KEMA Limited

Ofgem

Technical Advisors for the OFTO Tender Process:

Offshore Transitional Project Report

BARROW

Rev 2.1

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Revision History

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The Regulatory Asset Values determined will reflect the opinion of KEMA as to the value of the transmission assets if they had been developed in an economic and efficient manner. The primary source in preparing this opinion has been information provided by the offshore windfarm developer during the period from February 2009 up and until 22 May 2009 and we have not sought to establish the reliability of the sources by reference or other evidence. We do not accept responsibility for such information, and the report does not incorporate the effects, if any, of events and circumstances that may have occurred or information that may have come to light after said dates. The issues covered in this report, and the emphasis placed on them, may not address the issues relevant to others than our Client, or reflect their specific requirements, objectives, interests or circumstances.

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Executive Summary

This report provides an assessment of the Barrow offshore wind project being developed by Barrow Offshore Wind Limited (BOW) as a joint venture owned by DONG Energy and Centrica. The report addresses project qualification with respect to Ofgem preconditions, project design and technical compliance with industry requirements, capital costs and equipment volumes. The assessments undertaken have considered the information provided by BOW to Ofgem, up to and including 22 May 2009.

The Barrow windfarm is located approximately 7.5km south west of Walney Island in the Irish Sea, near Barrow-in-Furness and has a total installed generation capacity of 90MW. The windfarm is a licence exempt generator with no Transmission Entry Capacity (TEC). The offshore transmission assets proposed for transfer comprise one single transformer offshore substation, a single 26.6km 132kV submarine cable, a single 3.5km 132kV underground cable and a 24MVAr shunt reactor located onshore. The windfarm is connected to the Electricity North West (ENW) 132kV distribution system close to the Heysham 400/132 kV substation of National Grid. The developer's forecast cost for the developed and constructed transmission assets is approximately £29 million. The windfarm has been in commercial operation since mid-June 2006 with the submarine cable and main offshore transformer being in permanent energisation since 21 February 2006.

The developer's proposed offshore transmission ownership boundary is at the 33kV cable connection to the offshore 33/132kV transformer with the offshore platform to be owned by the successful Offshore Transmission Owner (OFTO). The interface point onshore is at the 132kV cable sealing ends. BOW has stipulated that the proposed offshore transmission ownership boundary is conditional upon the relevant parties agreeing satisfactory terms for an operational and maintenance agreement. The developer would wish to retain the ownership, operation and maintenance of the protection, control and auxiliary systems that currently serve both generation and transmission assets and the right to use optical fibres of the OFTO assets. Otherwise, alternative offshore transmission ownership boundary options would need to be considered. One such option indicated by BOW would be at the 132kV submarine cable sealing end with the offshore platform to be owned by the developer.

The extent to which BOW, as project developer, has met the qualifying project pre-conditions[1] is summarised below:

C1. **Securing a connection agreement**: BOW has a connection agreement with ENW for an export capacity of 99.9MVA and an import capacity of 1000kVA.

C2. **Obtaining all necessary property rights and all environmental and planning consents:** BOW has obtained all necessary property rights and environmental and planning consents.

[1] Offshore Electricity Transmission: Updated Proposals for the Competitive Tender Process, Ofgem, 5 March 2009.

C3. **Entered into all necessary contracts for the construction of the offshore transmission assets:** Construction was completed formally in January 2007 and the windfarm is operational.

C4. **Secured financing to the satisfaction of the Authority:** The Barrow project is operating and BOW has confirmed that the EPIC contractor has been remunerated.

C5. **Provided its financial model and all other necessary financial and other data for the offshore transmission infrastructure:** BOW has provided Ofgem with the asset valuation information for the whole project with separation of costs between generation and transmission expenditure driven on a project average pro rata approach in order to derive estimates of the proportion of the project attributable to transmission assets. The financial information provided by the developer has been sufficient to undertake the cost assessment process.

The offshore transmission infrastructure is stated to be fit for purpose in a marine environment. The statements of compliance were issued for the offshore substation structure and fabrication in 2005. All electrical equipment has been specified to IEC standards. The electrical system is designed with no redundancy and an outage of the main transformer, the submarine or land cable or the 33kV busbars would lead to a total loss of generation export. Current connection and operational arrangements with NGET and ENW are impacting availability of the transmission circuit either due to an NGET transmission maintenance schedule (e.g. 8 weeks outage every 3 years) or an ENW maintenance requirement or unplanned outage. The Barrow windfarm, as a licence exempt generator of less than 100MW and connected to a distribution network is currently exempt from compliance with the several specific current Grid Code connection conditions. BOW has indicated that further derogations may be required should draft change proposals to electricity industry codes currently under consultation be implemented.

Costs and Volumes

The costs assessment process undertaken by KEMA analyses the submitted developer cost information and reports on the extent to which the capital costs are reasonable and therefore could be judged as economic and efficient.

For that purpose capital asset valuations for two boundary options[2] are provided in the table below with explanations of significant variances. For each boundary option, KEMA has derived a normalised version of the developer's valuation, the "Normalised Valuation" and a benchmark valuation based on mean values derived from the transitional projects; this "Comparator Valuation" is described below:

- **Normalised Valuation**: uses the developer cost information and removes elements relating to contingencies, project financing and project purchases to provide a baseline figure relating to

[2] BOW indicated its preferred ownership boundary point is at the 33kV busbars. The two boundaries are the 33kV offshore switchgear ownership boundary and the CUSC boundary, which is the default commercial ownership boundary contained in the industry framework document and is at the transformer side of the 132kV switchgear on the offshore substation.

the actual (or forecast) costs associated with establishing the transmission assets. The Normalised Valuation is based upon submitted cost information incorporating contract cost data as provided by the project developer[3]. The Normalised Valuation is used throughout the report as the baseline against which comparisons are made.

