KEMA Limited

Ofgem

Technical Advisors for the OFTO Tender Process:

Offshore Transitional Project Report

GREATER GABBARD

Rev 3.1

25 June 2009

Table of Contents

Revision History

Rev.	Date	Description	Author	Checker	Approver
1.0	1/05/09		DPop	IW	DP
2.0	18/05/09	Revised to incorporate Ofgem's comments to version Rev 1.0 and GGOWL's information of 20 April and 29 April 2009.	DPop	IW	DP
3.0	28/05/09	Revised to incorporate Ofgem's comments to version Rev 2.0 and GGOWL's information of 20 May 2009.	DPop	IW	DP
3.1	25/06/09	Explanation inserted regarding impact of rounding approximations in valuations	DPop	IW	DP

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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 wind farm 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 Greater Gabbard offshore wind project being developed by Greater Gabbard Offshore Wind Limited (GGOWL) as a joint venture owned by Scottish and Southern Energy (SSE) and RWE Npower Renewables Ltd. 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 GGOWL to Ofgem, up to and including 22 May 2009.

The Greater Gabbard windfarm will be located 23km from the Suffolk coast and will have a total installed generation capacity of 504MW, with a corresponding Transmission Entry Capacity (TEC) of 500MW. The transmission assets proposed for transfer to the Offshore Transmission Owner (OFTO) comprise two offshore substations (Inner Gabbard and Galloper), three 45.5km 132kV submarine cables, a single 16km 132kV submarine cable connecting the two offshore platforms, three 0.6km 132 kV land cables and onshore 132kV infrastructure comprising a circuit breaker and reactive power compensation equipment for each incoming submarine cable. The onshore OFTO infrastructure will connect to National Grid's new 132 kV substation at Leiston. The developer's forecast cost for developing and constructing these transmission assets is approximately £289 million. Onshore substation construction and cabling is underway and offshore work is due to commence in the summer of 2009. Construction completion is planned for December 2010 with final commissioning to be completed by the end of March 2011.

The developer's proposed offshore transmission ownership boundary with the generator is at the 33kV busbars on the two offshore substations. The exact interface point with the onshore transmission system is at a position to be finalised at the new Leiston substation although developer schematic diagrams imply a position adjacent to National Grid's 132 kV switchgear. The ownership of the offshore platforms and associated equipment has yet to be finalised and therefore asset valuations for alternative boundaries have been assessed. The developer is proposing an operational control boundary for the generator at the onshore 132kV circuit breakers although these assets are scheduled to transfer to the enduring OFTO.

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

C1. **Securing a connection agreement**: GGOWL has secured a 500MW connection agreement with NGET containing a connection date of October 2009.

C2. **Obtaining all necessary property rights and all environmental and planning consents:** GGOWL has obtained all necessary property rights and environmental and planning consents. Only the final submarine cable routes remain to be determined.

[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:** GGOWL has entered into generation assets supply and transmission assets construction contracts.

C4. **Secured financing to the satisfaction of the Authority:** GGOWL has provided a Board meeting record confirming internal approval for the project subject to satisfactory contract negotiations with suppliers (Siemens & Fluor Ltd). This record does not however specify the total level of authorised expenditure.

C5. **Provided its financial model and all other necessary financial and other data for the offshore transmission infrastructure:** GGOWL has provided the relevant transmission infrastructure financial model and other information to assess efficient and economic costs in the form of a Business Plan Questionnaire (BPQ) return and subsequent information releases. The financial information provided by the developer has been sufficient to undertake the cost assessment process.

The transmission infrastructure specified by GGOWL has been comprehensively designed and incorporates advanced offshore and onshore technology. Cost optimisation and environmental assessments have also been undertaken. All relevant offshore equipment is stated to be fit for purpose in a marine environment and the electrical equipment has been specified to IEC standards. The electrical system is designed with a relatively high level of redundancy to accommodate offshore cable outages between Inner Gabbard and the onshore substation or transformer outages on Inner Gabbard. There is, however, no redundancy for a circuit outage between Inner Gabbard and the smaller Galloper substation. The project is compliant with current Grid Code requirements at the onshore connection point. GGOWL has indicated that derogations may be required should draft change proposals to electricity industry codes 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] A 33kV offshore switchgear ownership boundary is proposed by GGOWL. The CUSC boundary is the default commercial ownership boundary contained in the industry framework document, which is the transformer side of the 132kV switchgear.

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.

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

- £8.7M, removal of a contingency amount; and
- £1.0M removal of an estimate for unspecified OFTO costs.

Table 1 Overview of project valuations

Ownership boundary	Developer Valuation	Normalised Valuation	Comparator Valuation
33kV busbars	£289.1M	£279.4M	£244.4M
CUSC[4] boundary	Not provided	£176.9M	£151.9M

33kV Busbar boundary

For an ownership boundary at the 33kV switchgear on the offshore platforms (as proposed by GGOWL), the Normalised Valuation exceeds the Comparator Valuation by £35.0M (13%). This variance comprises:

- +£28.0M higher costs for capitalised development;
- +£5.5M higher costs for submarine cable supply and install;
- +£1.4M higher costs for reactive compensation equipment; and
- +£0.1M higher costs for offshore substation.

The variations for the submarine cable supply and install, offshore substation and reactive compensation equipment are each within 10% of the total costs for these elements of the project and would not be considered unreasonable.

[3] All of the figures are extracted from the Offshore BPQ document submitted by GGOWL in February 2009.
[4] CUSC = Connection and Use of System Code

The variation on the capitalised development cost is a significant variation. GGOWL's submission contains a capitalised development cost representing 23% of the Normalised Valuation compared to a project peer group mean of 15%. This variation is partially explained by the inclusion of a contingency amount within the fixed price contract; however, even noting this, KEMA's analysis indicates it to be high.

CUSC Boundary

For a CUSC default boundary at the 132kV busbars on the offshore platforms GGOWL capitalised development costs have been pro-rated in line with the reduction in capital item costs. Thus, a total of £102.5M has been removed from the Greater Gabbard Normalised Valuation and £92.5M from the Comparator Valuation respectively. This reduction represents offshore platform and associated electrical equipment costs. The CUSC default boundary shows a variance between the Normalised Valuation and the Comparator Valuation of +£25.0M (14%).

