FICHTNER
Consulting Engineers Limited

OFGEM

NSN INTERCONNECTOR

ASSESSMENT OF DEVEX, PROCUREMENT APPROACH AND TECHNOLOGY

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1 CONSULTING SERVICES - INTRODUCTION

The NSN Interconnector, developed jointly by National Grid and Statnett, will transmit up to 1,400 MW of electric power over approximately 700 km between Norway and Great Britain. The Interconnector is scheduled to become operational in 2020.

OFGEM requested the Consultant to perform a high level review on the costs and process efficiency of:

- Development costs (incurred by NSN so far);
- Procurement approach taken by NSN; and
- Technical solution (cable route, capacity, technology etc.) of the HVDC system chosen by NSN.

The following describes the Consultant's high level review results of the above tasks as instructed on November 4, 2014.

1.1 NSN Interconnector – General

The NSN Interconnector is a 1,400 MW, +/- 525 kV HVDC transmission scheme between Great Britain and Norway. The interconnector is conceived to mainly balance the Norwegian hydro based system with the British system that is substantially based on thermal power, but increasingly also on renewables.

The HVDC link shall be able to operate at rated power in both directions. The converters shall be based on multilevel Voltage Source Converter (VSC) technology in bipolar configuration (with grounded midpoint) and without dedicated metallic or ground return.

The cables shall be of mass-impregnated type.

The HVDC systems shall consist of:

- HVDC converter station at Kvilldal, Norway, including AC connection.
- HVDC converter station at Blyth, Great Britain, including AC connection.
- 6 km HVDC tunnel/lake/underground cable from Kvilldal to Hylsfjorden.
- 714 km HVDC submarine cable from Hylsfjorden to Blyth.
- 2.5 km HVDC underground cable to the UK converter station.

The Project Developer NGIH (National Grid Interconnector Holdings) and Statnett intend to split above scope into the following Engineer, Procure, Construct (EPC) Contracts:

- One EPC contract for the HVDC converter stations; and
- Up to three (3) EPC contracts for the HVDC cable in accordance with their lotting strategy.

1.2 Documents provided by OFGEM

Based on the Consultant's request and in addition to the originally provided documents:

- NSN Link Submission Guide
- NSN Link Needs Case
- NSN Link Cost Assessment Submission

The Consultant's review and assessment is mainly based on the documents and information provided by NSN via OFGEM with:

- Round 1 SQs
- Round 2 SQs
- Round 3 SQs
- Round 4 SQs
- Round 5 SQs

The additional information submitted by NSN was mainly based on an information request issued by the Consultant as part of the services.

2 CONCLUSIONS

2.1 Development Costs

The development costs (devex) for NSN associated with NGIH are indicated to be [redacted] this representing only devex to NGIH as the majority of development costs incurred for the project are not shared. The sharing of costs in this way is in our view typical in the context of broadly comparable projects.

A significant amount of devex of NGIH is associated with a geophysical, geotechnical and bathymetric survey of the marine route corridor (around 700km) and the survey costs were shared equally between NGIH and Statnett, again this being typical practice. On the basis of this limited evaluation, we are unable to comment if the costs of the survey are reasonable or not. Various environmental studies were also carried out onshore and offshore but again, we are unable at this stage to assess whether the costs are within an expected range.

UK legal advisers have been engaged in supporting development of the Ownership and other agreements with Norwegian lawyers advising in respect of the Ownership Agreement. It is not clear whether all the UK legal costs are borne by NGIH or shared with Statnett. UK legal costs are indicated to stand at [redacted] and, depending on the extent and circumstances associated with engaging legal advisers, this seems to us a relatively high figure.

The NG employee costs amount to [redacted] which very roughly could be in the range of 2,500 mandays and we consider this to be credible for such a major and complicated project.

In summary, apart from the UK legal adviser costs, we consider that known and predicted development costs are within a credible range.

2.2 Procurement Approach

Our assessment of the procurement approach and development costs has been completed over a short period of time. Thus, the statements made should be considered as constituting Fichtner's initial view and are without reference to usual levels of background due diligence.

[redacted]

Procurement is being implemented by a procurement team from NGIH and Statnett. [redacted] The procurement advisory team has established separate procurement processes for the cable and converter contracts which, subject to the issues described in this report, is considered by us to be a generally sound approach.