- **Comparator Valuation**: KEMA has derived the benchmark Comparator Valuation using a set of cost drivers, calculated from the information provided by the transitional projects. These cost drivers are mean unit cost values that are used to create cost benchmarks that can be compared with the Normalised Valuation. Where disaggregated cost data has not been provided, independent KEMA benchmark costs have been adopted.

  Barrow was completed in 2006 and the comparators have been inflation adjusted downwards to reflect this.

Barrow cost information was adjusted to derive the Normalised Valuation as follows:

- [redacted]
- [redacted].

Table 1 Overview of project valuations

Ownership boundary	Developer Valuation	Normalised Valuation	Comparator Valuation
33kV busbars	£29.3M	£27.9M	£32.4M
CUSC[4] boundary	£21.5M	£22.4M	£24.2M

33kV Busbar boundary

For an ownership boundary at the 33kV switchgear on the offshore platforms (as proposed by BOW) the Normalised Valuation is less than the Comparator Valuation by £4.5M (16%). The variance comprises:

[redacted]

[redacted]

[redacted]

[3] All of the figures are extracted from documents submitted by BOW up to and including 22 May 2009.
[4] Connection and Use of System Code

[redacted]

The main cost elements of the Barrow project are generally less than the comparison cost derived from the mean of the peer projects, which may suggest that the general inflation factor used understates the movement in the prices for the assets comprising the project. If the general inflation factor is changed to one aligned with copper prices rises (approaching double the general inflation), the Barrow costs continue to appear low in comparison to the peers projects.

CUSC Boundary

For a CUSC default boundary at the 132kV transformer connections on the offshore platform, BOW's development costs have been pro-rated in line with the reduction in capital item costs. Thus, a total of £5.5M has been removed from the Normalised Valuation and £8.2M from the Comparator Valuation respectively. This reduction represents the platform and all electrical equipment operating at less than 132kV, inclusive of the transformers. The CUSC default boundary shows a variance between the Normalised Valuation and the Comparator Valuation of -£1.8M[5] (8%).

The variance comprises:

[redacted]

Overall, the Barrow Normalised Valuation is consistently less than the project peer group mean and KEMA would consider the total cost to be reasonable.

[5] Any divergences between KEMA's Capital Asset Valuations and the sum of the individual cost components are attributable to rounding approximations for each of the components to one decimal place.

1. Introduction

Ofgem and the Department for Energy and Climate Change (DECC) have been developing the regulatory arrangements for offshore electricity transmission. These arrangements cover projects that are already built or are expected to be under construction before the new regulatory arrangements reach the 'Go Active' or 'Go Live' dates in June 2009 and June 2010 respectively. Such projects are known as transitional projects and developers have to meet certain pre-conditions in order to be tendered under these arrangements. Projects where the new transmission assets would be designed, financed and constructed by an offshore transmission owner (OFTO) are known as enduring projects.

The offshore electricity transmission licences will be granted by way of a competitive tender process that aims to deliver fit for purpose transmission infrastructure to connect offshore generation economically and efficiently whilst simultaneously attracting new entrants to the sector. The first round of tenders in the transitional arrangements is expected to commence shortly after the Go Active date.

This document provides KEMA's initial review and assessment of the Barrow Offshore Wind Limited's (BOW's) Barrow project, owned jointly by DONG Energy and Centrica, in terms of meeting Ofgem's transitional qualifying project criteria and overall technical and operational compliance, cost rationality and risk profile.

2. Project Assessment Approach

KEMA's approach for assessing each transitional project wishing to enter into the first tender round has been designed to confirm:

- Compliance with the proposed qualifying pre-conditions[6];
- Technical and operational compliance including the project 'fit for purpose' design; and
- Estimates of economic and efficient costs incurred during the development and construction of the transmission assets.

Responses to Ofgem's Developer Information Request (DIR), in conjunction with subsequent correspondence and bilateral meetings with developers have been used as the primary information sources when assessing each project. This assessment includes a review of the specified technical requirements and operational performance criteria as set out in relevant industry codes and standards. During the course of this assessment, no additional modelling, simulation of individual components or physical testing has been undertaken. Areas requiring clarification or further information have been identified and are noted in this report.

[6] Offshore Electricity Transmission: Updated Proposals for the Competitive Tender Process, Ofgem, 5 March 2009.

3. Technical Assessment

3.1 Project Overview

Name	Barrow Offshore Wind Project
Developer	Barrow Offshore Wind Ltd (BOW) owned jointly by DONG Wind (UK) Ltd[7] - 50% and Centrica (BOW)[8] Ltd - 50%.
Location	Near Barrow-in-Furness; approximately 7.5km south west of Walney Island in the East Irish Sea.
Generating Capacity	90MW (30 x 3MW wind turbine generators) Transmission Entry Capacity (TEC): n/a
Construction timetable for transmission asset	Construction completed mid-June 2006; formal completion January 2007.
Commissioning timetable for transmission asset	Commercially operational since mid-June 2006.

The Barrow offshore windfarm is owned by Barrow Offshore Wind Ltd (BOW). The original project developer Warwick Energy sold the project to Centrica and DONG Energy on 1 January 2004. At the time of sale, the project had already been granted the main consents. The windfarm is managed by DONG VE A/S[9] on behalf of BOW.

