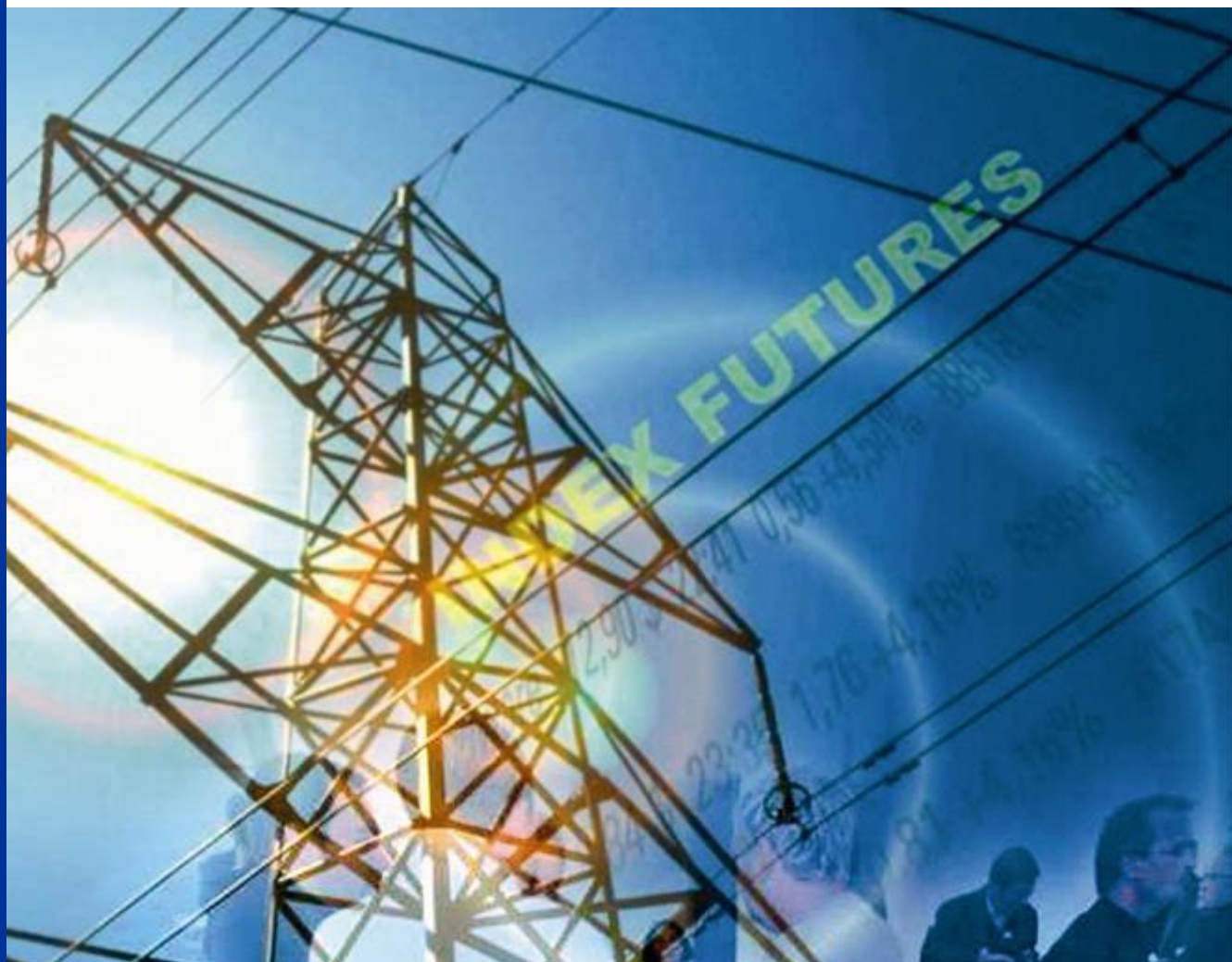
TECHNICAL ASSESSMENT OF SPT INVESTMENT FOR RENEWABLE GENERATION (TIRG) FUNDING REQUEST FOR BEAULY DENNY

Final Report

9 July 2014



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EXECUTIVE SUMMARY

Overview of Beauly Denny and SPT's additional funding request

Beauly Denny is the largest project funded by the Transmission Investment for Renewable Generation (TIRG) mechanism. This was established by Ofgem in 2004 to separately fund anticipatory investments to enable large scale development of renewables in Northern Scotland outside of the prevailing TPCR4 regulatory settlement.

The Beauly Denny project spans the transmission licence areas of both SHE Transmission and SPT. The project is considered an essential part of network reinforcements required to facilitate flows of energy from increased renewable generation in North of Scotland. It involves:

- an upgrade of the existing 220km 132kV to 400kV double-circuit transmission line between Beauly in northern Scotland to Denny in central Scotland;
- upgrades to six substations along this route; and
- satisfying a number of consent conditions arising from the Public Inquiry in order to mitigate the visual and environmental impact of both the line itself and additional electrical equipment along the route.

The transmission line within SPT's area is 22km of overhead line (based on the revised route enforced as a direct result of Section 37 Consent) which terminates at Denny substation. In December 2012, SPT submitted a substantive Asset Value Adjusting Event (AVAE) for their section of the Beauly Denny reinforcement project. SPT's forecast of £174m (2009/2010 price base) represents a £115.33m increase from the £58.7m estimate of construction costs provided through the initial allowances by Ofgem under TIRG in 2004. In April 2014, SPT submitted a revised funding request for £169.3m (2009/2010 price base)[1] following a detailed risk analysis carried out by Gardiner & Theobald. This is a reduction of £4.7m from the December 2012 submission.

Pöyry's assessment of SPT's AVAE for Beauly Denny

Ofgem has commissioned Pöyry to undertake a technical assessment of SPT's AVAE for Beauly Denny as follows.

The licence conditions state that any formal notification of an Asset Value Adjusting Event shall be accompanied by an independent technical assessment which supports the costs and expenses expected to be incurred by the amended scope of construction works, as detailed in the notice.

This technical assessment reviews the overall robustness of SPT's forecast construction costs (including contingency) and evaluates the techno-economic efficiency in relation to specific planned and completed activities for the Beauly Denny project. It includes an evaluation of the relevance of the proposed activities compared to the consent conditions stipulated by the relevant planning authorities.

The key areas reviewed for the technical assessment of the Beauly Denny project AVAE funding submission are:

- Relevance of the budgeted activities compared to the consent conditions stipulated by the Scottish Government/relevant planning authorities.

[1] A revised funding request for £186.3m was submitted in a 2011/2012 price base

- Adequacy of the amended scope and technical design in view of the intended output and consent conditions.
- Efficiency of costs incurred or planned to be incurred in relation to procurement of engineering services and required raw materials.
- Approach to methodology for calculating cost contingencies.

Our key findings and recommendations

The outcomes of our final assessment of the four key areas above can be summarised as follows:

- A mapping exercise indicates that the revised budgeted activities appropriately address consent conditions.
- Based on a robust techno-economic assessment, the amended scope and technical design appear to be adequate and efficient in relation to the consent conditions and intended output.
- The procurement process undertaken by SPT appears to be robust and efficient. We have undertaken a bottom-up cost assessment that considers key technical features and project specific characteristics such as ground conditions and the scale and complexity of the works. SPT provided us with additional details where requested to enable a robust cost assessment. Our view is that the overall expenditure category costs (excluding contingency costs) and key cost items within these are reasonable as supported by our benchmarking analysis.
- An initial review raised some concerns over limited explanation or justification of the original internal SPT risk assessment used to determine the contingency costs, including an absence of detail on the probabilistic model used, the allocation of risks between SPT and contractors and the evolution of views of risk over time.

  To their credit, SPT recognised this and commissioned a full re-assessment by Gardiner & Theobald; which in part led to SPT's revised funding request in April 2014. Following review of the Gardiner & Theobald analysis as well as further information provided by SPT, our view is that the revised risk assessment conducted by Gardiner & Theobald and adopted by SPT is robust. There is also sufficient explanation on the probabilistic methodology to consider potential risks and associated costs borne by SPT, and sufficient justification of reasonable inputs (potential costs and probabilities of occurrence) which are ultimately supported by SPT's expert opinion. Based on the evidence presented, we are also satisfied that the risk allocation between SPT and contractors is efficient.

Table 1 – Overview of Pöyry's technical assessment

Assessment Area	Consents	Scope	Costs	Risks
Final assessment	●	●	●	●

On the basis of our assessment and key findings as outlined above we recommend that Ofgem approves the most recent requested funding of **£169.3m**.

GLOSSARY

AVAE	Asset Value Adjusting Event
IEC	Iberdrola Engineering Construction
OHL	Overhead Line
RETS	Renewable Energy Transmission Study
SCA	System Construction Authorisation
SHE Transmission	Scottish Hydro Electricity Transmission
SPEN	Scottish Power Energy Networks
SPT	Scottish Power Transmission
TIRG	Transmission Investment for Renewable Generation
TPCR	Transmission Price Control Review

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1. INTRODUCTION

1.1 Background

The Transmission Investment for Renewable Generation (TIRG) mechanism was implemented in 2004 to provide the three transmission licensees with revenue allowances to connect renewable generation that was not forecast at the time of setting the relevant transmission price controls.

Beauly Denny is the largest project funded by this mechanism. This project is considered an essential part of network reinforcements required to facilitate flows of energy from increased renewable generation in North of Scotland. It involves an upgrade of the existing 220km 132kV to 400kV double-circuit transmission line between Beauly in northern Scotland to Denny in central Scotland and upgrades to six substations along this route.

The revenue allowance for Beauly Denny as set out in the licence provisions is based on a forecast made by SHE Transmission and SPT at the time of the original assessment in 2004. However, the mechanism contains provisions for the revenue to be reviewed should costs or expenses be incurred or saved from the forecast due to unforeseen circumstances (e.g. to meet the planning requirements). Several AVAEs have been assessed from both licensees including approval of the cost incurred by the licensees during the Public Inquiry.

In December 2012, SPT submitted an Asset Value Adjusting Event (AVAE) notice. SPT's forecast of £174m (2009/2010 price base) represents a £115.33m increase from the £58.7m estimate of construction costs provided through the initial allowances in 2004. In April 2014, SPT submitted a revised funding request for £169.3m (2009/2010 price base) following a detailed risk analysis carried out by Gardiner & Theobald. This is a reduction of £4.7m from the December 2012 submission.

This concise report provides Pöyry's technical assessment of the SPT's AVAE for Beauly Denny under the TIRG process.

1.1.1 Structure of this report

This concise report assessing SPT's AVAE for the Beauly Denny project is structured as follows:

- Section 2: Description of the TIRG Mechanism;
- Section 3: Overview of Beauly Denny Project;
- Section 4: Pöyry's preliminary technical assessment.

1.2 Conventions

- All monetary values quoted in this report are in GB Pounds Sterling in real 2009/10 prices consistent with SPT cost forecasts, unless otherwise stated.
- Annual data relates to financial years running from 1 April to 31 March, unless otherwise identified

1.2.1 Sources

Unless otherwise attributed the source for all tables, figures and charts is Pöyry Management Consulting.

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2. DESCRIPTION OF THE TIRG FUNDING MECHANISM

2.1 TIRG mechanism

The Transmission Investment for Renewable (TIRG) mechanism enables the three GB transmission licensees with revenue allowances to connect renewable generation that was not forecast at the time the relevant transmission price controls were set. It was put in place in 2004 and includes explicit expenditure allowances for specific projects for each of the three transmission licensees.