NSN has not considered splitting the design, manufacture, installation or commissioning of the works and, in the specific context of this project, we consider this to be an appropriate procurement approach. There will be separate EPC Contracts associated with the converters and cable manufacture and laying.

The sponsors of NSN have indicated that they do not have the detailed design capability in house, thus calling upon the EPC Contractors to complete the detailed design. We consider this to be a logical and well grounded approach, as the tenderers should be able to optimize their respective designs thus encouraging competitive pricing and optimizing technical proposals. We consider it important however that the NSN procurement team has compiled a robust functional specification.

In its procurement strategy, NSN has considered the issue of manufacturing capacity internationally and we consider this to be important. Coupled with the limited number of potential EPC Contractors, NSN rightly recognized chosen technology as being a critical issue ultimately selecting mass impregnated cable with VSC converter technology.

[redacted]

The procurement approach adopted follows generally well recognized principles to the extent that, having assessed the supplier marketplace, a PQQ process was implemented and shortlisted (qualified) suppliers established, this procedure being in our view very important in that only qualified parties would have been entitled to bid.

Following this, the tender packages were completed and ITT issued in December 2013 and returned in May 2014. Clarification and evaluation of the tenders along with negotiation of the provisions has been ongoing since with completion scheduled for February 2015.

[redacted]

[redacted]

It should be emphasized that Fichtner has as part of this short review, not been able to establish in detail the circumstances and conditions of the procurement process nor has it had the opportunity to discuss process with the project sponsors.

2.3 HVDC Converter Stations

2.3.1 Technical Solution & Technology

The proposed solution of a 1,400 MW, +/- 525 kV, Voltage Sourced Converter (VSC) based bipolar HVDC converter represents the state of the art technical solution for this kind of interconnector taking reasonable technical risks and project experience of manufacturers into consideration.

The VSC technology provides the most efficient technology approach based on the current stage of development and the detail and quality of the technical and functional specifications provided by NSN will ensure a high level of technical standard and quality.

From the Consultant's point of view and experience, each of the European manufacturers is capable to deliver, install and commission the proposed VSC technology and comply with the project specific requirements.

The recommendations outlined in section 5.6 shall support a cost efficient project design and execution in line with the anticipated project schedule and further cost optimization.

2.3.2 Converter Capacity

The selected transmission capacity of 1,400 MW in connection with the chosen VSC technology provides an efficient and cost optimized solution in terms of converter capability and invested money.

Furthermore the transmission capacity is in alignment with the UK and Norwegian Transmission System Operator requirements and meets the available network capacity, especially at the connection point in Blyth (assuming that the transfer from Norway to the UK would be the primary transmission direction).

2.3.3 Converter Station Locations

The locations of the converter stations (and in fact the AC connections points) have been chosen based on a typical process for this kind of HVDC application (interconnector).

They reflect suitable connection capacity, reasonable connection distance and possibly minimal social and environmental impacts as well as the assumption of being supported by the local planning policy.

A potential connection point in Scotland has been excluded by NSN due to network requirements.

2.3.4 Price Levels

[redacted]

A further assessment can be performed and a final conclusion can be provided as soon as a detailed cost breakdown has been submitted by NSN.

In order to perform a prudent cost assessment a certain level of detail is required regarding the equipment, material, services etc. to be included in the EPC contract of the converter stations.

The Consultant is proposing to develop an HVDC specific cost breakdown template (based on OFGEMs request) for the NSN Interconnector. OFGEM should then request NSN to provide the required detail and cost breakdown for further assessment by the Consultant.

2.4 HVDC Cable Technical Solution and Technology

The Mass-Impregnated cables are a well-proven technology for both HVDC Line Commutated Converters (LCC) and VSC links. Nevertheless and on grounds of further cost effectiveness, a careful assessment of a solution based on Mass-Impregnated lapped paper polypropelyene laminate (PPLP) cables should be undertaken. The higher losses prompted by a combination of smaller conductor cross-sections and higher operation temperatures could be eventually counteracted with a tailored cable design. A high level analysis suggests that savings of approximately [redacted] could be realised with the use of Mass-Impregnated PPLP when compared to Mass-Impregnated paper cables. This potential cost saving would need to be considered in conjunction with the associated higher cable losses of Mass–Impregnated PPLP cables.

From the point of view of the Consultant such assessment should be made given the cost reductions at stake.

Due to the limited number of players with the required know-how and references, the availability of both solutions should also be taken into account.