The construction process started in early 2005 and the project was due to be completed on 20 November 2005. The project did however suffer a seven month delay due to the delay with installation of the offshore substation foundation mono-piles. A transmission element was marginally delayed (some 3 months) due to issues with submarine cable failure in August 2005 (remedied in November 2005) and burial depth concerns. The latter was remedied by post-lay jetting in January 2006 with outstanding snagging works planned to be completed in June 2009. The submarine cable and main offshore substation transformer went into permanent energisation on 21 February 2006. The windfarm became commercially operational in mid-June 2006.

A simplified project diagram is shown in Appendix A1.

3.2 Project status in relation to meeting the pre-conditions

The status of BOW in respect of the transitional project pre-conditions is as follows:

C1. Secured a connection agreement with NGET or a connection offer with a DNO for a connection at 132kV or above.

7 DONG Wind (UK) Ltd is part of the DONG Energy group.
8 Centrica (BOW) Ltd is part of the Centrica group.
9 DONG VE A/S is part of the DONG Energy group.

BOW has a connection agreement with Electricity North West (ENW) for an export capacity of 99.9MVA and an import capacity of 1000kVA dated 31 August 2005. The associated construction agreements are also in place. With introduction of Licence Exempt Embedded Medium Power Station (LEEMPS) Agreements in April 2006, the original Licence Exempt Generation Agreement (LEGA) signed on 15 January 2005 with National Grid was changed to a LEEMPS agreement with ENW in February 2007.

C2. Obtained all necessary property rights (e.g. consents and leases) and environmental and planning consents for the offshore project and offshore transmission assets

BOW has obtained all necessary property rights and environmental and planning consents for the offshore project and regulated assets. These include marine consents and licences and planning permissions and land agreements. Comprehensive environmental assessments and surveys have also been completed.

KEMA's assessment of environmental and planning consents is included in Appendix A2.

C3. Either completed construction of, or entered into all necessary contracts for the construction of the offshore transmission assets.

Construction was completed formally in January 2007. The Engineering, Procurement and Installation turnkey contract (EPIC) was awarded to Vestas-KBR[10] on 22 July 2004 for wind turbines and other project costs. The contractual aspects relating to transmission elements were not considered in detail as they were not regarded as being critical at the time. The EPIC contract and amendments to the contract made in 2007 have not been provided for confidentiality reasons.

KEMA's assessment of BOW's procurement and contracts is included in Appendix A3.

C4. Secured financing to the satisfaction of the Authority to construct the regulated assets.

The Barrow project is operating and BOW confirmed the EPIC contractor has been remunerated.

C5. Provided its financial model for the offshore transmission infrastructure and all other necessary financial and other data to Ofgem to enable the assessment of the efficient and economic cost of constructing the offshore transmission assets

BOW has provided Ofgem with the asset valuation information for the whole project with separation of costs between generation and transmission expenditure driven on a project average pro rata approach in order to derive estimate of the proportion of the project attributable to transmission assets.

[10] Kellogg Brown & Root Ltd

The financial information provided by the developer has been sufficient to undertake the cost assessment process.

3.3 Proposed Boundary Options

The proposed offshore transmission ownership boundary is at the 33kV cable connection to the offshore 33/132kV transformer with the offshore platform to be owned by the new Offshore Transmission Owner (OFTO) as illustrated in Appendix A1. The interface point onshore is at the 132kV cable sealing ends.

BOW has stipulated that the proposed offshore transmission ownership boundary is conditional upon the relevant parties agreeing satisfactory terms for an operational and maintenance agreement [redacted]. The current owner would prefer to retain the ownership, operation and maintenance of the protection and Supervisory Control and Data Acquisition (SCADA) assets, ownership of all auxiliary systems that currently serve both generation and transmission assets and right to use optical fibres of the OFTO assets. Otherwise, alternative offshore transmission ownership boundary options would need to be considered. One such option indicated by BOW would be at the 132kV submarine cable sealing end with the offshore platform to be owned by the developer.

3.4 Design Overview

3.4.1 Offshore design and construction

The offshore substation consists of two painted steel decks on a painted steel mono-pile foundation. The main 132/33kV transformer is situated on the upper deck along with a well protected housing for associated electrical equipment, auxiliary systems and accommodation quarters. The transformer is equipped with a fire fighting water mist system. Any oil spill is drained to a fire protected bund in the mono-pile.

All relevant offshore equipment is stated to be fit for purpose in a marine environment. The substation structure was surveyed and approved during the design phase by the DNV[11] with a statement of compliance issued on 4 May 2005. The statements of compliance were also issued for the fabrication of the substation, secondary steel and transition pieces and piles as part of a manufacturing survey conducted by the DNV in March/April 2005.

The substation platform design is considered fit for purpose with good accessibility provisions for personnel. Even though there is no helideck, a provision is made for helicopter rescue of personnel.

[11] Det NorskeVeritas (DNV) is a provider of consulting and certification services for the maritime industry.

Lifting of equipment onto the platform deck is by a davit crane limited to a load of 0.5 tonnes; any heavier lifting requirements will require a ship crane.

The maintenance needs of the offshore infrastructure are estimated as every five years to include preventive painting of the substation housing and replacement of parts (e.g. doors, hinges etc) as necessary. Similar consideration should then also be given to the pipeworks, cable trays, ladders, railings and other secondary steelwork. There is currently no indication that the primary steelwork is to require attention within the same timescales. The evidence in a form of more detailed and up-to-date report from a corrosion expert might be helpful.

[redacted]

[redacted]

KEMA's assessment of Barrow's offshore design and construction is included in Appendix A4.