TIRG comprises four projects:

- Beauly Denny, a project jointly delivered by Scottish Hydro Electric Transmission Plc (SHE Transmission) and SP Transmission Limited (SPT);
- Sloy, a joint project between SHE Transmission and SPT;
- South West Scotland, a project delivered by SPT; and
- the Anglo Scottish Interconnector, a joint project between SPT and National Grid Electricity Transmission.

Beauly Denny is the largest project funded by the mechanism.

Revenue allowances may be amended up or down with the TIRG mechanism by the Authority, due to uncertainty over the design and cost of these projects at the time initial allowances were set. The mechanism requires the licensee to give notice to the Authority of an Asset Value Adjusting Event (AVAE) where relevant amendment to the scope of construction work is expected to cause additional costs or savings to be incurred. The licensee is required to give notice of such an event to the Authority as soon as is reasonably practicable after it has occurred and in any event prior to the TIRG relevant year when construction of the project commences.

Three key criteria must be met for the Authority/Ofgem to determine that a TIRG asset value adjusting event has occurred, in accordance with the TIRG condition;

1. That the costs in the licensee's notice are expected to result in a material increase or decrease to the average asset value for the relevant years t=0 to t=n compared to the existing allowance.
2. That the costs are expected to be incurred or saved efficiently.
3. That the costs cannot otherwise be recovered under the TIRG revenue allowance provided under the TIRG condition.

The licensee's TIRG allowances are subject to an ex post adjustment at the end of a project's construction period in order to determine the revenue allowances during the subsequent five years.

Changes allowed in an AVAE are based on the best information available at the time, whereas further adjustments to the revenue allowance could be made, up or down, in the subsequent steps when further evidence becomes available. The licensee is expected to share some risks of potential cost fluctuations, as with other regulatory funding mechanisms such as price controls.

2.2 SPT's AVAE submission for Beauly Denny

In December 2012, SPT informed Ofgem of an AVAE and provided a submission detailing amended scope and cost of construction works. SPT's forecast of £174m represents a £115.33m increase from the £58.7m estimate of construction costs provided through the initial allowances. SKM was appointed by SPT to carry out an independent techno-economic audit of their AVAE as required by the TIRG mechanism, and submitted a report to Ofgem in January 2014.

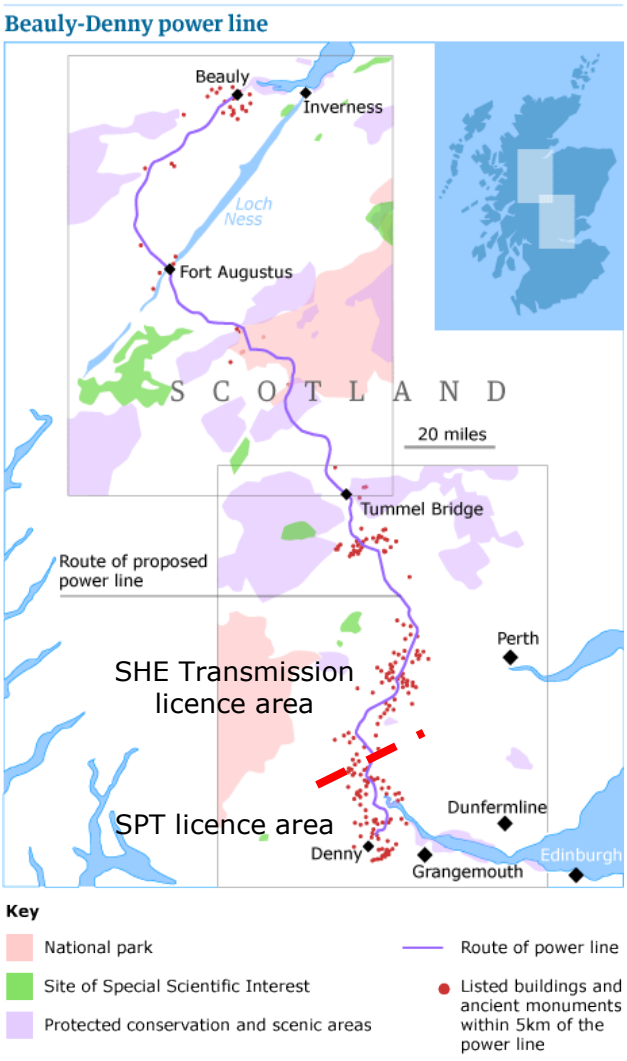
Pöyry was appointed in February 2014 to review the SPT AVAE submission including the independent SKM audit that accompanied the submission. In April 2014, SPT submitted a revised funding request for £169.3m (2009/2010 price base) following a detailed risk analysis carried out by Gardiner & Theobald. This was initiated following Pöyrys initial assessment. This is a reduction of £4.7m from the December 2012 submission and included consideration of actual construction costs incurred up to March 2014 and updated forecast costs.

3. OVERVIEW OF THE BEAULY DENNY PROJECT

The Beauly Denny project requires an upgrade of the existing 220km long double circuit transmission line from 132kV to 400kV between Beauly in the north of Scotland and Denny in central Scotland (route labelled "1" in Figure 1) and an upgrade to six substations along the route. Beauly Denny lies primarily within SHE Transmission's area, with SPT being responsible for building the southern part of the line (22km).

Once completed, Beauly Denny will deliver a significant increase in the transmission capacity in the region and it is expected to result in considerable benefits to consumers through reduced constraint costs and transmission losses.

Figure 1 – SPT Beauly Denny project



Source: http://www.theguardian.com/environment/2010/jan/06/power-line-scotland-green-energy

In September 2005, SHE Transmission and SPT applied for planning consent, involving five planning authorities. Given the length, size and siting of the proposed line, the application attracted significant local interest. Following receipt of objections from statutory consultees, the planning application was referred to public inquiry in February 2007. The inquiry reporters submitted their final report to the Scottish Government in February 2009. Following consideration of this report, the Scottish Government granted planning consent

for the line in January 2010. The consent included numerous conditions in relation to mitigation of the visual and environmental impact of both the line itself and additional electrical equipment along the route, and was subject to the following conditions of consent which SPT had to discharge prior to construction taking place; Condition 18 – Wirescape Rationalisation Schemes Stirling & Condition 19 – Stirling Visual Impact Mitigation Scheme.

The additional planning conditions applied to Southern Scotland where SPT owns the transmission system. SPT produced proposals for mitigation in September 2010 and in February 2011, both of which were rejected by Stirling Council. In March 2011 the Minister for Energy, Enterprise and Tourism asked Stirling Council and SPT to work together to review these proposals and any new options including partial undergrounding. A series of meetings took place and SPT submitted revised proposals to the Scottish Government on 26 August 2011. This decision was for Scottish Ministers to make following a 45 day consultation period with Stirling Council. The Council response to Scottish Ministers on 14 October 2011 was to formally reject the proposals.

In July 2011, the Minister for Energy, Enterprise and Tourism procured the services of a Landscape Consultant, Ironside Farrar, to provide independent expert advice for Scottish Ministers on undergrounding and the SPT Proposals. In their report, Ironside Farrar concluded that there was some merit in the SPT mitigation proposals but they could go further and proposed that additional mitigation measures could be undertaken, including compensatory mitigation, to provide a holistic landscape enhancement scheme which would deliver wider environmental and societal (amenity) benefits. The consultants noted that this could be achieved at a fraction of the cost identified as necessary to underground cables.

The report highlighted that, through partnership working, such an enhanced scheme would not only represent compensatory mitigation for the visual impacts of the line, but would also contribute to the aims and objectives of Stirling Council's Green Belt enhancement policies and those of the Central Scotland Green Network. The report also pointed to the benefits from undergrounding the Fallin to Glenbervie 132kV line to reduce the wirescape in this highly congested area.

The Minister announced his decision to accept the SPT proposals to meet consent conditions 18 and 19 on the 7 December 2011 and asked SPT to undertake two additional compensatory measures:

- Undergrounding of the existing 132kV overhead line between Fallin and Glenbervie.
- Broad suite of proposals for widespread improvements to landscape amenity in the area.

SPT received substation planning consents from Falkirk Council in March 2012.

SHE Transmission have recently completed the first 50km (plus three sub-stations), and SPT have commenced access road improvements and substation preparation at Denny. SHE Transmission are expected to complete their section of the upgrade in 2014 whilst SPT are due to commission in 2015/16.

4. PÖYRY'S TECHNICAL ASSESSMENT

Following the preliminary assessment, we have further assessed the provided data and carried out a technical assessment of SPT's AVAE submission including available supporting documentation, against the four key assessment areas.

We address each of these in the following sections before presenting a summary of our assessment for SPT's AVAE submission.

4.1 Relevance of budgeted activities to consent conditions

A review of the relevance of the specific budgeted activities to the consent conditions has been undertaken. Key consent conditions are described below.

4.1.1 400kV Overhead Line Route (OHL)

The initial proposed 400kV OHL route followed the existing 132kV OHL route corridor from Wharry Burn, near Dunblane, to the proposed substation north east of Dunipace, Denny. The final consented 400kV overhead line route deviates eastwards away from this route corridor from Tower TD203 to the proposed Denny North substation site. The resulting increase in length to the final consented route is around 5km to give a total length of 22km.

4.1.2 Consent condition 18

Consent Condition 18 requires that "Neither the overhead transmission line or the towers carrying that line shall be installed or constructed in the area of Stirling Council until – (a) the applicant has submitted to the Scottish Ministers for approval a scheme prepared in accordance with this condition setting out proposals to mitigate the impact of wirescape in the vicinity of the lines mentioned in paragraph (2) of the Wirescape Rationalisation Scheme; (b) the Scottish Ministers have, in consultation with Stirling Council, approved the Wirescape Rationalisation Scheme: and (c) the applicant has obtained any consents and permissions necessary to enable the applicant to implement the approved Wirescape Rationalisation Scheme.

The Wirescape Rationalisation Scheme is to include proposals for:

- the removal of and undergrounding of 7 spans of 132kV double circuit OHL BJ route ("the Stirling T");
- the removal of and undergrounding of 7 spans of 132kV double circuit OHL on AB route between towers AB39A and AB46A;
- the removal of and undergrounding of 5 spans of 132kV double circuit OHL on AB route between towers AB46A and AB51A, all as described in the APL STG 37 (Wirescape Rationalisation Documentation for Stirling Council Area) and shown in drawings SP4020430, SP4020503 and SP4030856;
- the removal of two 33kV steel lattice towers referred to as the Forth crossing and undergrounding on the Scottish Power distribution network of the 33kV line as shown in drawing SP4032230 of APL STG 37A; and
- the removal of and undergrounding of wood pole distribution services in Manor Powis as shown in drawing SP4032223 of APL STG 37A.

4.1.3 Consent condition 19

Condition 19 requires that "Neither the overhead transmission line or the towers carrying that line shall be installed or constructed in the area of Stirling Council until – (a) the applicant has submitted to the Scottish Ministers for approval a scheme prepared in accordance with the condition setting out proposals to mitigate the visual impact of the 400kV line in the Stirling area ("the Stirling Visual Impact Mitigation Scheme (SVIM)"); and (b) the Scottish Ministers have, after consultation with Stirling Council, approved the Stirling Visual Impact Mitigation Scheme.