The variance comprises:

- +£18.1M higher costs for capitalised development;
- +£5.5M higher costs for submarine cable supply and installation; and
- +£1.4M higher costs for reactive compensation.

Overall, Greater Gabbard's Normalised Valuation compares reasonably well within the project peer group; however, adjustments may be justifiable to reduce the high capitalised development costs towards the peer group mean.

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 report provides an assessment of the Greater Gabbard offshore wind project being developed by GGOWL with respect to meeting Ofgem's transitional project qualification criteria, 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[5];
- 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.

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

3. Technical Assessment

3.1 Project Overview

Name	Greater Gabbard Offshore Wind Project
Developer	GGOWL (Greater Gabbard Offshore Wind Ltd), 50% Airtricity (SSE), 50% RWE NPower Renewables Ltd
Location	Inner Gabbard and Galloper; 23km off the Suffolk Coast
Generating Capacity	504MW (140 wind turbine generators, 3.6MW each); Transmission Entry Capacity (TEC): 500MW
Construction timetable for transmission asset	Onshore works started; offshore works begin in Summer 2009 (construction completion expected by December 2010)
Commissioning timetable for transmission asset	31 March 2011 (full TEC available)

The Greater Gabbard project was originally planned as a 50:50 Joint Venture between Airtricity and Fluor Ltd. In May 2008, following Scottish and Southern Energy's (SSE's) acquisition of Airtricity, SSE bought out Fluor's 50% stake, with Fluor retaining responsibility for the engineering, procurement and construction of the project. In November 2008, SSE sold a 50% stake of the project to NPower Renewables Ltd (a subsidiary of RWE AG). Airtricity acts as the operator of the project under a management services agreement (for maintenance and operational phases) with GGOWL.

Construction work on onshore cables and substations has commenced and is planned to be completed in October 2009 and July 2010 respectively. Construction work on the offshore substations and submarine cables is scheduled to start in summer 2009 and to be completed by December 2010. The commissioning date for the whole project is scheduled to be 31 March 2011 when the full Transmission Entry Capacity (TEC) will be available.

A simplified project diagram is shown in Appendix A1.

3.2 Project status in relation to meeting the pre-conditions

The extent to which GGOWL, as project developer, has met the qualifying project pre-conditions is summarised below:

C1. Secured a connection agreement with National Grid Electricity Transmission (NGET) or a connection offer with a Distribution Network Operator (DNO) for a connection at 132kV or above.

GGOWL has entered into a CUSC Bilateral Connection Agreement and a CUSC Construction Agreement with NGET for a 500MW grid connection at the new Leiston 132kV substation on 10 November 2005 with subsequent amendments in 2007. The Connection Agreement has a connection date of October 2009.

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

GGOWL 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. The final submarine cable routes are still to be determined.

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

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

The project is to be constructed on a fixed price multi-contract basis with separate contracts for wind turbine generators supply by Siemens and a Balance of Plant (BOP) contract by Fluor Ltd (the latter was signed on 14 April 2008). Fluor's obligations are to design, execute, test, commission and complete the entire infrastructure works including remedy of any defects. All major construction contracts have been awarded.

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

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

GGOWL has provided a Board meeting record confirming internal approval for the project subject to satisfactory contract negotiations with suppliers (Siemens & Fluor Ltd). This record does not however specify the total level of authorised expenditure.

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.

GGOWL has provided the relevant transmission infrastructure financial model and other information to assess efficient and economic costs in the form of a Business Plan Questionnaire (BPQ) return and subsequent information releases. The financial information provided by the developer has been sufficient to undertake the cost assessment process.

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3.3 Proposed Boundary Options

GGOWL's proposed offshore transmission ownership boundary with the generator is at the 33kV busbars on the two offshore substations. The exact interface point with the onshore transmission system is at a position to be finalised at the new Leiston substation although developer schematic diagrams indicate a default position adjacent to National Grid's 132 kV switchgear. The ownership of the offshore platforms and associated equipment has yet to be finalised by the developer and therefore asset valuations for alternative boundaries have been assessed.

The proposed operational boundary differs from the proposed ownership boundary in that it is at the 132 kV circuit breakers at the new Leiston 132kV substation. GGOWL has stated a preference to retain operational responsibility for the offshore transmission system rather than transferring it to the successful OFTO. GGOWL's justification for this request is related to their wish to use the reactive equipment, to use an operational control room at the Port of Lowestoft and also to use an integrated Supervisory Control and Data Acquisition (SCADA) system. In GGOWL's opinion, this would minimise risks associated with codes compliance for generation assets and potential cost implications. Similarly, the maintenance boundary is proposed to be at the onshore connection point in order for the offshore platforms to be used for staging of necessary works on the wind turbine generators. GGOWL is currently considering alternative options in relation to ownership, operational and maintenance boundaries and is seeking to reserve the right to redefine these at a later date.

3.4 Design Overview

3.4.1 Offshore design and construction

The location and design of the offshore platforms have been finalised. The number of offshore platforms has been chosen in order to minimise the build costs and electrical losses whilst taking into account associated environmental and maintenance considerations. The design of the offshore platforms has been undertaken in accordance with the offshore industry standard RP2A[6] and is planned to be verified by an independent third party, DNV[7].

The final submarine cable route is still to be determined, with the Crown Estate lease award giving a submarine cable corridor of 500 metres. The three submarine cables are to be routed to optimise the costs and take into account environmental considerations. Each cable is a single length submarine 132kV cable, i.e. no joints and will be embedded in the seabed. The submarine cable installation is proposed to be under tension without the requirement for additional slack to be laid. A detailed study for the actual cable installation is currently underway.

6 API RP2A is a standard for the structural design of fixed offshore platforms.
7 Det Norske Veritas (DNV) is a provider of consulting and certification services for the maritime industry.

The issue of potential submarine cable damage has been addressed for hazards from anchors and fishing but no information was available on the risk of the dynamic hazards associated with potential fatigue in free spans of lead sheathed submarine cables due to seabed scouring.

The mass of the substations (in excess of 1850 tonnes) will require the use of specialised lifting vessels. This should be taken into account when defining decommissioning plans and requirements.

All relevant offshore equipment is stated to be fit for purpose in a marine environment. KEMA's assessment of GGOWL's offshore design and construction is included in Appendix A4.