3.4.2 Electrical infrastructure design

The Barrow windfarm comprises 30 x 3 MW wind turbines and a single transformer offshore substation connected via a single 26.6km long 132kV submarine cable and a single 3.5km underground cable to the Electricity North West (ENW) 132kV distribution system. In addition to the main 132/33kV transformer, the offshore substation contains 132kV Gas Insulated Switchgear (GIS), a 33kV switchboard, two 33kV capacitor banks (5MVAr each), a diesel generator set including diesel tank and auxiliary systems (e.g. low voltage supply, batteries, chargers). The onshore substation, close to National Grid's Heysham 400/132kV substation is shared between ENW and BOW such that each party has a separate outdoor switchyard with individual locking and access. BOW's switchyard contains a 24MVAr reactive power compensating shunt reactor. A simplified project diagram is shown in Appendix A1.

The Barrow windfarm is currently required to operate at 1 per unit power factor, +/- 5MVAr; there is no response time associated with this requirement. The provision of reactive power control required to maintain such an operating condition is a combination of the wind turbines control system, BOW's reactor onshore and a supplementary capacitor bank control system that instigates switching if the

reactive power exchange with ENW at 132kV onshore becomes < -3.75MVAr or > 3.75 MVAr respectively. The capacitor banks have hardly been in use to date and are largely regarded as a back-up system to the SCADA based turbine control of reactive power.

The entire electrical system (both onshore and offshore) is controlled and monitored via the SCADA system provided with the wind turbine generators. The SCADA servers are located in the BOW compartment of the ENW/BOW onshore substation building.

A list of the main onshore and offshore apparatus, proposed ownership and life expectancy is provided in Appendix A5. All equipment has been specified to IEC standards. The design life of the majority of the equipment will meet the lifetime of the OFTO revenue stream i.e. 20 years. Any anticipated exceptions, such as small elements of reactive equipment, protection and control systems, batteries etc are noted in Appendix A5. A list of equipment envisaged to need repair or replacement over 20 years is provided as part of BOW's DIR submission.

3.4.3 Redundancy and asset availability

The windfarm's electrical system is designed with no redundancy. There is only one 132kV cable (onshore and offshore) and one 132/33kV transformer. Similarly, there is no redundancy on the 33kV offshore substation busbars. The 33kV busbars comprise two coupled single-bar sections and consequently full generation cannot be maintained in the case of a single section outage.

The offshore and onshore protection systems are fully backed up 33kV and 132kV schemes. Back-up low voltage supplies is provided by a 2-battery / 2-charger 110V system on the offshore substation for all 132kV and 33kV plant. Similar back-up supplies which are dedicated to BOW's protection and SCADA exist on the onshore substation. The emergency supply of the offshore substation is provided via standby generation equipment i.e. a diesel generator with a diesel tank for 7 days. Onshore, the substation batteries are the only back-up supply with no arrangements for connection of mobile generators. There is no redundancy in the SCADA and communication networks.

The information provided by BOW regarding the overall generation and transmission asset reliability reveals no major faults or outages associated with the windfarm's plant and equipment. Due to current connection arrangements, availability of the transmission circuit has however often been affected by National Grid or ENW restrictions and/or outages. A careful examination of all recorded 132kV outages (including the 132/33kV transformer and 33kV busbars) since the windfarm energisation on 21 February 2006 reveals that six out of total of seven outage events relate to ENW plant and equipment; only one outage event on 11 March 2006 was due to a fault in the fire detection alarm on the windfarm. On that basis, BOW has calculated the whole windfarm availability as 99.82% with the transmission assets themselves being 100% available.

The Barrow windfarm is subject to operational inter-tripping as per National Grid/ENW arrangements and former LEGA. NGET will trip the farm when islanding, i.e. without the Heysham Supergrid transformers in operation and at certain outages in the 400kV system. National Grid's Supergrid maintenance schedule (i.e. an 8 week outage every 3 years) also imposes a significant constraint on the windfarm operation and maintenance planning. As the windfarm connection to ENW's 132kV distribution system is non-firm, any ENW outage for maintenance implies the disconnection of the windfarm. Similarly, any unplanned outage such as an ENW overhead line fault introduces the risk of a long duration outage of the windfarm. There is an additional constraint on windfarm energisation in that ENW is entitled to energise only if all three Heysham Supergrid transformers are in operation.

BOW has made some provisions for main repairs and/or replacements that may be needed over the next 20 years. More specifically, given the possibility for a local submarine cable damage due to anchoring or migrating seabed, BOW has already procured a cable repair kit (two straight joints and a 50m of submarine cable) to be stored on a drum at the operation and maintenance facility in Barrow-in-Furness. There is also a plan for a spare 132/33kV transformer to be available in spring 2010 and stored in Denmark. The transformer is to be shared with another DONG Energy development, Burbo Bank. A decision is still to be made on the transfer arrangements for spares to a new OFTO.

3.4.4 Compliance with Industry Codes and Standards

The Barrow windfarm was developed before the current Grid Code obligations for asynchronous generation technologies were introduced or were relevant to a LEEMPS type power station. As a result, a number of derogations from specific current Grid Code connection conditions and associated obligations in the Distribution Code in respect of the windfarm's LEEMPS provisions were granted to National Grid and ENW in March 2007. The derogations relieve BOW of formal compliance with the current Grid Code in respect to reactive power capability at the 132kV onshore connection point, voltage and frequency control and fault ride through. It may also be noted that the current Great Britain Security and Quality of Supply Standard (GBSQSS) and System Operator Transmission Owner Code (STC) have not so far been applicable to any LEEMPS type power station.