4.1.4 Other consent conditions

There are also a number of environment conditions under Section 37 consent that require discharge through additional works. These are described below:

- Condition 6 (Environmental Liaison Group).
  - Provide advice on appropriate and necessary mitigation and construction procedures and any associated restoration and habitat management measures and to advise Scottish Ministers of any concerns relating to the construction of the overhead line.
- Condition 7 (Tourism, Cultural Heritage and Community Liaison Group)
  - Provide advice on appropriate and necessary mitigation and construction procedures that impact on tourism, historic sites and cultural heritage and advise Scottish Ministers of any concerns relating to the construction of the development. Furthermore the group are asked to identify opportunities associated with the development and make recommendations to SPT and local and national enterprise and skills agencies how these can be delivered.
- Condition 8 (Construction Procedures Handbook)
  - Submit to Scottish Ministers a document, entitled 'The Construction Procedures Handbook' (CPH), setting out how the development is to be constructed and managed and construct scheme in accordance with this.
- Condition 9 (Independent Environmental Contractor)
  - Appoint an independent Environmental Contractor whose appointment must be approved by the Scottish Ministers in consultation with Scottish National Heritage. The appointee shall have responsibility to scrutinise the process of construction and compliance with the CPH and to supervise and direct if necessary the work of the specialists appointed by SPT.
- Condition 10, 11, 12, 13, 14, 15,16 & 17 (Environment)
  - Management of the environment in which the development will be constructed and makes provision for various surveys and habitat management plans associated with Otters, Wild Cats, Bats, Birds, Pine Martins, Red Squirrels and watercourses.
- Condition 20 (Glenside Mitigation Scheme)
  - Submit to the Scottish Ministers for approval a scheme prepared in accordance with this condition setting out proposals to mitigate the visual impact of the 400KV line in the Glenside Farm area ("the Glenside Mitigation Scheme").
- Condition 21 (Wester Moss SSI)
  - Upgrade the existing access track in the SSSI and provide and maintain a new fence along the access track for the duration of the build.
- Condition 22 (Firth of Forth SPA and Ramsar Site)

  - Address the strategy for access to the above site within the Environmental Statement that will define the protocol for constructing the overhead transmission line in this area.
- Condition 23 (Geology)
  - Undertake a detailed appraisal for all Geological Conservation Review (GCR) sites along the route of the development
- Condition 24 (Pollution)
  - Take due care and attention and discharge any containment and contingency measures to safeguard against the pollution of groundwater, reservoirs, lochs or any watercourse from all construction activities.
- Condition 25 (Landscape & Visual Impact)
  - Submit to Stirling Council a general Landscaping Scheme
- Condition 26&27 (Noise Sensitive Properties & Noise Impact)
  - Restriction upon SPT in terms of hours of work and disturbance and lay out a requirement to prepare and submit to Stirling Council a Noise Management Plan.
- Condition 28 (Blasting Scheme)
  - Provide Stirling Council with notice of any Blasting Schemes required as part of the development and are restricted from undertaking such activity until written approval in received from Stirling Council.
- Condition 29, 30, 31, 32, 33, 34, 35 & 36 (Access & Car parking, Roads etc)
  - Where the proposed development runs along existing highways and public right of ways and footpaths, SPT must ensure that such routes continue to be in use during the construction and that this can be done in a safe manner. Where this is impossible due to the nature of the works, SPT are requested to implement & construct temporary access arrangements.
- Condition 37 & 38 (Private Water Supplies & Watercourses)
  - Undertake an assessment of the affects that the development may have on the private water supply for all dwellings that fall within 1km of the overhead line and produce an Environmental Risk Assessment and detail mitigation measures for the protection of private water supplies.
- Condition 40 (Community Liaison Scheme)
  - Submit to the relevant planning authority a Community Liaison Scheme which shall contain measures that SPT will take to ensure close liaison with local community representatives, landowners and statutory consultees during the construction phase.
- Condition 41 (Organic Use of Agricultural Land)
  - In areas where the construction of the new overhead line or existing 132kV line which is to be dismantled, crosses land in agricultural use which has organic status or is farmed to organic standards, all works must be carried out in liaison with the appropriate organic certification body and in accordance with advice from that body.
- Condition 42 (Glenside Farm)
  - Erect a stock proof fence around the base of any tower constructed on land forming part of Glenside Farm sufficient to prevent horses from coming into contact with said tower.
- Condition 43 (Mitigation of Impact on Promoted Paths etc)

– Cannot undertake any works until a payment to Stirling Council and which will be used to fund any mitigation works in respect of paths identified in Document SC8 "Eastern Villages Community Paths" and the Dumyat Paths as noted in APL STG 72, 73 & 75 A to E inclusive.

These are included within the budgeted activity of Environment Works – Conditions of Section 37 Consent (Other Conditions).

4.1.5 Mapping of revised budgeted activities to consent conditions

Consent conditions are mapped to proposed budgeted activities for each relevant expenditure category in Table 2 to assess the degree of alignment and relevance. The appropriateness of the proposed activities to meet the stipulated consent conditions is assessed based on a traffic light system.

Table 2 – Mapping of consent conditions to budgeted activities

	Consented 400kV OHL	Consent Condition 18	Consent Condition 19
Is consent condition fulfilled?			
Construction of 400/275kV/132KV Overhead Line Works Construction of consented L12x TD route from TD189 to TD239A	The consented OHL route deviates eastwards away from the current 132kV OHL route corridor. The resulting increase in length to the final consented route is around 5km.		
Environmental Works – Condition of Section 37 Consent (Condition 18)		Removal and undergrounding of the following 132kV OHL sections: ■ 7 spans of the BJ route ■ 15 spans of the AB route between towers AB39A and AB54A. (Note that the Consent specifies termination at Tower AB51A. SPT have terminated the cable at tower AB 54A for technical reasons).	
Environmental Works – Condition of Section 37 Consent (Condition 19)			■ Planting and Landscape Reinforcement. ■ Undergrounding of LV OHLs at 6 locations. ■ Tower Painting (limited) ■ Widespread improvements to landscape amenity in the area, ■ Undergrounding of the existing 132kV OHL between Fallin and Glenbervie

It is also our view that SPT has addressed the various consent conditions detailed in the expenditure category 'Environment Works – Conditions of Section 37 Consent (Other Conditions)' adequately through the amended scope of work.

Our review indicates that revised budgeted activities sufficiently address Section 37 consent conditions for the Beauly Denny scheme. The SPT TIRG Beauly Denny AVAE Notice[2] notes that the details proposed for both Condition 18 (Wirescape Rationalisation) and Condition 19 (SVIMS) have already been submitted and approved by the Scottish Ministers. An assessment of the costs for the amended scope of work is provided in Section 4.3.

4.2 Adequacy of the amended scope and technical design

The amended scope and technical design changes for each expenditure category are detailed in Table 3. These are assessed against the consent conditions and intended output using a traffic light rating.

To recap; consent condition 18 refers to the removal and undergrounding of 132kV OHL sections under the Wirescape Rationalisation works of the Stirling Tee and consent condition 19 refers to the 132kV undergrounding to Glenbervie and SVIMS.

[2] SP Transmission Ltd Transmission Investment for Renewable Generation (TIRG) Beauly Denny Asset Value Adjusting Event Notice, December 2012.

Table 3 – Adequacy and efficiency of amended scope and technical design changes

		Scope/Technical Design Change	Consented 400kV OHL route	Consent Condition 18 – Wirescape Rationalisation	Consent Condition 19 – 132kV Undergrounding and SVIMS	Traffic Light Rating
1	**Enabling Works – Fibre Optic Works**	This activity was not in original scope	New underground fibre optic cabling for protection and control circuits to be installed.			
2	**Enabling Works – 132kV Undergrounding**	Limited scope for this activity was in original scope. The consented route deviates from the existing 132kV OHL corridor.	Undergrounding of short section of the 132kV double circuit OHL on the AB route close to Plean and Torwood required to provide electrical clearance between the consented 400kV OHL and other existing 132kV OHL routes. Also, a short section of the CN route requires undergrounding to accommodate construction of the substation.			
3	**Enabling Works – Distribution Undergrounding**	This activity was not in original scope on basis that required number and rating of circuits to be undergrounded could not be determined until the final consented route of the new line was established	33kV, 11kV and LV lines require undergrounding to mitigate hazards and facilitate construction of final consented Beauly Denny OHL.		Undergrounding also required to meet Section 37, Condition 19 – Stirling Visual Impact Mitigation Scheme (SVIMS).	
4	**Construction of 400/275kV Overhead Line Works**					
a	Final consented 400kV OHL route	Final consented OHL Route (TD) deviates eastward from the existing 132kV OHL corridor.	The final consented route is approximately 5km longer than the equivalent existing 132kVOHL corridor.			

B	Double shuffle to allow the new TD route to utilise the existing ZC(N) route. ZC(N) to utilise the existing ZC(S) route.	This activity was not in original scope	Additional scope caused by the 400//275kV route deviation.			
C	Modifications at Denny North against the ZG and ZD routes.	This activity was not in original scope	Additional scope caused by the 400//275kV route deviation.			
D	Reconfiguration of AB & CN at Bonnybridge	This activity was not in original scope	Additional scope caused by the 400//275kV route deviation. Efficient and appropriate.			
E	CN OPGW to Denny North from Bonnybridge	This activity was not in original scope	Additional scope caused by the 400//275kV route deviation.			
F	OPGW replacement between Longannet and the ZC Shuffle for ZC(N) and ZC(S)	This activity was not in original scope	Additional scope caused by the 400//275kV route deviation.			
5	**Denny Substation Works**					
a	Additional 275kV cable connections on the ZC route circuits to the substation 275kV busbar	This activity was not in original scope	Required to facilitate the connection route from the new TD route to the 400kV Substation at Denny North.			
b	Undergrounding of small sections of 275kV and 132kV overhead lines around the substation perimeter	This activity was not in original scope	Due to changes to entry points of the OHLs into substation impacting on configuration and layout.			
C	Access routes for OHL and Cables.	Included in original scope	The OHL route deviation and the double shuffle works required amended access routes for OHL and Cables.			

D	Additional remote end protection and control configuration works.	Included in original scope	The changes to the ZC(N) and ZC(S) routes require additional remote end protection and control configuration works.			
E	Denny North substation location change	Substation costs included in original scope	Location of the Denny substation affected by changes to the line route due to consent conditions and also to allow access for the existing 275kV and 132kV circuits which are required to connect into the substation.			
F	Access road into the substation	Access road costs included in original scope	Changes to the electrical layout of the substation require modification of the access road in comparison to the original design. Influenced by the changes to the OHL entry points into the substation and the new requirement for undergrounding of small overhead line sections around the perimeter of the substation.			
6	**Environmental Works – Condition of S37 Consent (Condition 18)**	This activity was not included in original scope		Removal and undergrounding of 132kV overhead line sections under wirescape rationalisation works of the Stirling Tee; 7 spans of the BJ route and 15 spans of the AB route between towers AB39A and AB54A. Efficient and appropriate. Consent specifies termination at Tower AB51A. However, for technical reasons SPT have elected to terminate cable at tower AB 54A.Seems to be appropriate based on SKM report review[3].		