3.4.2 Electrical infrastructure design

The electrical infrastructure design has been finalised. A simplified project diagram is shown in Appendix A1. The project comprises 140 x 3.6MW wind turbines and two offshore platforms, Inner Gabbard and Galloper, with 102 wind turbine generators connecting to Inner Gabbard and the remaining 38 connecting to Galloper. The two platforms are connected via a single 16km 132kV submarine cable. An onshore connection to National Grid is provided by three 45.5km 132kV submarine cables (each with a transport capability of 200MW) that run from the Inner Gabbard platform. The Inner Gabbard substation supports 3 x 33/132 kV 180 MVA generator transformers. At the Leiston onshore connection point, there will be two adjacent compounds, one containing the reactive compensation equipment to be transferred to the OFTO and the other housing a new 132kV gas insulated substation (GIS) owned by NGET.

Reactive power capability is planned as a combination of the wind turbine generators, two 30MVAr shunt reactors on the Galloper platform and onshore compensation equipment comprising three Static Var Compensators (SVC+) rated at 50MVAr each, three shunt capacitors rated at 40.4MVAr each and three shunt reactors rated at 47.3MVAr each. The type and sizing of the onshore reactive compensation equipment associated with each submarine and land cable has been determined to ensure current Grid Code compliance at the onshore connection point under various wind farm operating conditions. The shunt reactors at Galloper have similarly been sized to minimise the need for onshore reactive power compensation by providing an offset of the reactive power generated by the cable between Inner Gabbard and Galloper.

The control system is to be operated from a control room located at the Port of Lowestoft, approximately 30km from the Leiston 132kV substation. A back up control system is also available in the form of an identical secondary system located at Leiston 132kV substation. The control system is designed to provide control and monitoring of both generation and transmission assets.

Detailed system studies have been conducted in relation to the number of offshore platforms, number and capacity of submarine cables, onshore and offshore electrical equipment and reactive equipment. GGOWL has provided overviews of the design, optimisation and cost benefit analyses used to identify the preferred design option and associated operational ability and compliance.

The final design in relation to onshore substation location, connection point onshore, land cables location etc has sought to optimise the costs and take into account all environmental considerations.

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 elements of reactive equipment and protection and control systems, diesel generators, switches etc are noted in Appendix A5. A complete list of components with less than 25 years design life is provided as part of functional specifications within GGOWL's DIR submission.

3.4.3 Redundancy and asset availability

The Greater Gabbard electrical system is designed to provide a relatively high level of redundancy to accommodate a submarine cable outage between Inner Gabbard and the onshore 132kV substation or a transformer outage on Inner Gabbard. For example, loss of a single submarine cable from Inner Gabbard to shore will restrict the windfarm capacity to 360 MVA due to the transformer rating constraints. There is, however, no redundancy for a circuit outage between Galloper and the smaller Inner Gabbard substation.

An appropriate level of redundancy is also provided for protection systems which are designed with secondary equipment such that the primary protection systems may be maintained. There is also provision for back-up LV supplies, with each of the offshore 132/33kV transformers having been specified with an auxiliary transformer which will provide the LV electricity supplies for the offshore platforms. During periods of outages on the primary transformers, diesel generators on the offshore platforms will be used to provide the necessary LV supplies. GGOWL also advise that in the case of an outage of auxiliary transformers, power supply will be provided by EDF Energy.

Reliability studies of the wind turbines have been used as a basis for calculation of the wind farm availability, currently estimated by GGOWL at 93-95%. As for the transmission assets, GGOWL assumes 100% availability of transmission capability based on the redundancy provided by the submarine and land cables and 132/33kV transformers. However, windfarm output may need to be constrained in the event of any cable or transformer outages.

The purchase and storage of strategic spares is planned to be procured as part of the build contract with Fluor Ltd. The spares include 1.5 km of submarine cable, three joint kits, two termination kits, a spare platform grating for one complete platform and one spare of each type of navigational light installed. A full spares list is set out in a schedule of the BOP agreement with Fluor. GGOWL indicated that these spares are to be transferred with the transmission assets. Mobilisation or installation contracts for the spares are currently under consideration.

3.4.4 Compliance with Industry Codes and Standards

The Greater Gabbard project is designed as an integrated system, compliant with current Grid Code requirements at the onshore connection point. In light of the proposed changes to industry codes relating to introduction of offshore transmission regulatory framework, GGOWL has suggested that a small number of derogations in relation to the transmission assets may be required. These relate to Grid Code compliance in relation to reactive power capability at the OFTO/GGOWL interface and current Great Britain Security and Quality of Supply Standard (GBSQSS) compliance issues associated with the lack of redundancy on Galloper for either a circuit outage between Galloper and Inner Gabbard or loss of a 132/33 kV transformer.

KEMA's assessment of this project compliance with the draft industry codes currently under consultation is provided in Appendix A6-A9. Evidence of additional system studies will be required to confirm overall future compliance. However, where information has been provided, the project was found to be compliant.

3.4.5 Project risk profile

Overall, this project is well designed and procured with construction lead-times that could accommodate reasonable delays. The risk assessment has identified the following low-risk concerns:

- Accessibility of offshore platforms to third parties requires that appropriate arrangements and liabilities are put in place;
- Logistics costs may need to be included; and
- Greater Gabbard is a fishing area, with trawl fishing that can cause submarine cable damage. Preliminary GGOWL investigations have however indicated that a cable burial depth of 2m will be adequate to mitigate this risk.

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

4. Cost Assessment

This section provides a cost assessment of the Greater Gabbard offshore transmission assets to connect 504MW of wind generation capacity at a developer estimated cost of approximately £289M. 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 Greater Gabbard project. The comments provided in this report reflect the cost information provided to Ofgem by GGOWL up to and including 22 May 2009. All figures have been extracted from either the GGOWL's Offshore BPQ document or from their contract documentation. These together 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[8] 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 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;

[8] 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[9]); and
- Capitalised development costs are presented on a percentage of total Normalised Valuation or percentage of total Comparator Valuation cost basis[10].

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[11].
- **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[12].

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 Greater Gabbard project.

4.2 Equipment Costs and Volumes

As the largest first round transitional offshore development in terms of electrical capacity and distance offshore, the total cost of the Greater Gabbard is the highest of all the projects considered at £289.1M.