In light of the proposed changes to industry codes relating to introduction of offshore transmission regulatory framework, BOW has suggested a number of non-compliances with the draft industry codes currently under consultation. These relate to Barrow's current non-firm connection to ENW's distribution system with no redundancy at the onshore connection point, the single 33kV busbars, and the single offshore transformer. (Note: These are in addition to the windfarm's inability to comply with specific connection conditions of the current Grid Code for which the appropriate derogations have been in place since March 2007.) All existing derogations and potential new non-compliances may need to be revisited in light of the changes to the industry codes currently under consultation.

KEMA's assessment of this project compliance with the draft industry codes, currently under consultation, is provided in Appendix A6-A9.

3.4.5 Project risk profile

The project has been fully operational for three years and the risk items evaluated as being of higher concern in that period are:

- [redacted]

- As the two 33kV cables connect to a single 33/132kV transformer, a transformer or cable failure will result in the loss of full windfarm output;

- Seabed scouring around the wind turbine generators has exposed array cables to potential damage that may impact the business case of the new OFTO, and

- Under current connection arrangements, availability of the windfarm output could be noticeably affected by National Grid and ENW outages and maintenance programmes.

KEMA's risk assessment for the project is provided in Appendix A10.

4. Cost Assessment

This section provides a cost assessment of the Barrow offshore transmission assets to connect 90MW of wind generation capacity at a developer estimated cost of approximately £29.3M. Details of the cost assessment methodology applied to the developer-sourced cost data are described below. A commentary is also provided regarding the relative magnitude of total project costs and the main disaggregated cost components to highlight any anomalies, inconsistencies, information shortfalls and/or mitigating factors with respect to the Barrow project. The comments provided in this report reflect the information provided to Ofgem by BOW up to and including 22 May 2009. These documents provided sufficient information to undertake the following cost assessment.

4.1 Cost Assessment Process and Assumptions

The costs assessment process undertaken by KEMA analyses the submitted developer cost information and reports on the extent to which the capital costs are reasonable and therefore could be judged as economic and efficient.

The overall approach normalises the information provided by developers, allocates it consistently to the main project components[12] of the offshore transmission system and creates a set of cost drivers that can be used as peer benchmarks. KEMA regards the peer comparators as the most useful indicators of reasonable costs as these relate to projects being developed over a similar timeframe, in the same regulatory and legal framework, with the comparable economic drivers and a similar supplier base.

In preparing this cost assessment the following general assumptions have been made:

- For projects yet to complete construction, all costs used are at their contractual values at the time of signing;
- For projects that are commissioned, the comparator costs that are presented (but are not included in the comparator average) are adjusted downwards for copper prices for the cable supply costs and by general inflation for the remainder to be comparable with the developer submitted information;
- All contingency costs have been excluded where these have been explicitly stated;
- All financing costs have been excluded where these have been explicitly stated;
- All project purchase costs have been excluded where these have been stated;

[12] The main components being the offshore substation, supply and installation of the submarine and land cable, reactive compensation equipment, onshore connection equipment and capitalised development costs (e.g. project management, overheads, leases and consents etc).

- Maintenance costs have not been included in the capitalised cost valuation;
- It is assumed that each project has procured a similar level of spares as part of the capital cost across the main components of all projects (i.e. no analysis has been completed to normalise for spares costs[13]); and
- Capitalised development costs are presented on a percentage of total Normalised Valuation or percentage of total Comparator Valuation cost basis[14].

Two valuations are created for each boundary, the "Normalised Valuation" and a benchmark valuation the "Comparator Valuation" as described below:

- **Normalised Valuation**: uses the developer cost information and removes elements relating to contingencies, project financing and project purchases to provide a baseline figure relating to the actual (or forecast) costs associated with transmission asset construction. The Normalised Valuation is based upon submitted cost information incorporating contract cost data as provided by the project developer[15].
- **Comparator Valuation**: KEMA derives the benchmark Comparator Valuation using a set of cost drivers, calculated from the information provided by the transitional projects. These cost drivers are mean unit cost values (for example, cable supply cost per kilometre) that are used to create comparative cost benchmarks that are comparable to the Normalised Valuation. Where disaggregated cost data has not been provided, independent KEMA benchmark costs have been adopted[16].

The Normalised Valuation is used throughout the report as the baseline against which comparisons are made.

The following sections describe the cost assessment as applied to the Barrow project.

4.2 Equipment Costs and Volumes

Barrow cost information was adjusted to derive the Normalised Valuation as follows:

[13] The costs of any spares included have been found to be small and unlikely to make a material difference to the comparator cost estimates.

[14] In the Comparator Valuation Capitalised development costs are calculated by taking the normalised costs, deducting the Capitalised development costs from the total and then calculating the Capitalised development costs as a percentage of the remainder, i.e. the percentage is calculated net of the Capitalised development costs themselves.

[15] All of the figures are extracted from documents submitted by BOW.

[16] This captures the majority of the costs for each project. KEMA independent benchmarks are used to form a cost for comparison for elements not covered by the comparator metrics. Where neither is possible, the developer number is used in the comparator cost valuation and a comment is included to that effect.

- [redacted]

[redacted]

These adjustments resulted in a reduction of Barrow stated project costs from £29.3M to £27.9M for the 33kV busbar boundary.

The normalisation process leads to a slight increase for the CUSC boundary from £21.5M to £22.4M

These adjustments are due to the specific allocations of costs made in line with the developer's data submission, rather than BOW's approach to use an average allocation between the transmission and generation activities.

The main offshore transmission costs relate to the offshore substation, the submarine and land cable supply and installation, and capitalised development costs. Following disaggregation and peer comparison of developer stated costs, valuations for each of the considered ownership boundaries as shown in Table 2.

Table 2 Overview of valuations and comparisons

(table redacted)

Note 1: Divergence between KEMA's Capital Asset Valuations and the sum of the individual cost components is attributable to rounding approximations for each of the components to one decimal place.