[3] TIRG: Beauly–Denny Project SPTL Asset Value Adjusting Event Independent Assessment Report, February 2014

7	**Environmental Works – Condition of S37 Consent (Condition 19)**					
a	Removal and undergrounding of 132kV AB Route between tower AB39 at Fallin and AB13 at Glenbervie	This activity was not included in original scope			Removal and undergrounding of 132kV overhead line sections for SVIMS seems efficient and appropriate.	
B	Undergrounding of LV overhead lines at 6 locations	This activity was not included in original scope			Limited and component of SVIMS.	
C	Planting and Landscape Reinforcement	This activity was not included in original scope			Component of SVIMS.	
D	Tower Painting (limited number of towers)	This activity was not included in original scope			Component of SVIMS.	
8	**Environment Works – Conditions of Section 37 Consent (Other Conditions)**	This activity was not included in original scope. Required to discharge Section 37 Consent conditions.				

The analysis above clearly indicates additional scope items and technical design changes that were not in the original Beauly Denny scope, required either directly or indirectly due to consent conditions. These changes are mapped to the related consent conditions. The SKM AVAE independent assessment report[2] contains details of the justification and evidence for the amended scope and technical design changes as provided by SPT and this is generally robust and comprehensive. We have provided an independent analysis of the appropriateness of the amended scope and technical design changes below in relation to the consent conditions and the intended outputs.

4.2.1 Enabling Works – Fibre Optics Works

New underground fibre optic cable is required to maintain continuity to the control and protection circuits during outages for construction and avoid putting network at significant risk. This is due to the 400kV consented route deviation and “double shuffle” works.

We consider this to be appropriate and efficient as it retains system security while the works are undertaken.

4.2.2 Enabling Works – 132kV Undergrounding

The undergrounding of a short section of the 132kV double circuit OHL on the AB route close to Plean and Torwood is required to provide electrical clearance between the new 400kV OHL and other existing 132kV OHL routes. This is now required due to the consented 400kV OHL route deviating from the existing 132kV OHL corridor. Also, a short section of the CN route requires undergrounding to accommodate construction of the substation.

Comparison of 132kV cable pre-fault ratings specified (160MVA (Summer), 185MVA (Spring, Autumn) and 201MVA (Winter)) with existing OHL ratings (based on 1 x TOTARA (425mm^2 AAAC)) overhead line ratings (148MVA at 50°C, Summer) indicate that the cables are appropriately sized replacements to the OHL. Therefore these design amendments are considered appropriate and efficient. Similarly the amended scope to facilitate construction of the 400kV OHL and the substation is reasonable, and SKM’s findings are in line with these.

4.2.3 Enabling Works – Distribution Undergrounding

A number of 33kV, 11kV and LV lines require undergrounding to mitigate hazards (e.g. several overhead lines crossing) and facilitate construction of final consented Beauly Denny line. Most additional costs are due to the new 400kV OHL route deviation of circa 4.5km from the existing 132kV OHL, therefore the amended scope was considered efficient and appropriate.

4.2.4 Construction of 400/275kV Overhead Line Works

Additional works include deviation of the 400kV OHL from the existing 132kV OHL route by 5km, the Double shuffle to allow the new TD route to utilise the existing ZC(N) route and the ZC(N) to utilise the existing ZC(S) route and reconfiguration of AB & CN lines at Bonnybridge. These are all necessitated by the 400kV OHL route deviation from the original 132kV OHL route as the consented 400KV OHL route interferes with other existing OHL. These are assessed as technically appropriate and efficient.

4.2.5 Denny Substation Works

Additional works including 275kV cable connections on the ZC route circuits to the substation 275kV busbar are required to facilitate the new TD route to the 400kV Substation at Denny North due to interference issues with existing circuits.

Entry points to allow access for the existing 275kV and 132kV circuits have changed due to consent conditions requiring a change in the TD. Small sections of 275kV and 132kV overhead lines are to be undergrounded around the substation perimeter and the location of the Denny substation has also been affected by changes to the line route. This in turn, has affected the access road into the substation. All these are considered technically efficient and appropriate in order to respond to the consent condition for the 400kV OHL.

SPT have made provision for the turn in of the WIYH-LAMB-LOAN 275kV circuit into Denny North 275kV in the Denny North Substation layout. This is beyond the scope of the original TIRG project and is described by SPT as future-proofing. The reinforcement to create additional boundary capacity across boundaries B4 and B5 which includes WIYH-LAMB-LOAN 275kV circuit was included in RIIO-T1 as the “East Coast 400KV Upgrade” and is to be funded through the Strategic Wider Works (SWW) process. Two technical designs were considered and SPT are progressing with the most cost effective. Based on the technical design details provided, we are satisfied that this approach is efficient and appropriate. However, it will be assessed in detail through the SWW process.

4.2.6 Environmental Works – Condition of S37 Consent (Condition 18)

This includes the removal and undergrounding of 132kV overhead line sections under the wirescape rationalisation works of the Stirling Tee in order to meet consent condition 18.

Existing 132kV OHL ratings are 183MVA (800A) Summer and 229MVA (1001A) Winter. Comparison with 132kV cable pre-fault ratings specified (1175A Summer, 1410A Winter) indicates that the cables are sized larger than the OHL but not materially. This may be due to standardised SPT cable sizes.

4.2.7 Environmental Works – Condition of S37 Consent (Condition 19)

These works include removal and undergrounding of 132kV AB Route between tower AB39 at Fallin and AB13 at Glenbervie, Undergrounding of LV overhead lines at 6 locations, Planting and Landscape Reinforcement and Tower painting – none of which were in the original scope.

All these works are to satisfy Condition 19 of the Section 37 which requires that overhead lines should not be installed in the Stirling council area until a scheme to mitigate the visual impact has been submitted e.g. tower-painting.

Existing 132kV OHL ratings are 183MVA (800A) Summer and 229MVA (1001A) Winter. Comparison with 132kV cable pre-fault ratings specified (1175A Summer, 1410A Winter) indicates that the cables are sized larger than the OHL but not significantly.

4.2.8 Environmental Works – Condition of S37 Consent (Other Conditions)

These were not included in the original scope but are required to meet a number of consent conditions. The scope of the Environmental works is reasonable to meet the stipulated consent conditions.

4.2.9 Summary

In summary, our view is that the amended scope and technical design appear to be appropriate and efficient in relation to meeting the consent conditions and the intended output.

4.3 Efficiency of costs

4.3.1 Procurement

The influence of SPT's approach to procurement of engineering services and raw materials for the amended scope was assessed. A review of the procurement and selection process for the amended scope was carried out to assess how the market was engaged and SPT's approach to definition and application of evaluation criteria to short-list and select the final supplier/s and technology. This includes supply of plant, construction and installation services, and engineering and design.

A capital project delivery strategy was developed by the Beauly Denny project team based on input from:

- SPEN Major Projects;
- SPEN Procurement; and
- Iberdrola Engineering & Construction (IEC).

SPT indicate that the overall project delivery strategy has been maintained and is consistent with that set out at commencement of the project works.

SPT's approach for the RIIO-T1 regulatory period is based on an engineering and project management model in which IEC has a Principal Contractor role, moving away from the traditional EPC approach. SPT state that a key advantage of this is the reduced reliance on the limited number of turnkey / tier 1 contractors and allowance for the direct engagement of a much wider contractor / supplier base.

4.3.2 Description of procurement delivery models and tiers

SPT have confirmed that five delivery models (types) are defined in the Framework Agreement introduced between SPEN and IEC in 2010 as follows:

4.3.2.1 Delivery model 1 – EPC

Model 1 is a full Turnkey or Engineer, Procure and Construct (EPC) contract. SPT are responsible for conceptual design and project management. IEC may undertake management of the existing EPC contract and provide contractor resources if required.

Tier 1 Contractor: Larger contractor responsible for detailed design, purchasing equipment, appointing sub-contractors, site management, site safety, CDM Principal Contractor role.

4.3.2.2 Delivery model 2 – Free issue of main equipment and / or multiple lots of 'Design and Build' contracts

Model 2 involves a free issue of substation main Equipment (e.g. transformers) and Balance of Plant by an EPC Contractor (Tier 1). SPT is responsible for management of multiple lots of "Design and Build" contracts, conceptual design and project management.

4.3.2.3 Delivery model 3 – Free issue of main equipment, detailed engineering by IEC, Principal Contractor is Tier 1 / 2 contractor

Model 3 includes a free issue of substation main equipment (e.g. transformers). Detailed engineering is undertaken in house by IEC and two main site contracts are let and managed (Tier 1/2): civil works, and balance of plant supply and installation works. The principal contractor role is taken by Tier 1/2 contractors. SPT is responsible for conceptual design, project management (including smaller contracts) and procuring the remaining equipment.

Tier 1 / 2: Large of smaller contractor responsible for civil works or balance of plant supply and installation works, site management, site safety, CDM Principal Contractor role.

4.3.2.4 Delivery model 4 – Free issue of main equipment, detailed engineering by IEC, Principal contractor is IEC

Model 4 includes free issue of substation main equipment. Detailed engineering is undertaken in-house and two main site contracts are let and managed (Tier 1/2): civil works, and balance of plant supply and installation works. The CDM principal contractor role is taken by IEC. SPT is responsible for conceptual design, project management (including smaller contracts) and procuring the remaining equipment.

4.3.2.5 Delivery model 5 – Full Iberdrola model

Model 5 entails a full Iberdrola model in which IEC undertakes the CDM principal contractor role. There is free issue of cable and/or all equipment with detailed engineering undertaken in-house. Two main site contracts are let and managed (Tier 2); civil works and installation works. SPT is responsible for conceptual design and project management (including smaller contracts).

Tier 2: Small contractor responsible for civil works or balance of plant supply and installation works.

4.3.2.6 Beauly Denny delivery models

Four project types have been identified for Beauly Denny and corresponding selected delivery models used as the basis for Invitation to Tender (ITT):

- Substation Works: Denny North Substation
  - Delivery model No. 2 – Free issue of main equipment and / or multiple lots of 'Design and Build' contracts
- Overhead Line Works
  - Delivery Model No. 1 – EPC
- Distribution Works
  - Delivery model No. 3 – Free issue of main equipment, detailed engineering by IEC, Principal Contractor is Tier 1 / 2 contractor
- Cable Works
  - Delivery Model type No. 5 – Full Iberdrola model

We note that the Beauly-Denny construction project was first tendered back in 2005 but was suspended due to planning delays. SPT decided to continue with the EPC approach for the main substation works and the overhead line as work was already underway, and a large part of the works involved new overhead line build.

4.3.3 Current contract award position

The current contract award status for major contracts is shown in Table 4. Approximately 75% of contract costs have now been awarded.

Table 4 – Contract Award Status

	Delivery Model (based on BAFO Docs)	Contract Status	[redacted]	[redacted]
Enabling Works – fibre optic cable	Type No.1	Awarded and completed	[redacted]	[redacted]
Enabling Works – 132 kV Underground comprising:				
Towers package	Type No.5	Awarded	[redacted]	[redacted]
Civil works	Type No.5	Awarded	[redacted]	[redacted]
Cable supply and install	Type No.5	Awarded	[redacted]	[redacted]
400/275kV Overhead Line Works comprising:				
Construction of 400/275kV Overhead Line	Type No.1	Awarded	[redacted]	[redacted]
Public Road Improvements	Type No.1	Awarded	[redacted]	[redacted]
Denny North Substation Works comprising:				
Denny Access Road	Type No.2	Awarded	[redacted]	[redacted]
Denny Civil Platform	Type No.2	Awarded	[redacted]	[redacted]
Denny North and Remote Ends – Electrical Construction	Type No.2	Awarded	[redacted]	[redacted]
Total			**£86,715,904**	**£78,833,196**

The following contracts are still to be awarded:

- Transformer SGT3 (275kV/132kV) – Contract award June 2014;
- Denny North Security System – Contract award June 2014;
- Road Remediation (Denny) – Contract award planned for September 2015; and
- Condition 18 and Condition 19 – Contract awards planned for July 2015.