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

10 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.

11 All of the figures are extracted from the Offshore BPQ document submitted by GGOWL in February 2009.

12 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 will be included to that effect.

GGOWL's valuation has been normalised by removing the following costs to allow consistent assessment between projects:

- - £8.7M, removal of a contingency amount; and
- - £1.0M removal of an estimate for unspecified OFTO costs, which is regarded as a further contingency amount.

These adjustments resulted in a reduction of Greater Gabbard's stated project costs from £289.1M to £279.4M.

As for all the transitional projects, the main offshore transmission costs relate to the offshore substation, the submarine and land cable supply and installation and the onshore reactive substation and connection works. Following disaggregation and peer comparison of the stated costs for each of the considered ownership boundaries, a number of consistencies and areas meriting further investigation have become apparent as shown in Table 2.

Table 2 Overview of valuations and comparisons

Table redacted

4.2.1 Cost assessment comparisons

Offshore substation: At [redacted], the offshore substations represent one of the most significant Greater Gabbard project costs. The Greater Gabbard offshore substation is the highest capital cost amongst the transitional project peer group but is comparable on a mean unit cost basis with its peer group. The costs of the offshore substation have been evaluated in two ways:

- By comparing the offshore substation cost with the peer comparator mean based on the offshore substation unit cost per MW secure[13].
- By separating the electrical costs from the non-electrical cost, using a peer comparator to evaluate the electrical costs and ignoring the more variable platform costs for the purposes of comparison.

The results of these two approaches are shown below:

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

[13] The MW that are able to be transmitted during the outage of any one transformer on the Offshore substation

The Greater Gabbard offshore substation valuation lies within 15% of both costs derived from the peer group analysis and KEMA would not regard the Greater Gabbard offshore substation costs as unreasonable.

Submarine cables supply and install: At [redacted], the cable supply costs represent the largest single project cost component for the Greater Gabbard offshore transmission assets. The significant magnitude of these cable costs is attributable to the cable length requirement for the project. All transitional projects with redundancy indicate comparable unit costs for the supply of cable and the corresponding Greater Gabbard costs align closely with the comparator peer group. With respect to cable installation, the Greater Gabbard costs are the lowest of all the projects assessed, noting that these costs include redundancy. The Greater Gabbard submarine cable supply and installation cost lies within 15% the cost derived from the peer group and therefore, KEMA would not regard the Greater Gabbard submarine cable supply and installation costs as unreasonable.

Capitalised development costs: The normalised capital development costs relating to the Greater Gabbard project represents 23% of the Normalised Valuation. This figure is significantly higher than the mean average of the peer projects at 15%. This is driven by a [redacted] allocation to the transmission activity of the Fluor BOP contract described as project management and profit, with no similar figure being included for the generation activity. This [redacted] represents 24% of the value of the Fluor BOP contract and is regarded as high. It has been suggested by GGOWL in a meeting with Ofgem that this includes an element of contingency; however, no evidence has been provided to support this statement. The KEMA Comparator Valuation suggests an adjustment to the Greater Gabbard capitalised development costs to bring them in line with the average peer comparator would reduce the capitalised development costs by [redacted]. It may be appropriate that an additional allowance is made for this contingency is allowed for Greater Gabbard, however, no evidence has been provided to KEMA to support this.

4.2.2 Impact of different ownership boundary options

GGOWL has proposed the offshore transmission ownership boundary with the generator is at the 33kV busbars on the two offshore substations. In addition to this a valuation has been created that reflects the standard boundary described in the CUSC, at the transformer side of the offshore 132kV switchgear. Each of these two ownership boundaries has been analysed to establish the capital asset valuation and associated variances as described below.

GGOWL's proposed boundary – 33kV busbars on the offshore platforms

The GGOWL's capital valuation varies from the Comparator view by +£35.0M (13%) and this variation is explained by:

- [redacted] higher costs for capitalised development;
- [redacted] higher costs for submarine cable supply and installation;

- [redacted] higher costs for reactive compensation equipment; and
- [redacted] higher costs for offshore substation.

The variations for the submarine cable supply and installation, reactive compensation equipment and offshore substation are within 10% of the total costs for these elements of the project and would not be considered unreasonable.

The variation on the capitalised development cost is a significant variation, with GGOWL's submission containing capitalised development costs representing 23% of the Normalised Valuation compared to a project peer group mean of 15%. This variation is partially explained by the inclusion of a contingency amount included within the fixed price contract; however, it is regarded as high.

CUSC default boundary – transformer side of offshore 132kV switchgear

Under the CUSC default boundary, it has been assumed that GGOWL's view of capitalised development costs would be pro-rated in line with the reduction in the cost of the capital items. A total cost of £102.5M is removed from the Greater Gabbard project Normalised Valuation and £92.5M from the Comparator Valuation. This represents the platform and its electrical equipment. With this ownership boundary, the variance between the normalised Greater Gabbard project valuation and the comparator valuation is [redacted] (14%). The variance comprises:

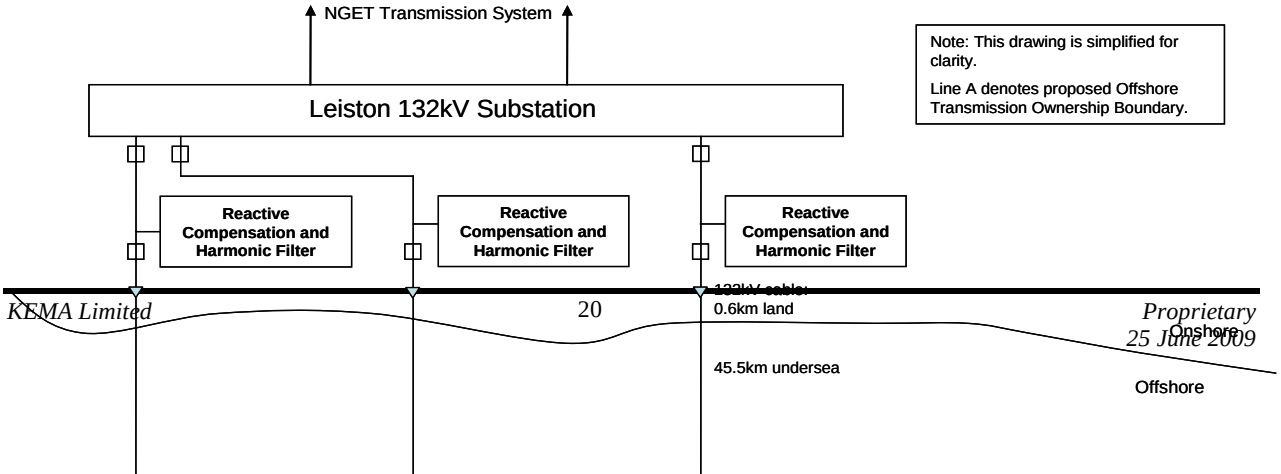
- [redacted] higher costs for capitalised development;
- [redacted] higher costs for submarine cable supply and installation; and
- [redacted] higher costs for reactive compensation equipment.