4.2.1 Cost assessment comparisons

Barrow was completed in 2006 and the comparators have been inflation adjusted downwards to reflect this difference in timing compared to the other transitional projects. The exact mix of inflation factors is uncertain and the following simplified approach has been applied to adjust the Comparator Valuation:

- movement in copper price between the April 2005 and Q3 2008 to be applied to the submarine and land cable supply costs ([redacted]); and
- a general RPIX inflation factor for the remainder of the cost ([redacted]).

Offshore substation: At £[redacted], the offshore substation represents one of the most significant Barrow project costs. In comparison to the peer group Barrow is relatively inexpensive. The costs of the offshore substation are normally evaluated in two ways:

- [redacted]
- [redacted]

The result is shown below:

Normalised Valuation £M	Comparator Valuation £M	Per MW (Secure) Valuation £M
[redacted]	[redacted]	[redacted]

The Barrow offshore substation appears to be relatively inexpensive compared to the costs derived from the peer group analysis and KEMA would not regard the offshore substation costs as unreasonable.

Submarine cables supply and installation: [redacted]. The Barrow submarine cable supply and installation cost lies within [redacted] of the cost derived from the peer group and KEMA would not regard the Barrow submarine cable supply and installation costs as unreasonable.

Land cables supply and installation: The cost of supply and installation of the land cables at [redacted] was derived from the budget allocations as submitted by BOW. This cost is significantly lower [redacted] than the peer mean cost drivers. The variability of this comes from both the lower than average cable supply costs and low installation costs. Overall this cost element is small [redacted] and therefore KEMA would not regard this cost for land cable supply and installation as unreasonable.

Capitalised development costs: The normalised capitalised development costs relating to the Barrow project [redacted] is lower than the mean of the peer projects at 15% and KEMA would not regard the Barrow capitalised development costs as unreasonable.

The main cost elements of the Barrow project are generally less than the comparison costs derived from the mean of the peer projects, which may suggest that the general inflation factor used for the body of the costs understates the movement in the prices for the assets comprising the project. If the general inflation factor is changed to one that reflects copper prices rises over the period (approaching one and a half times the general inflation), the Barrow costs continue to appear low in comparison to the peers projects.

4.2.2 Impact of different ownership boundary options

BOW indicated its preferred ownership boundary point as the 33kV busbars. The two different boundary options are presented consisting of the 33kV busbars and the boundary described in the CUSC, i.e. on the transformer side of the 132kV switchgear. These have both been analysed to establish the capital asset valuations and associated variances as described below.

33kV Busbar boundary

For an ownership boundary at the 33kV busbar on the offshore platform the Normalised Valuation is less than the Comparator Valuation by £4.5M (16%). The variance comprises:

- [redacted];
- [redacted];
- [redacted]
- [redacted]

CUSC Boundary

For a CUSC default boundary at the 132kV transformer connections on the offshore platform, BOW's development costs have been pro-rated in line with the reduction in capital item costs. Thus, a total of £5.5M has been removed from the Normalised Valuation and £8.2M from the Comparator Valuation respectively. This reduction represents the platform and all electrical equipment operating at less than 132kV, inclusive of the transformers. The CUSC default boundary shows a variance between the Normalised Valuation and the Comparator Valuation of -£1.8M[17] (8%).

The variance comprises:

- [redacted]
- [redacted]
- [redacted]