The following key stages of the SPT procurement process were identified as follows:

- pre-qualification of potential bidders;
- invitation to tender;
- tender evaluation;
- negotiation including BAFO stages leading; and
- contract award.

IEC provide SPT with full project delivery services in respect of engineering design, project delivery and construction management for the Beauly Denny project under an intercompany agreement. This is based on existing agreements and arrangements between the two. IEC design costs are explicitly listed for Enabling Works – 132kV Undergrounding and Environmental Works – Condition 19 and amount to 9-10% of each

individual work package which is reasonable. Total project management costs (outside of project management costs embedded within specific contracts) are approximately 6% of the total Beauly Denny project cost and 6-10% for individual work packages. Project management costs are lower for work packages with delivery model 1 as would be expected. Our view is that these are acceptable for a project of this size and complexity and probably reflect to an extent the efficiency of the IEC approach.

4.3.4 Summary of Procurement Assessment

A review of the comprehensive description of the SPT procurement approach for this project contained in the SKM AVAE independent assessment report[2] was carried out along with independent analysis. Our view is that SPT has competitively engaged with the market and followed a robust tendering and selection process for the amended scope that aligns with their selected procurement models. The various works have been sub-divided appropriately to enable efficient procurement and the approach to project delivery services is efficient. The existence of risk management mechanisms and allocation of risk between SPT and contractors is assessed in Section 4.4.

4.3.5 Cost assessment

Key project unit costs for items of plant, construction and installation (i.e. substation transformers, HVAC cables and overhead lines, civil work etc.) have been compared with benchmark unit costs.

Benchmark unit costs are sourced from an extensive in-house TNEI cost library used for tendering, benchmarking and estimating purposes. This library includes data from multiple projects for public bodies and private companies across a wide range of industries, including transmission and distribution and onshore and offshore wind, in the UK and worldwide. This is further supplemented by publically available information. The primary data sources used for benchmarking of this project are:

- TNEI's internal database;
- National Grid 2010 Offshore Development Information Statement (ODIS) Appendices;
- National Grid Electricity Ten Year Statement (ETYS);
- RIIO-T1 asset cost data; and
- IET/PB Power Cost Study 2012.

Benchmarking is undertaken for the major items and activities only. Even where projects appear technically similar, costs can vary due to a range of issues such as location, supply and demand, contract strategy, material costs, exchange rates and inflation and thus, when benchmarking, a range of values is often utilised rather than a single benchmark cost. The cost or cost range should be considered typical, for guidance only and not absolute as each project must be considered in its own right.

This is further necessitated as no two technical solutions are the same and no two projects utilise a consistent approach to cost allocation. This suggests that for what would appear to be two identical cost items may not consist of the same component build up; allocation of design, commissioning and project management costs may be spread across all components or lumped into a single large one split evenly between manufacture and installation. Costs are assessed with reference to the design details and efficiency and comparison with similar projects in GB, Ireland and internationally.

The revised Beauly Denny AVAE construction cost is broken down into main expenditure categories in Table 5, as provided by SPT TIRG Beauly Denny AVAE Notice[1]. A cost assessment of each of the expenditure categories is provided below. Note that this is

based on the December 2012 submission. Expenditure category costs including contingency costs have now altered slightly (but not materially) following a detailed risk analysis and review of completed contracts (and current/potential remeasure) commissioned by SPT in April 2014. This is explored in further detail in our assessment of risk.

Table 5 – Expenditure Categories (Dec 2012 submission)

Description of Work (2009/10 prices in £'000s)	Revised Cost (2009/10) (£)	% of Total
Enabling Works – Fibre Optic Works	3,059,685	2%
Enabling Works – 132kV Undergrounding	9,851,747	6%
Enabling Works – Distribution Works	3,108,270	2%
Construction of 400/275kV Overhead Line Works	58,012,889	33%
Denny North Substation Works	48,443,853	28%
Environmental Works – Condition of S37 Consent (Condition 18)	11,515,117	7%
Environmental Works – Condition of S37 Consent (Condition 19)	14,763,198	8%
Environmental Works – Condition of S37 Consent (Other Conditions)	2,632,521	2%
Legal Fees	1,162,398	1%
Contingency	21,470,926	12%
Total Forecast Construction Costs (2009/10 Prices)	**174,020,604**	**100%**

4.3.6 Enabling Works – Fibre Optic Works

The consented 400kV OHL route requires modifications to the existing 275kV ZC North and South overhead line double circuits. The ZC south line will be transferred to a new short section of line into Denny substation and the ZC north line will be transferred onto the short section of the original ZC south line which is vacated by the transfer of the ZC south line ("double shuffle"). New underground fibre optic cable is required to maintain continuity to the control and protection circuits during outages for construction. The cost for fibre optic works amounts to around 2% of the overall scheme cost.

According to details provided by SPT, the fibre optics routes include Tower XD119 via Junction ZCN48 to Denny North Site (9.45km), Denny North Site to Bonnybridge 132kV S/S (10.5km), Denny North Site to Stirling 132kV S/S (12.4km) and Stirling 132kV substation to Tower AB54 (6km) and these are generally to be installed in public roads or verges. Tenderers for these works were also asked to include additional 132kV ducting works at two further locations (Plean to Greencornhills 2.6km, and Manor Powis to Blackgrange Garage 2.8km).

Table 6 – Costs for Enabling Works – Fibre Optics

Item	SPT (£k)	Benchmark (£k)	Source
Fibre Optic civil works (38.35km) and cable lay (inc 132kV ducting, 5.4km)	[redacted]	3,508	TNEI internal cost database
Fibre Optic service transfers and terminations	[redacted]		
Fibre Optic cabinet relocation	[redacted]		
Total	**3,060**	**3,508**	

The benchmark cost range for 38.35km of grass verge or B-Road cable installation is approximately £2,861k-£4,735k and including ducting costs of £647k, totals £3,508k – £5,382k. The lower cost in the range which corresponds to the verge-dig is 15% higher than SPT costs. Our view is that these costs are acceptable.

4.3.7 Enabling Works – 132kV Undergrounding

A short section of the 132kV double circuit OHL is required to be undergrounded on the AB route close to Plean and Torwood. This includes removal of existing 132kV OHL towers, installation of replacement terminal towers and new cable sealing end platforms. A short section of the 132kV CN route also requires undergrounding to accommodate construction of the Denny North substation.

From details provided by SPT, these works involve installation of 2 new L7(C)/1 DT terminal towers with 2 sealing end platforms on each tower on AB19 to AB23 route, 2 new 132kV L7(C)/1 DT terminal towers each complete with 2 sealing end platforms on AB45A to AB45B route, 1 new L4(M) DT terminal tower complete with auxiliary crossarms, together with 2 four-pole trident terminal sealing end structures on CN route. Dismantling and removal of 11x 132kV towers is also included.

Based on information from TNEI's internal cost database (sourced from similar transmission works tenders), tower supply and installation costs (including foundations and sealing end platforms) and OHL dismantling costs total approximately £2,360k. Whilst this is somewhat lower than SPT's costs of [redacted], we recognise that there is some complexity involved in this work including meeting compressed timescales and higher fixed costs due to limited sites and thus no economies of scale. This is likely to have resulted in the cost benchmarking difference and therefore, we are satisfied that the SPT cost is reasonable.

Ground conditions will have a significant impact on cable installation costs, and a high level assessment of the route between Plean and Torwood indicates that hard-dig would likely be required for most of the route, with occasional grass-verge dig, therefore the benchmark cost assumes a hard-dig for the route. Benchmark figures for 132kV cable supply, install and civils total £6,388k which is slightly higher than SPT's cost of [redacted].

Table 7 – Costs for Enabling Works – 132kV Undergrounding

Item	SPT (£k)	Benchmark (£k)	Source
132kV Towers	[redacted]	2,360	TNEI internal cost database
132kV Cable Civils	[redacted]	6,388	TNEI internal cost database
132kV Cable Supply and Install (5km)	[redacted]		
IEC Design Costs – 132 & 275kV Cable	[redacted]	639	Based on TNEI experience
Total	**9,851**	**9,387**	

4.3.8 *Enabling Works – Distribution Undergrounding*

There are a number of 33kV, 11kV and other low voltage lines crossing the consented 400kV OHL corridor deviation. These are to be undergrounded at crossing points to mitigate hazards and enable construction of the new Beauly Denny line. Distribution undergrounding works and associated costs have been scoped by SP Distribution.

From details provided by SPT, these works involve installation of a number of short length sections of HV (33kV and 11kV) and LV cabling to replace OHL spans ranging from about 100m to 1.4km. The works include OHL dismantling and installation of several secondary substations. TNEI cost benchmarking details are shown below and total £2,267 which is """""""" of SPT's undergrounding costs. Details provided to us by SPT indicated mainly unmade ground (or soft dig) with some road and river crossings. We have assumed that dig conditions will range from soft dig to hard dig (to represent costs associated with road and river crossings). We recognise that fixed costs are likely to be higher due to the large number of fairly limited distance undergrounding works, reducing economies of scale. SPT costs are appropriate.

Contractor Resources (PM, Clerks of Works, Safety Co-ordinator, Environmental Clerk of Works) are estimated to be 10% of the works based on our experience. Our estimate is comparable to SPT costs.

Table 8 – Costs for Enabling Works – Distribution Undergrounding

Item	SPT (£k)	Benchmark (£k)	Source
Distribution Undergrounding	[redacted]		
LV Cable Supply, Install and Civils (0.94km)		115	TNEI internal cost database
11kV Cable Supply, Install and Civils (11.3km)		1068	
33kV Cable Supply, Install and Civils (3.25km)		953	
33kV new OHL (0.14km)		16	
New 500kVA substation (2)		40	
OHL Dismantling			
LV (1.3km)		6.9	
11kV (9.2km)		49.4	
33kV (2.71km)		18.7	
Contractor Resources	[redacted]	225	TNEI experience
Total	**3,108**	**2,492**	

4.3.9 Construction of 400/275kV Overhead Line Works

SPT indicate that the cost of works associated with the construction of the main overhead line were based on tender prices. SPT has indicated that cost estimates were based on robust engineering and environmental estimates for the remaining cost elements.

TNEI has reviewed the key cost items for the 400/275kV overhead line works, consisting of overhead line construction and refurbishment. This accounts for about 72% of the overall project costs. The remaining costs are for road surveys, public road improvements, environmental surveys, wayleaves, contractor services etc.

TNEI benchmark costs for 400kV overhead line construction are based on National Grid's 2013 Electricity Ten Year Statement. The cost per route km for 400kV double-circuit overhead lines is in the range of 1.57-1.99 £m/km. This corresponds closely to SPT's costs for the construction of the new 18.848km L12x TD route from TD189 to TD237B once inflation is taken into consideration.

SKM benchmarked 400kV overhead line costs using an industry-recognised report commissioned by the IET and produced by PB Power ("Energy Transmission Costing Study") and reached a view consistent with ours.

TNEI's benchmark for the ZC(N) & ZC(S) refurbishment from Shuffle to Denny is based on replacement of the present quad conductors with twin and replacement of the insulators and fittings, consistent with the SKM report. Along with construction of L12 X route (TD240A to TD248A) from Shuffle to Denny, total benchmark costs are lower than SPT costs however, the route lengths are short which can mean that unit costs are typically not so representative due to higher fixed costs and reduced economies of scale. Therefore, the SPT costs are considered appropriate for these works.