4.3 Overall summary

The cost valuation of the Greater Gabbard project appears reasonable subject to adjustments or clarifications to better align the capitalised development costs with the peer group.

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	FEPA licence no 33097/07/0 (effective 19/2/08, expires 18/02/2013) enclosed.	FEPA licence granted and valid but will need to be shared with potential OFTO	None in the short term. Awaiting decision on treatment of shared consents and leases.
Crown Estate lease		Crown Estate lease C/04/0381F/BOND granted and signed in May 2008; enclosed.	Lease granted and valid but will need to be shared with potential OFTO.	None in the short term. Awaiting decision on treatment of shared consents and leases.
CPA licence	Sec 34 of the CPA, 1949; ameded by sec 36 of the Merchant shipping Act 1988	CPA consent no 33097/07/0/CON (granted 19/04/07, expires 19/04/12) enclosed.	CPA licence granted and valid but will need to be shared with potential OFTO.	None in the short term. Awaiting decision on treatment of shared consents and leases.
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. Sec 36A of Electricity Act to extinguish the public rights of navigation.	Electricity Act 1989, Sec 36	Consent 36 and 36A (no GDBC/001/00160C) granted on 19/02/2007and enclosed.	The consent is subject to certain conditions to include commencement of construction no later than the expiry of 5 years, an approved decommisssioning programme and an agreed Active Safety Management system as per MCA recommendations. In addition, this consent will need to be shared with potential OFTO.	None required for now; need regular progress update incl resolution on shared consents.
Sec 90 (or sec 57) of TCPA for associated onshore works (eg substations)	TCPA 1990	Sec 57 no CO6/2191/FUL granted on 27/11/2006, expires 27/11/2011 subject to an approved grid connection offer.	The consent is subject to certain conditions to include an approved grid connection offer, approved (by loacl planning authority) constructuion management plan, approval of drawings etc	None
Land Agreements / Way leaves		British Energy lease of land for a substation, access and cables provided. Licence for survey work at Sizewell obtain from NGET in May 2008.	British Energy Lease obtained in March 2008, expires in Sep 2061. NGET Licence for survey work expired on 1 July 2008; all the survey work finished and hence renewal not necessary.	None
Crossing Agreement(s)		Farland and Interroute cable crossing agreements. Two onshore easements provided. obtained; one in 2008 and	Offshore Agreements signed in 2006. Both easements signed, one in 2006 and one in 2008.	None None
Wayleaves (local councils / highways etc)		Part of /covered by Sec 57 above.	The development needs to ensure that it complies with all the requirements stated in Sec 57 above.	regular progress update required
River Works (if appropriate)	Water Resource Act 1991, Sec 109	n/a	n/a	n/a
Natural England permissions		See comment under Appropriate Assessment below.	See comment under AA below	See comment under AA below
Port Authority		Route abondoned.	n/a	n/a

Environmental Assessments				
Environmental Statement	EIA regulations (Directive85/337/EEC as amended by 97/11/EC)	Environmental statement (both onshore and offshore works) 2006 enclosed.	A rigorous and detailed EI study conducted. No significant impacts have been identified. Responsibilities for complying with the procedures have been clearly outlined along with the enforcement procedures.	None
Appropriate Assessment (AA)	Habitats and the Wild Birds Directives and regulations 1994	Conducted by DTI in 2006 as part of Sec 36 application assessment. Copy of the AA document enclosed.	The development is judged not to adversely affect the conservation objectives incl impact on birds and a European site.	none
MGN requirements	Maritime and Coastguard agency marine guidance note MGN 275	External consultancy report 2005 on maritime traffic survey enclosed.	In addition to detailed vessel traffic analysis, the report contains info on navigational incidents (historic and potential)	None
Flood risk assessment	Environment Agency (?)	External consultancy flood risk assessment for a new substation at Sizewell Wents conducted in 2006; report enclosed.	A number of potential flood mechanisms identified in and around the site.None is however going to impact the development. All assessed risks are low. There are several off site impacts that would need controlling and mitigating (eg site specific infiltration testing required prior to construction).	None
Metocean design variables		External consultancy study 2006 enclosed.	Detailed analysis of correlation between wave hights and hub height wind speed, wave hights and water levels, forecast current speeds etc	None
Metocean measurements		External consultancy report 2005 enclosed.	Monitoring of coastal processes conducted in winter 2004-05 to include monitoring of tidal heights and currents within the development site. Waves are also monitored at selected locations.	None