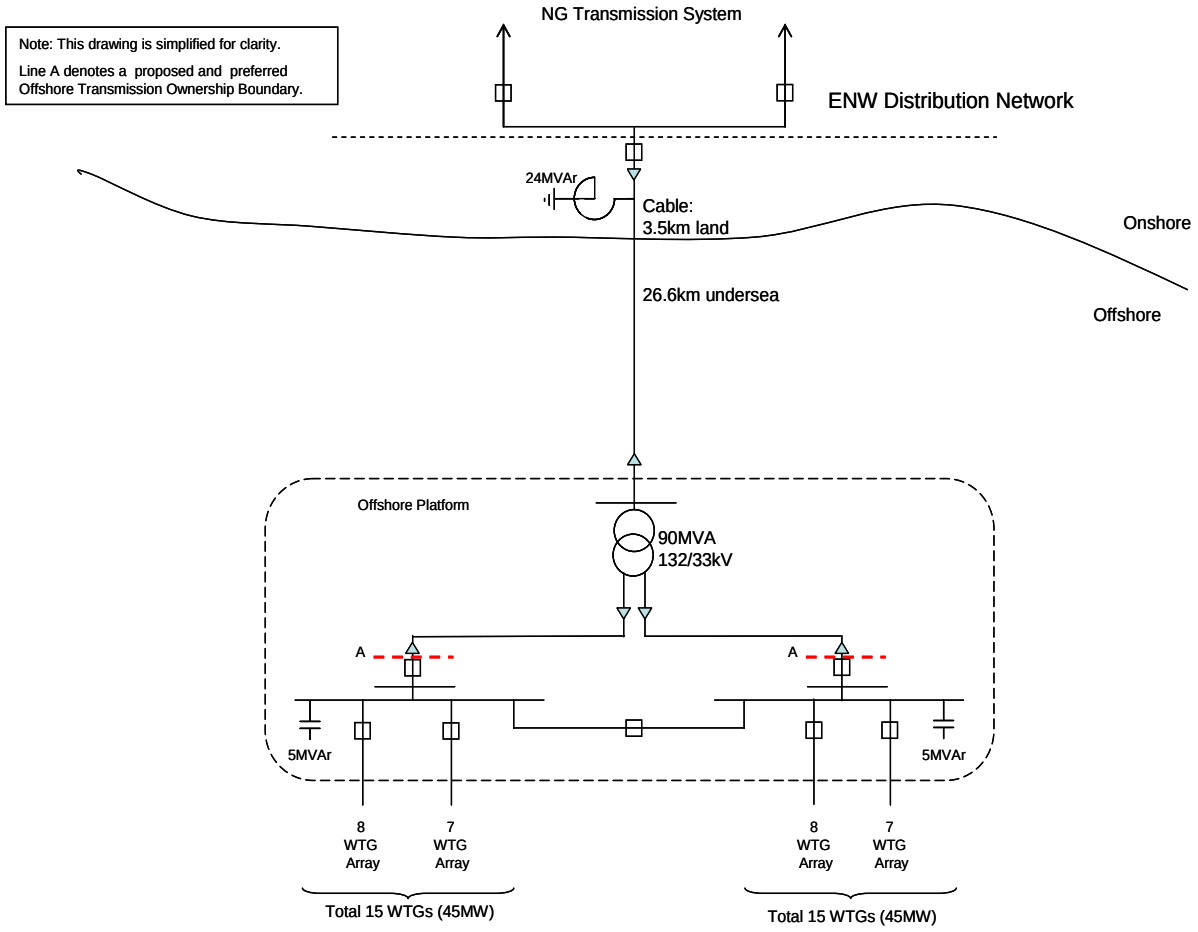
4.3 Overall summary

Overall, the Barrow Normalised Valuation is below the project peer group mean and KEMA would regard the total costs for the Barrow project as reasonable.

[17] Rounding approximations of individual cost components imply a difference of -£1.9M whereas the actual variance equates to -£1.9M

Appendix A: Review & Assessment Templates

A1. Simplified project diagram



A2. Planning and Environmental Assessments

Consents and licence requirements	Reference	Info provided	Assessment result	Action Required (if any)
FEPA licence	FEPA Act 1985	Licence Number 33069/08/0 granted 30th September 2002.	In place	None
Crown Estate lease	Crown Estate Act 1961	Crown Estate Lease Agreement commenced 1st March 2005.	In place	None
CPA licence	Sec 34 of the CPA, 1949; amended by sec 36 of the Merchant shipping Act 1988	Granted 24th February 2003	In place	None
Any site specific consent needed		n/a	n/a	n/a

Planning permissions				
Sec 36 of Electricity Act consent for construction and operation of a wind farm	Electricity Act 1989, Sec 36	Section 36 consent granted 10th March 2003	In place	None
Sec 90 (or sec 57) of TCPA for associated onshore works (e.g. substations)	TCPA 1990	Planning permissions granted by DTI, 9th March 2004	In place	None
Sec 37 of Electricity act for a new onshore OHL	Electricity Act 1989, Sec 37	Not applicable as no overhead line		None
TWA Order/rights	Sec 3.1(b) of TWA 1992	No information		None
Land Agreements / Way leaves		Consents, Easements and Permissions provided	In place. Substation and cabling installed.	None
Crossing Agreement				
Wayleaves (local councils / highways etc)		Consents, Easements and Permissions provided	In place. All cabling installed	None
River Works (if appropriate)	Water Resource Act 1991, Sec 109	No information		None
Natural England permissions		No information		None
English Heritage		No information		None
Other Conservation permissions (as needed)	e.g. Wildlife and Countryside Act 1981, Countryside and Rights of Way Act 2000	No information		None
Port Authority		No information		None

Environmental Assessments				
Environmental Statement	EIA regulations (Directive85/337/EEC as amended by 97/11/EC)	Full ES provided stating approach reflects requirements of 85/337/EEC as amended by Directive 97/11/EC. Covers; Hydrodynamics, water quality, ornithology, ecology, marine mamals, fisheries, visual resources, shipping & navigation, archaeology, military & aviation, conservation.	Comprehensive EIS produced for Warwick Energy, 31st May 2002. Issues were identified in several areas and appropriate mitigation actions established for design, construction and operation phases. Mitigation measures likely to arise from decommissioning aspects will be subject to further study at the end of the operational life.	None
Appropriate Assessment	Conservation (Natural Habitats, & c.) Regulations 1994.	No information		None
Hydrology Assessment	Hydrological Management Plan	No information		None

A3. Procurement Status Assessment

Contracts

(table redacted)

A4. Offshore Design and Construction

(table redacted)

A5. Electrical Equipment and System Design

(table redacted)

6. Security and Quality of Supply Standard[18] Compliance Assessment

(table redacted)

A7. System Operator – Transmission Owner Code (STC) [19] Compliance Assessment

(table redacted)

[18] Government Response to Offshore Electricity Transmission – A further joint Ofgem/DECC Regulatory Policy Update: Annex 8 - National Electricity Transmission System Security and Quality of Supply Standard, Version 2.0, 23 March 2009

[19] Government Response to Offshore Electricity Transmission – A further joint Ofgem/DECC Regulatory Policy Update: Annex 7 - System Operator – Transmission Owner Code; 20 November 2008.