The lump sum of all other associated costs (£16,268k) is 28% of overall expenditure category costs and includes items such as overhead line route dismantling """""""""""""""" overhead line modifications and reconfiguration """""""""""""" """""" """""""""""""""" OPGW Replacement from Longannet to the Shuffle """""""""""""""" land compensation/damages """""""""""""""" public road improvements """""""""""""" Operational Contingency Planning """""""""""""""" Using a top-down assessment approach, these are considered appropriate given the scale and complexity of the project.

Table 9 – Key costs associated with construction of 400kV/275kV OHL Works

Item	SPT (£k)	Benchmark (£k)	Source
Construction of New L12x TD route from TD189 to TD237B (18.848km)	""""""""""""""	26,000-33,000	National Grid ETY Statement
ZC(N) & ZC(S) Refurbishment from Shuffle to Denny (4.8km)	""""""""""""""	3,000	TNEI internal cost database
Construction of L12 X route (TD241A to TD248A) from Shuffle to Denny (2.514km)		3,470-4,400	National Grid ETY Statement

4.3.10 Denny North Substation Works

A new 400/275kV substation will be constructed at Denny which forms the southern termination point for the Beauly to Denny OHL. It will serve as a connection point for the existing 275kV circuits which converge at the site as well as the new 400kV double circuit. There are also two 132kV circuits that converge at the site which will connect to the 275kV busbars via a single transformer feeder circuit and a cable sealing end compound. The substation comprises 3x 400kV double busbar bays and 9x 275kV double busbar substation bays with provision for future expansion as well as a 400/275kV supergrid transformer, a 275/132kV supergrid transformer and associated auxiliary systems. TNEI has reviewed the key cost items for the Denny North substation works. These account for about 91% of the overall project costs.

SPT has reported that changes to the routing of the 400kV double circuit overhead line due to consent conditions to minimise the visual and environmental impact of the substation has resulted in significant additional cost. This affects the entry points of the overhead lines into the substation which influences the configuration and layout and requires undergrounding of small sections of 275kV and 132kV overhead lines. Short cable connections between the 275kV busbars and the existing ZG route twin overhead line circuits which connect to Bonnybridge substation are also included.

Based on TNEI's cost benchmarking, a 1000MVA Auto-Transformer 400/275kV transformer costs in the range of £1.5m-£2.25m and a 275/132kV 240MVA Auto-Transformer costs in the range of £1.3m to £2m. This gives a total of £3.5m on average or £4.25m maximum which is fairly consistent with SPT's total transformer costs. There is no breakdown of individual transformer costs in provided costs data.

With regards to the substation cable works, Denny North 400/275/132 kV substation has several short 275kV cable connections which are 750m (Bonnybridge No 1) and 600m (Bonnybridge No 1) as well as some 132kV circuit works. TNEI's benchmarking costs are somewhat higher than SPT costs.

The Denny North substation will contain 3x 400kV feeder/transformer AIS bays and 9x 275kV feeder/transformer AIS bays with provision for further expansion. Our benchmarking costs indicate that 400kV bays are approximately £2m to £3m and 275kV bays are approximately £1m to £2m to give an average total of £21,000k. A number of protection and control works are also required for the remote ends associated with reconfiguration of all existing 275kV Circuits during Denny North Main substation RETS stages. These include works at Longannet 275kV substation, Bonnybridge 275/132kV substation, Easterhouse 275kV substation, Clydesmill 275kV substation, Lambhill 275kV substation and Windyhill 275kV substation. Denny North-Bonnybridge high capacity 132kV circuits will require to be rated to comply with the cyclic rating of SGT3 275/132 kV 240MVA transformer at Denny North substation irrespective of the existing rating of CN/BRW OHL Route. These costs are contained in SPT costs for Denny North and Remote Ends (£23,549k). Given that the scale of the control and protection works at the remote ends are material but likely to be somewhat less than the substation bays, our view is that the costs are relatively consistent.

The Denny civil platform costs are [redacted] These costs are mainly driven by the large amounts of peat that require excavation and backfill. TNEI's benchmark for a substation civil platform is £6,400k which is consistent with SPT's cost. However, it should be noted that substation civil platform works and associated costs are highly dependent on the ground conditions and the other specific factors. Access road cost estimates are fairly consistent between TNEI and SPT.

Contractor Resources (PM, Clerks of Works, Safety Co-ordinator, Environmental Clerk of Works etc) are estimated to be 10% of the works based on our experience. Our estimate is comparable to SPT costs.

Table 10 – Key costs for Denny North Substation Works

Item	SPT (£k)	Benchmark (£k)	Source
Transformers			
400/275kV 1000MVA Auto-transformer	''''''''''''''	2,250	TNEI Internal cost database
275/132kV 240MVA Auto- transformer		2,000	
Cabling			
275kV Cable Supply, Install and Civils (1.35km)	''''''''''''	5535	TNEI Internal cost database
145kV Cable Supply, Install and Civils (1.8km)		2191	
Denny North Substation			
3x 400kV double busbar bays	''''''''''''''	7,500	TNEI Internal cost database
9x 275kV double busbar bays		13,500	
Remote Ends control and protection modifications		-	
Denny Access Road (2km)	''''''''	1,120	TNEI Internal cost database
Denny Road Remediation	''''''''		
Denny Civil Platform	'''''''''''''	6,400	TNEI data from previous project
Contractor resources	''''''''''''	4,844	Based on TNEI experience

4.3.11 Environmental Works – Condition of S37 Consent (Condition 18)

Consent condition 18 requires wirescape rationalisation for visual amenity purposes. This includes removal and undergrounding of the following 132kV overhead line sections under the wirescape rationalisation works of the Stirling Tee:

- 7 spans of the BJ route (BJ01-BJ08 approximately 2km “The Stirling Tee”); and

- 15 spans of the AB route between towers AB39A and AB54A.

Table 11 – Costs for Environmental Works – Condition of S37 Consent (Condition 18 132kV Wirescape Rationalisation of Stirling "T" – from received tenders)

Items	SPT (£k)	Benchmark (£k)	Source
Cable Civils (6.2km)	""""""""""""	7921	TNEI Internal cost database
Cable Supply and Install (6.2km)	""""""""""""		
OHL Dismantling	""""""""	341	TNEI data from previous project
Stirling GSP mid point switching station	""""""	500	TNEI Internal cost database
Sealing end set	Not detailed	360	SKM report
New terminal towers and sealing end platforms	Not detailed	1380	TNEI data from previous project
IEC fees (assume 10% PM/design)	Not detailed	1050	TNEI Internal cost database
Total	11,372	11,553	

Based on our internal cost database and a desktop assessment of the proposed cabling route, we benchmark 132kV underground cable costs at approximately £1217/m assuming a hard dig is required. This is generally consistent with the SPT cost. We have been provided with some resolution of the SPT cost estimate build-up. Although it is not completely clear which items fall into which cost categories, it has given us confidence that costs are acceptable.

4.3.12 Environmental Works – Condition of S37 Consent (Condition 19)

Environmental Works required to satisfy consent condition 19 include:

- planting and Landscape Reinforcement including native tree and shrub planting and landscape improvements in the broad corridor surrounding the overhead line route;
- undergrounding of Low Voltage (LV) Overhead Lines in six locations;
- tower Painting in locations where they are seen against a vegetated backdrop in two areas of the overhead line within the Stirling area;
- undergrounding of the existing 132kV overhead line between Fallin and Glenbervie (10km);

- removal of 7km of the existing AB line from AB39-AB13; and
- broad suite of proposals for widespread improvements to landscape amenity in the area.

Based on our internal cost database and a desktop assessment of the proposed cabling route between Fallin and Glenbervie, we benchmark 132kV underground cable costs at approximately £840/m assuming some soft dig and hard dig is required. This is generally consistent with the SPT cost, noting that SPT costs also include for some LV undergrounding. We have been provided with some resolution of the SPT cost estimate build-up. Although it is not completely clear which items fall into which cost categories, it has given us confidence that costs are acceptable.

SVIMS implementation costs are considered acceptable based on the scope of works required.

Table 12 – Costs for Environmental Works – Condition of S37 Consent (Condition 19)

Items	SPT (£k)	Benchmark (£k)	Source
132kV Cable Civils (10km)	""""""""""""	8,820	TNEI Internal cost database
132kV Cable Supply and Install (10km)	""""""""""""		
OHL Dismantling (7km)	""""""	385	TNEI data from previous project
Sealing end set	Not detailed	360	SKM report
New terminal towers and sealing end platforms	Not detailed	1,380	TNEI data from previous project
IEC fees (assume 10% PM/design)	""""""""""""	1,095	TNEI Internal cost database
SVIMS implementation	""""""""""	1,254	SPT cost
Total	14,763	13,294	

4.3.13 Environmental Works – Condition of S37 Consent (Other Conditions)

Key findings from our analysis of the costing for the environmental works required to meet the other consent conditions are as follows based on SPT provided cost data;

- Chargeout rates used across the board (by various different consultants/specialists) are reasonable.
- Single cost elements such """ """""""""""" """""""" """""""" """""""""""""""""" """""""""""" """""""""""""""" """""" days of surveying looks reasonable.

- The overall time input (man hours) within the scope appears commensurate with the level of work anticipated to be necessary to meet the conditions and implement various elements of mitigation.

Therefore based on our previous experience with these types of works and the volume of works required for a project of this scale and complexity, the costs for the various cost items and the overall cost look broadly reasonable.

Table 13 – Costs for Environmental Works – Other Conditions

Item	SPT (£k)
s37 Condition – Others (1-7 & 21-30, 32 -42)	'''''''''
s37 Condition 8 – Construction Procedures Handbook	''''''
s37 Condition 8(5) – Technical specialists	'''''''''
s37 Condition 9 – Independent Environmental Contractor	''''''''''
s37 Conditions 10 to 17- Various Environmental Surveys/Specialists	'''''''''
s37 Conditions 20 – Glenside Farm	'''''''''
s37 Condition 31	'''''''''
s37 Condition 43 (footpath mitigation)	'''''
Total	£2633

4.3.14 Legal and audit fees

Legal and audit fees total £1162k which is appropriate for a project of this scale and complexity given the level of construction, environmental works, wayleaves and land purchases.

4.3.15 Contingency costs

Contingency costs are reviewed separately in the assessment of risks and contingencies in Section 4.4.

4.3.16 Summary of Cost assessment

We have reviewed the cost data provided by SPT including contract and tender costs and cost estimates for elements not yet tendered using a bottom up cost analysis. Our view is that key cost items are comparable to our benchmarking and thus, SPT costs are appropriate.

Cost benchmarking data is summarized in Appendix A. Please note that these have been selected or derived to provide a reasonable representation of the specific Beauly Denny project works details provided.

4.4 Approach to risk and contingencies

The risk methodology used by SPT to determine contingency costs was assessed along with the contingency costs and supporting justification. A key principle of funding mechanisms such as TIRG and RIIO-T1 is that risk is best borne by the party able to influence it. Therefore, key to our assessment of the risk methodology and contingency

costs was whether SPT is able to influence the level and timing of the risk. Risk costs can sometimes be reduced through contracting arrangements or consideration of alternative solutions in response to consenting difficulties.