A3. Procurement Status Assessment

Contracts

Contract	Info provided	Assessment result	Action Required (if any)
Contracts strategy	The project is to be constructed on a fixed price multi-contract basis with separate contracts for wind turbines and construction works. The latter is a Balance of Plant contract by Fluor (eg EPC) and covers design, testing and commissioning of the infrastructure works and wind turbines foundation works, testing and completion of WT works and remedial actions. Agreements are also in place with NGET re grid connection.	Comprehensive contracts strategy. Aimed at ensuring an economic and efficient procurement. Considered appropriate.	None.
Procurement process and procedures	Detailed information on a procurement process and its current status enclosed. In addition to engineering and construction, Fluor is also responsible for the procurement is all of the BoP equipment which includes all of the HV transmission equipment. They also have a remit to engage suubcontractors. A competitive tendering process has been adopted with both technical and commercial evaluation processes to follow. Each tender process contained at least 3 tender applications. The procurement rules are clear - there must be at least 3 bidders for contracts £50000.	Appropriate	None
Contract Overview	Detailed overview of all relevant contracts and arrangements provided along with GGOWL's requirements and functional specifications for each package. Fluor's response / approach to execution also included.	Very detailed overview of contracts incl their current status has been provided. Summary of contracts awarded provided in the DIR report.	None
Wind turbines supply	n/a for OFTO	**n/a**	
Wind turbines installations	n/a	**n/a**	
Foundations supply	n/a	**n/a** (assumption that offshore substation foundation is not included)	
Foundations installations	n/a	**n/a** (see above)	
Export cables supply (onshore and offshore)	Preferred bidder identified.	Completed.	None
Installation of export cables offshore	Preferred bidder identified.	Completed	None
Installation of export cables onshore	Preferred bidder identified.	Completed.	None.
Array cables supply	n/a	n/a	n/a
Array cables installation	n/a	n/a	n/a
Offshore platform - topsides and jacket supply	Preferred bidders identified - one for topsides, one for jackets.	Completed.	
Offshore platform - topsides and jackets installation	Preferred bidder identified.	Completed.	None.
Offshore substation GIS switchgear (HV and LV)	Preferred bidder identified.	Completed.	None.
Offshore substation transformer	Preferred bidder identified.	Completed.	None.
Onshore substation and cabling	Preferred bidder identified.	Completed.	None.
Substation SCADA and protection	Preferred bidder identified.	Completed.	None.

Surveys and Feasibility Studies

Surveys and Feasibility studies	Info provided	Assessment result	Action Required (if any)
Geophysical surveys	Conducted in 2004 for offshore platforms and the proposed cable route.	Completed	None
Geotechnical investigations	Conducted for the wind park turbine foundations, part of the cable route corridors and subsequent emplacement offshore structures. Also, any potential hazards to the emplacement of a pipeline from the coast to the windfarm.	Completed.	None.
Onshore geological survey	Conducted in 2006.	Completed.	None.
Marine survey	Cable route marine survey conducted in 2005.	Completed.	None.
Metocean surveys	Export cable route conducted in 2005; burial assessment report in 2007	Completed.	None.
Working drawings of the building envelopes	Submitted to the Planning authority and approved on 9 May 2008. Enclosed for insight.	Completed	None
Seabed surveys	See above - geotechnical and marine surveys	See above - geotechnical and marine surveys	See above - geotechnical and marine surveys
Land surveys	See above - onshore geological surveys	See above - geotechnical and marine surveys	See above - geotechnical and marine surveys
Planned cable routes	See above - geotechnical and marine surveys for the proposed cable route and corridor.	Crown Estate granted a 500m cable corridor. Final submarine cable routes still to be finalised. All subsequent consents obtained for the granted corridor.	Regular update on the final cable route required.
Post-installation cable burial survey	An independent survey is to be conducted to verify that the required burial depth has been achieved.	Pending	Progress update would be required at the later stage.
Offshore electrical design studies	Submarine cable design and capacity options evaluated in detail taking into account an annual wind profile. Allowance made for short term overloading of cables - within their operational limits.	The design has been well studied and optimised so as to arrive at the most economic and environmentaly friendly solution. The DIR is also very informative in relation to optiones considered and studies conducted.	None.
Onshore electrical design studies	Consideration given to: 132kV switchboard at a new substation at Leiston (eg GIS), insullation of equipment on the offshore platforms (eg gas insullation), number and size of transformers (eg optimised); onshore substation (eg Sizewell as the best economic solution with minimal impact on environment). NGET was also involved in chossing the most cost effective solution - connection to a new substation at Leiston.	The design has been well studied and optimised so as to arrive at the most economic and environmentaly friendly solution. The DIR is also very informative in relation to options considered and studies conducted. A copy of design studies hasn't however been enclosed so as to be able to get a full insight and justification for the design decisions made.	Further more detailed information would be helpful.
Reactive compensation	Designed to comply with Grid Code requirements at the onshore interface point.	Grid Code compliance has certainly been the most relevant concern. Use of SVCs+ in combination with wind turbine generators appears not only appropriate but also innovative.	None.