A8. Grid Code[20] Compliance Assessment

Grid Code Reference (as stated in STC)		Requirement	Info Provided	Assessment Comment & Result	Compliance Action
CC	Connection Conditions.				
CC6.1	GB Transmission System Performance Characteristics.	Requirements in relation to voltage variation, frequency variation, waveform quality, harmonic content and phase unbalance.	LEEMP requirements apply. Harmonic filtering not required; compliant with G5/4.	Compliant	None.
CC6.2	Plant and Apparatus Relating to Connection Site.	Provision of earth fault factor and voltage rise, requirements for protection equipment and arrangements, settings, metering signals.	Detailed information provided on protection and metering equipment and arrangements.	Compliant	None
CC6.3	General Generating Unit Requirements.	Technical and design criteria and performance requirements for Generating Units, DC Converters & Power Park Modules (directly connected or embedded). Does not apply to small generators. Main points in STC Section K.	Derogations in place. See STC compliance sheet for details.	Derogations for CC 6.3 are in place and would need to be reassessed in light of proposed GC amendments.	None
CC6.4	General Network Operator and Non-Embedded Customer Requirements.	Technical and design criteria in relation to neutral earthing, frequency sensitive relays and operational metering.	132/33kV transformer is star -connected with star point earthed. Metering is installed and operational; no info on frequency sensitive relays.	Appears compliant	Check provision of underfrequency relays.
Appendix 1	Format, Principles and Basic Procedure to be Used in the Preparation of Site responsibility Schedules.	NGET to prepare schedules for new connection sites.	Responsibility and responsible person schedule provided.	Compliant	None
PC	Planning Code.				
PC6.2	Planning standards in relation to Scotland.	Appendix C lists technical and design criteria.	Not applicable	Not applicable	None
PC6.3	Planning standards in relation to Offshore Transmission System.	Appendix D lists technical and design criteria. Compliance with GBSQSS. Also results of steady state, fault level, dynamic and transient analysis including insulation coordination to be provided to NGET on request.	D1.1 Compliance with GBSQSS	see SQSS compliance sheet.	see SQSS compliance sheet.
			D1.2 Compliance with IEC standards	see Equipment & System Design sheet	see Equipment & System Design sheet.
			D1.2 Fit for purpose and designed for use in an offshore design environment	Detailed studies (2005) for offshore substation substructure design and installation have been enclosed. Compliance certificates provided.	None
			D1.3 Full System design study upon request from NGET	N/A	N/A
OC	Operating Code.				
OC8A	Safety Coordination on the E & W Transmission System.	Specifies the standard procedures to be used by Relevent E&W Transmission Licensee for the coordination, establishment and maintenance of necessary safety precautions.	Plant is operational with safety rules in place.	No evidence of any issues.	None
OC8B	Safety Coordination on Scottish Transmission Systems.	Specifies the standard procedures to be used by Relevent Scottish Transmission Licensee for the coordination, establishment and maintenance of necessary safety precautions.	n/a	n/a	n/a
OC9	Contingency Planning.				
OC9.4	Black Start	The implementation of recovery procedures following a total shutdown or partial shutdown.	Not required	n/a	None
OC9.5	Re-Synchronisation of Desynchronised Islands.	Requirements, strategies and planning for re-synchronisation following a total or partial shutdown.	Barrow not allowed to operate islanded.	n/a	None

[20] Government Response to Offshore Electricity Transmission – A further joint Ofgem/DECC Regulatory Policy Update: Annex 6 - Grid Code; 20 November 2009.

A9. Distribution Code[21] Compliance Assessment

Distribution Code Reference		Requirement	Info Provided	Assessment Comment & Result	Compliance Action
DPC4.2.2; DPC4.2.3; DPC4.2.4	Standard of Supply	Requirements in relation to normal operating frequency, likely impact on DNO's voltage control system, voltage disturbances and harmonic distortion, auto-reclosing and single phase protection operation	No specific information provided but LEEMPS requirements in relation to normal operating frequency, power output, transient stability, voltage changes and voltage control are clearly stated. No evidence of non-compliance issues has been reported.	LEEMPS' technical requirements infer compliance with Distribution Code requirements.	None
DPC4.4	Design principles	Specifications for equipment, earthing, voltage regulation and control, protection and use of signalling equipment	DPC4.4.1 Compliant with IEC standards, no reference to system meeting ESI technical specifications.	Appears compliant	None
			DPC4.4.2 no earthing system required	Not applicable.	None
			DPC4.4.3 no information provided	Operational for 3 years. No evidence of non-compliance has been reported.	None.
			DPC4.4.4 detailed information on all relevant protection (transformer, feeders, cable, onshore substation etc) provided along with coordination with ENW protection.	Appropriate protection is well integrated. No record of problems experienced to date.	None
DPC7.4	Technical requirements	Design and performance requirements for ETS in relation to protection coordination, phase voltage unbalance, neutral earthing, islanding and black start capability.	DPC7.4.3 relatively detailed description of the coordination in place.	All indications that the appropriate protection coordination has been achieved. .	None
			DPC7.4.6 Islanding	Barrow not allowed to operate islanded.	None.
			DPC7.4.7 Black start	Not required	None
DPC8.4	Reactive Compensation	Provision of information on reactive compensation plant connected to a DNO's system.	There is a 24MVAr onshore reactor.	Seems adequate; no evidence of problems to date provided.	None
DOC1, 2	Forecasting, Operational Planning	Provision of information to the DSO and coordination between DSO and Generating plant regarding demand and generation forecasting.	No specific information provided but no evidence of problems with process to date.	Current processes likely to continue but governance likely to change.	None
DDRC Schedule 5e	Embedded Transmission System data (if known/available)	This is not an assessment criterion as such but may present useful info if available.	Selected information provided as part of DIR submission.	Project is operational and these data are believed to be available	None

*ETS - Embedded Transmission System is an Offshore Transmission System directly connected to the DNO's Distribution System.

[21] Government Response to Offshore Electricity Transmission – A further joint Ofgem/DECC Regulatory Policy Update: Annex 5 - Distribution Code; 20 November 2009.

A10. Project Risk Log

(table redacted)