The assessment of the risk methodology was informed by the AVAE submitted in December 2012 and the accompanying independent audit report, as well as subsequent communications including meetings held in Glasgow (March 2014) and Ofgem premises (April 2014) and additional data and analysis results provided.

Assessment of the contingency costs considered the calculation of specific contingency allowances and mitigation measures applied by SPT to keep these to a minimum. Contingency costs were given as £21.47m (2009/2010 price base) in the December 2012 AVAE submission, which equals 14% of the total project budget (£174m). Table 14 provides a breakdown of contingency costs for each expenditure category.

Table 14 – Expenditure categories showing contingency costs

Description of Work (2009/10 prices in £'000s)	Cost Inclusive of Risk (2009/2010 Prices) (£k)	Risk Contingency Cost Provision (2009/2010) (£k)	Risk as % of Work Package Value (2009/2010 Prices)
Enabling Works – Fibre Optic Works	3,373.93	[redacted]	[redacted]
Enabling Works – 132kV Undergrounding	11,172.1	[redacted]	[redacted]
Enabling Works – Distribution Works	3,487.3	[redacted]	[redacted]
Construction of 400/275kV Overhead Line Works	66,132.2	[redacted]	[redacted]
Denny North Substation Works	53,828.6	[redacted]	[redacted]
Environmental Works – Condition of S37 Consent (Condition 18)	14,075.7	[redacted]	[redacted]
Environmental Works – Condition of S37 Consent (Condition 19)	17,830.6	[redacted]	[redacted]
Environmental Works – Condition of S37 Consent (Other Conditions)	2,828.8	[redacted]	[redacted]
Legal Fees	1,291.4	[redacted]	[redacted]
Total Forecast Construction Costs (2009/10 Prices)	**174,020.59**	**21,470.93**	**14.1%**

Source: SKM report, Page 13

All aspects relating to SPTs approach to risk and contingency costs were clarified following the AVAE submission and the supporting independent audit, along with further requested information/documentation. In addition and to their credit, SPT, recognising the original risk assessment was weak, commissioned a comprehensive re-analysis of the risks and contingencies as at April 2014 by an independent expert risk consultancy, Gardiner & Theobald.

Following its completion and issue in April 2014, we reviewed the revised risk assessment and held a presentation and discussion session with SPT and Gardiner & Theobald. Based on this detailed review and discussion we believe the revised risk assessment is robust. In addition, there is now sufficient explanation of the probabilistic methodology to consider potential risks and associated costs borne by SPT, and sufficient justification of reasonable inputs (potential costs and probabilities of occurrence) which are ultimately supported by SPT's expert opinion. As regards the allocation of risks, there is reasonable justification that SPT holds the risks that cannot be mitigated by the contractors in a more

cost efficient way, and that SPT's risk mitigation measures ensure an overall least cost project.

The materialisation of contingencies incurred as the project moves forward support that contingency provisions are in line with budget and that forward projections are reasonable.

4.4.1 Contracting strategy

SPT combines several contract types as a consequence of the new contracting approach agreed and adopted for RIIO-T1. Works are contracted in such a way to enable SPT to own the risks that it can control and mitigate better than contractors. This approach generally translates into higher contingency costs for SPT, but lower contracting costs and a lower overall project budget. Contingency costs borne by SPT relate to risks associated with landowner issues, interface with other contracts, delays associated with planning etc and/or where SPT is best placed to design out, mitigate and manage the risk. The remainder of the contingency costs are borne by contractors and embedded in the contract costs, and therefore neutral to the SPT project budget. No specific examples were provided by SPT to evidence the RIIO-T1 multiple contracting strategy as delivering a lower total cost despite higher allowance for risk contingencies.

Mitigation measures by SPT seek to minimise the contingency costs, and are based on thorough project management. Allocation of risk and risk costs in contracts is based on the professional judgement of the party in the best position to control and mitigate the risk, although specific examples were not provided by SPT. The risk register identifies risks and corresponding contingency costs borne by SPT and contractors.

The quantification of contingency costs was based on contractor delay penalties, estimated costs of additional material, estimated potential delays (with low, most probable and worst expected delays) and estimated probability of occurrence of each risk.

We have carried out some analysis to assess the evolution of risk ownership in Table 15. This indicates the pre-tender projected ownership of risk between SPT and the contractor and the actual risk ownership negotiated at contract award. For contractors, the risk costs are then bundled into the total contract cost. This indicates that SPEN has been successful in negotiating with contractors as contractors have accepted the pre-tender projected ownership of risk. '''''''' ''''''' ''''''''''''' ''''''''' ''''''' ''''''''''''''''''' ''''''' ''''''''''''''''' ''''''''''''''' ''''''''''''''''' '''' ''''''' ''''''''' ''''''''' ''''''''''''''' ''''''''''''''''' ''''' ''''''''''''

At the point of contracting with the successful contractors SPT has taken on around 70% of the calculated contingency costs and contractors 30%.

Table 15 – Risk Position (pre-tender vs contract-award) in 2010/2011 cost base

Item Risk Register	Pre-Tender – Ownership Of Risk Potential Risk (£)		On Contract Award – Ownership Of Risk Potential Risk (£)	
	Contractor	SPEN	Contractor	SPEN
400kV Overhead Line	'''''''''''''''''''''''''	'''''''''''''''''''''''''''''	'''''''''''''''''''''''''	'''''''''''''''''''''''''''
132kV Overhead Line	'''''	'''''''''''''''''''''''''''	'''''''''''''''''''	'''''''''''''''''''''''

Denny North Access Road	'''''''''''''''''''''	'''''''''''''''''''''''	'''''''''''''''''''	'''''''''''''''''''
132kV Cable Supply and Install	'''''	'''''''''''''''''''''''	''''''	'''''''''''''''''''''''
132kV Cable Civils	''''''	'''''''''''''''''''''''	''''''	'''''''''''''''''''''
132kV Overhead Line	'''''''''''''''''''''''	'''''''''''''''''''''''	'''''''''''''''''''''	'''''''''''''''''''''''
Fibre Optic Cabling	''''''	'''''''''''''''''''''	'''''	'''''''''''''''''''
Denny North Substation Platform	''''''	'''''''''''''''''''''''	'''''	'''''''''''''''''''''''''
Denny North and remote ends	''''''''''''''''''' '''''''''''''''''''''''	''''''''''''''' '''''''''''''''''''''''	'''''''''''''''''''''''	'''''''''''''''''''''
275kV Cable Supply and Install	''''''	'''''''''''''''''''	'''''	'''''''''''''''''''''
Public Road Improvements	''''''	'''''''''''''''''''''''	'''''	'''''''''''''''''''''''
Distribution Works	'''''	'''''''''''''''''''''	'''''	'''''''''''''''''''''
Total	**£887,776**	**£15,028,770**	**£6,614,352**	**£14,462,994**

4.4.2 Risk register

Following review of the AVAE submission and supporting documentation, we requested in addition the project risk register which was provided by SPT and assessed. We expected that the risk register would have a time stamp, to register all contingency costs materialise and adjustment of the risk component accordingly. We also expected that since December 2012, as part of the work had been carried out and a number of the contracts had been awarded, that the total project risk and the risk cost per element would be periodically updated, and that the total contingency cost as of January 2014 would be lower than £21.47m. At any point in time, the risk register should reflect any reductions in risk following contract award and contract completion. These features were not included in the risk register and there was no update in the January 2014 submission, which suggests that values prior to contract award were still being used for a number of works.

In the SKM independent audit, SPT state that 14% of the risk budget has materialised after completion of 18% of the project (18% of forecast spend). This is used to justify that similarly, 14% of the remaining budget is expected to be incurred as contingency costs until the end of the project. Generally, risks should reduce as construction works progress and there is greater certainty on remaining works requirements (including in percentage terms). This was not detailed in the risk register.

The SPT risk register did not include details of the evolution of risks over time, dates of signed contracts, nor the expected time of allocation and materialisation of risks. Throughout February to April 2014, in response to our queries, further information was provided by SPT on the evolution of the risk position. However, through this process, sufficient information was provided to understand the latest risk position, the current allocation of risks between SPT and contractors, and the underlying risk methodology.

4.4.3 Risk position

The latest risk update was provided by SPT in April 2014, supported by a risk management study commissioned from Gardiner & Theobald and includes the latest cost position including realised costs and updated contingency cost forecasts. This has helped to clarify some of the concerns that we raised in relation to the original risk methodology used and the risk register provided.

Table 16 provides an update on the risk position (2011/2012 price base) which indicates an overall decrease in the total project budget. This is due to a review of current and

completed contracts to identify current and potential remeasures and variation. Remeasure costs are representative of realised contingency costs and include compensation events / variation orders. Details of these were provided by SPT on works complete.

The total risk cost as a percentage of the total funding request has decreased slightly from the December 2012 submission. Contingency costs have reduced from £21.5m (total project cost of £174m) to £19.9m (total project cost of £169.3m) on a 2009/2010 price base. We would generally expect risk costs to reduce as a project progresses, the construction works are only 33% complete (by cost) which is not a major progression since the December 2012 submission (which was at 18% of budget spend, mainly pre-construction works) and thus the project is still not that advanced in terms of project programme. There has also been some compression of timescales due to unforeseen landowner access delays. The slight risk decrease has incorporated learning on risks from works underway (e.g. landowner access issues) and is acceptable on this basis.

For future contracts, risk costs have increased for Environmental Works – Consent Conditions 18 and 19 as well as for the 400kV OHL construction works from December 2012. For Environmental Works – Consent Condition 18 and 19, detailed site surveys have not been carried out yet for 132kV undergrounding works so there are underlying risks at pre-tender stage and with greater landowner access/wayleave issues experienced for other similar works than expected which also compresses timescales, this has led to the risk cost increase (based on our discussion with SPT in April 2014). For the 400kV OHL construction works, risk cost increases are associated with additional injurious affection claims; compensation for depreciation in the value of an interest in land which is attributable to the use of public works. Our view is that these risk cost changes are broadly reasonable based on the provided justification.

Please note that the contingency costs shown in Table 16 are only indicative for comparison as the latest risk analysis has been undertaken on a top-down basis and gives values which slightly differs from those calculated using the original bottom-up approach.

Table 16 – Update on risk position (April 2014)

	Submission Forecast Dec 2012		Forecast at March 2014			Value of Work Done	
All Costs at 2011/12 prices	[redacted]						%
COMPLETED CONTRACTS							
ENABLING WORKS - FIBER OPTIC WORKS							100%
DENNY NORTH SUBSTATION WORKS							100%
ENVIRONMENTAL WORKS - OTHER CONDITIONS							100%
LIVE CONTRACTS							
ENABLING WORKS - 132kV UNDERGROUNDING							76.0%
ENABLING WORKS - DISTRIBUTION UNDERGROUNDING							29.7%
DENNY NORTH SUBSTATION WORKS							29.7%
CONSTRUCTION OF 400kV OVERHEAD LINE							36.7%
ENVIRONMENTAL WORKS - OTHER CONDITIONS							47.7%
LEGAL & AUDIT FEES							16.6%
FUTURE CONTRACTS							
DENNY NORTH SUBSTATION WORKS							0.0%
CONSTRUCTION OF 400kV OVERHEAD LINE							0.0%
ENVIRONMENTAL WORKS - CONDITION 18							0.0%
ENVIRONMENTAL WORKS - CONDITION 19							0.0%
TOTALS	167,803,469	23,617,853	164,358,457	24,461,467	- 2,601,397	61,617,693	32.6%
		191,421,322	3,445,012	188,819,925			

Source: SPT

Following the risk management study and a review of current and completed contracts to identify current and potential remeasures and variation, SPT has submitted a reduced funding request for £169.3m at 2009/2010 prices compared to a funding request of £174m at 2009/2010 prices in the December 2012 submission (a reduction of £4.7m). This reduction of £4.7m is due to a reduction in latest cost forecast of £3.1m (£152.5m to £149.4m) and a reduction in risk/contingency costs of £1.6m (£21.5m to £19.9m).