A4. Offshore Design and Construction

Requirement	Info provided	Assessment comment & result	Action required
Metocean data	Provided.	Completed.	None
Soil data	No information provided.	Soil data are required to assess the stability of the substation foundations, foundation of jack-up platforms and cable stability.	Additional soil data are required (CPTs, bore samples at substation locations).
Offshore cable design	Information on cable design and installation is provided.	As scour can occur along the cable route, there is a risk for free spans if the scour is more then the cable burrial depth. Cables are lead sheated; the potential fatigue issues were not addressed in specifications.	Additional information required on lead sheating and dynamic loading at J-tube interface; need to ascertain that vortex induced vibrations (VIV) will not occur. (Note: VIV on the J-tube is not the concern; rather at free spans, caused by scour.) Dynamic loading of the cable at the bell mouth/ sea-bed interface should be considered.
Substation foundation design	Performance specification provided.	No design details are provided.	Design information is required (drawings, structural analysis,detailed J-tube design and lay-out, installation aids, transport and installation load cases etc.)
Substation deck design	Performance specification provided.	No design details are provided.	Design information is required (drawings, MTO's, specifications, requisitions, structural analysis, Hazops, Hazids, etc.)
Substation corrosion life time	Operational performance of 25 years.	For a technical life of 25 years periodic paint repair work will be required at the substation.	A maintenance philosophy and maintenance plan for the substation is required.
Substation fatigue lifetime	Operational performance of 25 years.	The fatigue of the substation foundation needs to exceed 25 years. No details have been provided.	A design report of the substation (foundation and deck) is required to assess the fatigue life.
Cable route bottom stability (scour and sedimentation)	Scour and local instability indicated; no information on mitigation provided.	Since the cables are lead sheated, fatigue can be a concern. Permanent and sufficient burrial depth of the cable is necessary to avoid fatigue damage and impacts by fishing trawler boards.	Design report on a cable routing and installation method is required.
Trenching depth	1.5-2.0 m	Not installed yet; actual challenges and as built data are not available.	Design report on cable stability and installation method required.
Crossings (shipping lanes, cables, pipelines)	Planned, no details provided.	Information is required to assess these interfaces.	Crossing design reports are required.
Landfall design	Unclear	Landfall is highly exposed and a critical part of the cable route.	Landfall design report and method statement required.
Maintainability	Required as per performance specifications.	No information on maintenance is provided.	Maintenance plans, maintenance management system, maintenance policy, reliability analysis, sparing and redundancy analysis etc are all required to assess the quality of the design and operational costs.
Substation accessibility for crew	Boat landing for catamaran access up to 2.5 m:	A crew boat (catamaran of 12m length) is anticipated; significant waves up to 2.5 m (this implies maximum waves up to 4.7 m) are far beyond safe crew practices.	Potentially unsafe and inadequate access arrangements.
Facilities for major repairs (crane capacity)	No information provided.	Not possible to conduct assessment due to lack of info.	Crane facilities are required to allow for component replacement. A failure of any component which cannot be lifted can cause full wind farm shutdown.
Access for intervention jack-up	No information provided.	One substation is located in shallow waters (on the bank) and the other is located sea wards the bank. A jack-up should be able to operate at both sites.	Information is required to assess the access of a jack-up at the substation (cable corridors, scour protection, scour holes, foot-prints).
Temporary accommodation	Provisions made, 12 POB per substation.	Sufficient POB for normal maintenance, unclear if these facilities are intended as emegency shelter for the wind turbine generators as well.	No further information required.
Lifting weight of a substation foundation	General arrangements for foundations have been provided,	One substation is in shallow waters (limited access installation vessel, considering tide and draft limitations for approaching afloat)	No further information required.
Dimensions of a substation foundation	All dimensions have been provided.		No further information required.
Lifting weight of a substation	Information provided.	One sub-station in shallow water (limited access installation vessel, considering tide and draft limitations for approaching afloat)	Design information required.
Dimensions of a substation	Information provided.		Design information required.
Critical installation spread	No information provided.	The maximim lifting weight of 1850 tons requires substantial de-commissioning spread.	Lifting plan and spread for the substation foundations and decks are required in order to assess decommissioning requirements.
J-tube design	J-tube design summary provided.	Confirmation has been received that the J-tube design is fit for purpose.	More detailed information required in order to assess cable loading.
Diverless installation	Yes	Confirmed	No further info required.
Dynamic loading of export cables	Indications are provided that this may be a concern.	Cables can experience dynamic loading if exposed to free spans or at the bell mouth interface.	Information is required on lead sheating and dynamic loading at J-tube interface
Project schedule	Project in under construction. Substations and export cables still to be constructed and installed.		Detailed schedule (level 3) for cable installation, sub-station installation and commissioning is required.

A5. Electrical Equipment and System Design

Equipment	Owner	Type	Rating	Voltage	Life Expectancy	Applicable Standards	Quantity	Design Comment	Modification Required
Offshore Substations									
Platform 1. Inner Gabbard 2. Galopper	under consideration						2		
High voltage switchgear	OFTO	GIS (Siemens)	2000A / 31.5 kA	132kV	40years	IEC; functional spec available for each asset type	5	The rating of 2000 A for the breakers seems not to be aligned with the (same) current carrying capacity of the LV system.	A check is advised.
Low voltage switchgear	OFTO	GIS	2000A	33kV	40 years	IEC; functional spec available for each asset type	8	The rating of 2000 A for the breakers seems not to be not consistant with the (same) current carrying capacity of the HV system.	
Environmental protection systems (cathodic protection of the OSP, transformer fluid containment, fire deluge, waste water collection systems)	tbc				< 25 years		2		
Protection & Control equipment (surge arrests, CT/VT etc)	tbc				< 25 years		unknown		
Accommodation Module	tbc						unknown		
Emergency back up DC supply	tbc				< 25 years		1		
Main Offshore Substation (Inner Gabbard)	under consideration					IEC; functional spec available for each offshore asset type			
Transformer			180/90/90 MVA	132/33kV	45-55 years		3		Additional information would be helpful.
Platform losses - no load (kW)			unknown					Taking into account that the installation of offshore substations is planned to be finalised by December 2010, it is expected that the full specification for the platform and transformers, including losses, is known.	
Transformer losses - average gen (kW)			unknown						
Transformer losses (kW) - 100%			unknown						
Earthing Aux Transformer			250kVA	33kV			3		
Earthing resistor				33kV			3		
Aux Transformer connected to earthing aux transformers				33kV			3		
Diesel generator			unknown				1		
Second Offshore Substation (Galloper)	under consideration					IEC; functional spec available for each offshore asset type			
Transformer			90/90 MVA	132/33kV	45-55years		2		
Platform losses - no load (kW)			unknown					See above - under Inner Gabbard.	
Transformer losses - average gen (kW)			unknown						
Transformer losses (kW) - 100%			unknown						
Earthing Aux Transformer				33kV	45-55 years		2		
Shunt reactors			30MVAr	33kV	< 25 years		2		
Diesel generator			unknown				1		
Transmission Circuit									
Subsea cable with fibre optic cable	OFTO	3 core	three export cables 45.5km; Galloper to Gabbard 16km; transport capability 200MW each	132kV	40years	IEC; functional spec available for each offshore asset type	3+1		
Sub Sea Cable losses - no load (kW)			unknown						
Sub sea cable losses - average gen (kW)			unknown						
Sub sea cable losses (kW)- 50%			unknown						
Sub sea cable losses (kW) - 100%			unknown						
Subsea cable sealing ends	OFTO			132kV			5sets		
Subsea cable joints	OFTO						unknown		
Transition joint at landfall	OFTO			132kV			3		
Land cable	OFTO	single core	0.627km	132kV	40years		3		
Land cable losses - no load (kW)			unknown						
Land cable losses - average gen (kW)			unknown						
Land cable losses (kW)- 50%			unknown						
Land cable losses (kW) - 100%			unknown						
Land cable joints				132kV			unknown		
Land cable termination				132kV			unknown		
Onshore Substation LEISTON 132 kV									
New compounds	NGET						1		
Bays	NGET						3		
Configuration	NGET	two section double busbar; 1.5 breaker and 7 feeder bays ; 2 bus transfer breakers							
High Voltage switchgear	NGET	GIS (Areva)	2000A	132kV			3		
Protection and control equipment	NGET				12-15years; with software upgrades up to 25years		1		
Metering CT/VT and displays	tbc				< 25 years		1		
Control system (monitoring the SCADA, LV supplies, emergency batteries,	tbc				< 25 years		1		
Auxiliary TR	tbc		150kVA	unknown			1		
Reactive Power Equipment									
New Compounds							1		
132kV High Voltage Switchgear	OFTO	GIS (Siemens)	2000A	132kV	40 years		6		
Harmonic filters	OFTO		20MVAr		10-15years		3		
132/13.5 kV transformers	OFTO		90MVA	132/13.5	40 years		3		
13.5kV switchgear	OFTO	4 panel board per bay	2500A	13.5 kV	40 years		3		
SVC units	OFTO		50MVAr		15years		3		
Shunt capacitor	OFTO		40.4MVAr				3		
Shunt reactor	OFTO		47.3MVAr				3		
Cable to NGET 132kV substation	OFTO						3		
SCADA (duplicate)	shared	T&G functions					1		
Overall Design Assessment									
Losses							3.08% of predicted annual energy yield (57669MWh)		
Maintenance								O&M plans and schedules under development	