4.4.4 Probabilistic model

In the original AVAE submitted in December 2012, it was stated that contingencies were calculated on a P80[4] basis however in the SKM independent audit report[2], SPT have indicated that this is also consistent with a P50 approach. Our view is that P50 and P80 are certainly not equivalent so this was a major point for clarification.

SPT contracted a risk management study[5] to Gardiner & Theobald in March 2014. This study has used a probabilistic methodology, and detailed risk input data provided by SPT, in order to give a clearer picture of the latest realised and projected project costs and risks and to provide an updated contingency cost.

Citing and summarising Gardiner&Theobald's report, *"The aim of this new assessment is to ensure that the risk contingencies reflected the changing situation for the project, as a number of packages are now complete, some are ongoing and there are some awarded*

[4] The 'exceedance probability' P(X) refers to a contingency value that has a probability of (100-X%) of exceeding the contingency value. For example, the P50 contingency cost has 50% probability of being exceeded, and the P80 cost has 20% probability of being exceeded.

[5] Beauly-Denny Risk management report.pdf

but yet to start. As such, the approach of costing both uncertainty on contracts let and the residual risk has been adopted to reflect the maturity of the works.

A 'top-down' approach has been undertaken. The discrete risks identified in the previous 'bottom up' assessment have been reviewed and consolidated where possible, avoiding duplications of impact at project level. The consolidation also reflects the works that have been completed to date (April 2014), namely the Denny North Access Road, the Denny North Substation Platform, and the Fibre Optic Cabling. As such, the discrete risks included are those residual risks considered relevant to the remainder of the works. However, an additional risk has been included, related to completed works. Additional risk items have been suggested.

An allowance has also been included for inherent estimating uncertainty, in order to reflect the number of separate contracts let and the current completion position of those contracts".

The methodology presented uses a Monte Carlo simulation. Each risk element has a triangular probability distribution of impact (a minimum value, a central 'most likely' value or a maximum value), as well as a probability of occurrence. The risk elements are both the generic risks raised within the risk register that may affect any or all of the tenderers, and also the specific risks highlighted against each tender.

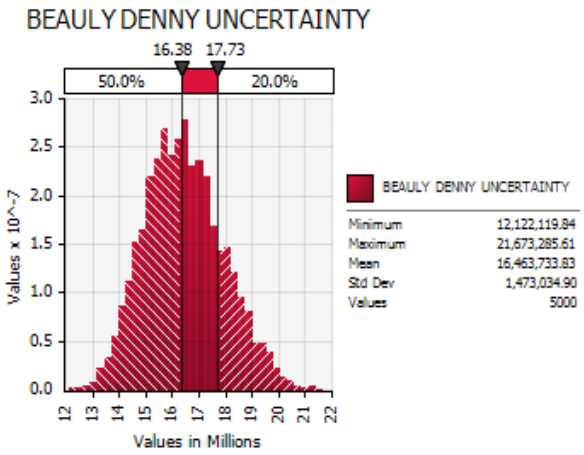
The Monte Carlo methodology tests random combinations of potential outcomes of risks occurring, and their potential impacts, following the probability distributions of each element. For instance, a risk occurring with 50% probability (as per the input expert estimate) is considered in 50% of the simulations; also, the impact of a risk being £100k/£300k/£600k will provide a random value within this range (closer on average to the central value).

When performing thousands of random simulations (5,000 in this case) the final result of the probabilistic study is a full curve of potential costs, ranging from the most favorable situation where few risks materialise and their impact falls in the low end (which is very unlikely), to the most unfavorable situation where all risks materialise and their impact falls on the most costly end (which is also very unlikely). This risk probability distribution curve is shown in Figure 2, i.e the probability that the project risk impact falls within a specific range (the width of each bar, or cost range).

Figure 3 further shows the cumulative probability distribution, i.e. the probability that the project risk is equal or lower than a specific value.

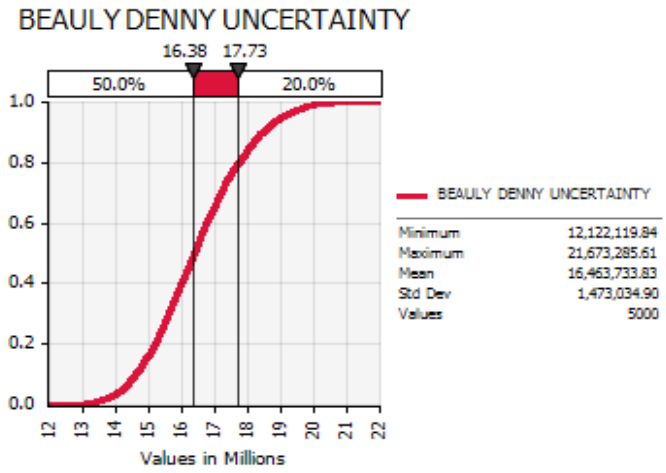
This methodology complies with best practice in risk assessment.

Figure 2 – Probability distribution of project risk value



Source: Gardiner&Theobald

Figure 3 – Cumulative probability distribution of project risk value



Source: Gardiner&Theobald

The input data plays a major role in the outcome of the study. The input data consists of a probability of occurrence, and a triangular distribution of impact.

The probability of occurrence is informed by 'expert assumptions' from SPT, and we find the values used for the different elements to be broadly reasonable, ranging from 2% (terrorism) to 90% (commissioning delays), with an average value of 35% for all 35 elements identified.

The impact of each risk, should it materialise, is generally defined by potential delays, multiplied by the delay costs as projected by contractors. Potential delay times are 'expert assumption' inputs, which we consider broadly reasonable (1 to 3 months, up to 1 to 12 months). Both a description of the risk element and supporting information on the resultant contingency costs are provided.

The contingency costs considered in the assessment are described as 'post mitigation costs', where specific mitigation actions to be applied are described for each individual risk element. These actions generally consist of anticipatory preparation of the

construction works including early discussion with landowners and contingency plans, appropriate planning of resources, and appropriate monitoring of the work i.e. project management best practice.

We find that both the risk methodology applied by Gardiner & Theobald, and details of the input data used for contingency cost calculation as provided by SPT, are suitable and appropriate for carrying out a robust risk assessment.

Finally, funding of a P50 contingency cost is requested by SPT, equivalent to the cost which may be exceeded with 50% probability. We find this value to be reasonable, as it shares the potential benefits or losses equally between SPT and the electricity consumers. Also, this is consistent with risk probability values accepted for other large transmission works. Also, considering the low standard deviation of the probability curve i.e. the relatively low variation of contingency costs for other probability values as seen from the results of the Gardiner & Theobald simulation, we find the P50 risk value to be reasonable.

4.4.5 Summary

SPT's resubmitted assessment of risk and contingency costs based on the risk management study by Gardiner & Theobald is well evidenced and justified with supporting evidence and/or explanation. We believe that the corresponding revised funding request for contingency costs is reasonable.

4.5 Summary of assessment findings

The outcomes of our detailed assessment of the four key areas above can be summarised as follows:

- A mapping exercise indicates that the revised budgeted activities appropriately address consent conditions.
- The amended scope and technical design appear to be adequate and efficient in relation to the consent conditions and intended output.
- The procurement process undertaken by SPT appears to be robust and efficient. We have undertaken a bottom-up cost assessment that considers key technical features and project specific characteristics such as ground conditions and the scale and complexity of the works. SPT provided us with additional details where requested to enable a robust cost assessment. Our view is that the overall expenditure category costs (excluding contingency costs) and key cost items within these are reasonable as supported by our benchmarking analysis.
- An initial review raised some concerns over limited explanation or justification of the original internal SPT risk assessment used to determine the contingency costs, including an absence of detail on the probabilistic model used, the allocation of risks between SPT and contractors and the evolution of views of risk over time.

  Following review of the Gardiner & Theobald analysis as well as further information provided by SPT, our view is that the revised risk assessment conducted by Gardiner & Theobald and adopted by SPT is robust. There is also sufficient explanation on the probabilistic methodology to consider potential risks and associated costs borne by SPT, and sufficient justification of reasonable inputs (potential costs and probabilities of occurrence) which are ultimately supported by SPT's expert opinion. Based on the evidence presented, we are also satisfied that the risk allocation between SPT and contractors is efficient.

Table 17 – Overview of Pöyry assessment

Assessment Area	Consents	Scope	Costs	Risks
Final assessment				

4.6 Recommendations in relation to SPT's AVAE find request

On the basis of our assessment and key findings as outlined above we recommend that Ofgem approves the latest requested funding of **£169.3m** (2009/2010 price base) inclusive of a provision for contingencies of **£19.9m** (2009/2010 price base).

APPENDIX A – COST BENCHMARKING DATA

Table A-1 – Cost Benchmarking Data

Unit Costs		2009/2010 prices	
Fibre Optics			
Cable		19	£/m
Civil Works	B-Road	107	£/m
	Grass Verge	58	£/m
Ducting		17	£/m
Cables			
LV Cable Supply & Install (including civils)	Ave (Soft Dig, Hard Dig)	117	£/m
11kV Cable Supply & Install (including civils)	Ave (Soft Dig, Hard Dig)	90	£/m
33kV Cable Supply & Install (including civils)	Ave (Soft Dig, Hard Dig)	279	£/m
132kV Cable Supply & Install (including civils)	Hard-Dig	1217	£/m
132kV Cable Supply & Install (including civils)	Ave (Soft Dig, Hard Dig)	840	£/m
145kV Cable Supply & Install (including civils)	Hard-Dig	1217	£/m
275kV Cable Supply & Install (including civils)	Lower Range	1500	£/m
	Upper Range	2600	£/m
OHL			
OHL Dismantling			
LV		5.1	£/m
11kV		5.1	£/m
33kV		6.6	£/m
132kV		55	£/m
OHL Build			
33kV		110	£/m
400kV Double Circuit	Lower Range	1380	£/m
OHL Refurbishment			
275/400kV refurbishment		308	£/m
Towers and Terminations			
132kV Sealing End Set		180	£k per set
132kV Terminal Towers and Sealing End Platforms		345	£k per tower
Substation			
500kVA Secondary Substation		20	£k per substation
GSP Switching Station		500	£k per substation
400/275kV Auto-Transformer 1000MVA	Lower Range	1500	£k per transformer
	Upper Range	2250	£k per transformer
275/132kV Auto-Transformer 240MVA	Lower Range	1300	£k per transformer
	Upper Range	2000	£k per transformer
Civil Works			
Access Road (Rural, Single Lane)	Lower Range	450	£/m
	Upper Range	670	£/m
400kV Double Busbar Bay (Feeder/SGT)	Lower Range	2000	£k per bay
	Upper Range	3000	£k per bay
275kV Double Busbar Bay (Feeder/SGT)	Lower Range	1000	£k per bay
	Upper Range	2000	£k per bay
Project Management and Design		10%	Total Works Cost
Cable/OHL Project Management		5%	Cable Install & Supply Costs

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