A6. Security and Quality of Supply Standard[14] Compliance Assessment

SQSS Reference		Requirement	Info Provided	Assessment Comment & Result	Compliance Action
1.14 to 1.25	Offshore Criteria & Methodologies	Ownership and boundaries of offshore transmission system components.	Scenario A: GEP at 33 kV busbars on the offshore substation platforms. IP at new 132kV Leiston substation - position tbc. Proposed operational and maintenance boundaries differ from ownership boundary. GGOWL wish to operate and maintain.	Scenario proposed complies with 1.17; platforms ownership incl electrical equipment housed on them not declared.	Proposed operational boundary differs
1.14 to 1.25	Offshore Criteria & Methodologies	Ownership and boundaries of offshore transmission system components.	Scenario B: GGOWL is considering alternative options.	tbc	tbc
7.2.1	Maximum capacity of offshore PPM	Maximum of 1500MW	140x3.6= 504MW total	Compliant	None
7.2.3	Distance GEP to IP	Maximum 100km	45.5km 3 core submarine cable x 3. 0.627km 1 core cable cct x 3. 16km offshore s/stn interconnector.	Compliant	None
7.2.4	Length of any overhead line section	Maximum 50km	Cable only therefore N/A	N/A	None
7.2.5	Offshore network configuration	Radial only	Radial configuration	Compliant	None
7.8.1.1	Planned or fault outage of a single AC offshore transformer circuit	Where GEP capacity is 90MW+, planned or fault outage of a single AC offshore transformer circuit the loss of power infeed shall not exceed the smallest of either 50% of the offshore GEP or the full normal infeed loss risk (at present 1000MW for frequency deviations of greater than 0.5Hz for longer term)	For Scenario A loss of single AC transformer circuit (180MVA) results in a loss of power infeed of less than 50%.	Compliant	None
7.8.1.3	Fault outage of single AC offshore transmission circuit during a planned outage of another AC offshore transmission circuit	The loss of power infeed shall not exceed the infrequent infeed loss risk (at present 1320MW)	No information on frequency varation for such a scenario(s) provided. Several outage scenarios possible. As a worst case, loss of generation of 165.6MW should not cause frequency variation of + or - 0.5Hz for more than 60sec.	Compliant against the 1320MW figure.	None
7.8.2.1	Planned or fault outage of a single DC converter	Loss of power infeed shall not exceed the normal infeed loss risk	N/A - no DC connection	N/A	None
7.8.2.2	Fault outage of single DC converter on offshore platform during a planned outage of another DC converter	The loss of power infeed shall not exceed the infrequent infeed loss risk	N/A - no DC connection	N/A	None
7.8.3.1 - 7.8.3.5	Loss of any single section of busbar or bus coupler circuit breaker on an offshore platform	Not to exceed normal or infrequent infeed loss risk	No information on frequency varation for such a scenario provided. However, loss of any single section of busbar or bus coupler circuit breaker will not result in exceeding the infeed loss risk (normal or infrequent)	Compliant	None
7.9.1 to 7.9.2	Loss of AC or DC cable transmission circuit (between offshore platforms or between offshore platform and IP)	Not to exceed normal or infrequent infeed loss risk	No information on frequency varation for such a scenario(s) provided. However, loss of any of the AC offshore cable transmission circuits will not result in exceeding the infeed loss risk (normal or infrequent).	Compliant	None
7.10 to 7.12	Onshore Overhead Line Sections	Justification for a minimum number of overhead lines 132kV and above and infeed loss risk	N/A as landfall to IP is three cable circuits	N/A	None
7.13	Onshore connection facilities (AC, DC, Busbar & Switchgear)	AC circuit requirements where GEP capacity is 120MW+ ; infeed loss risk for loss of onshore connections	For Scenario A (GEP is 504MW) loss of single AC transformer circuit (180MVA) results in a loss of power infeed of 165.6MW i.e less than 50%. For an outage of the ac transmission circuit the loss of power infeed is less than infrequent infeed loss risk (1320MW).	Compliant.	None
7.14	Background conditions with respect to active and reactive power output of the offshore power station	Active power output at the offshore GEP is equal to registered capacity. Reactive power output should be set to deliver unit power factor at the GEP and meet STC, Section K requirements at IP	Reactive power control will be delivered by the onshore compensation /filter station and offshore windfarms. System feasibility studies have been conducted to ensure compliance with current Grid Code at the onshore connection point which would allow for Sec K compliance at the IP. GGOWL indicated that Section K requirements are unlikely to be met at the GEP though.	Appears compliant at the IP.	None
7.15 - 7.19	Pre and post fault criteria with and without local system outage	Various	No information has been provided at this stage to make an informed judgement	To be determined, if appropriate	tbc
7.20 & Appendix A Part 2	Switching Arrangements	Offshore and onshore substation (GEP & IP) configuration	Offshore GEP (Gabbard) has a three transformer feeder arrangement with multisection 132kV switchboards for operational flexibility and maintainability. Onshore IP has main and reserve 132kV double busbar arrangement with sectioning and transfer switching.	No compliance issues anticipated	None
8.5 to 8.10	Demand Connection Criteria applicable to an Offshore Transmission System	Offshore power station demand connection capacity requirements; includes planned and unplanned contingency conditions and supply capacity following a secured event.	There is offshore power station auxiliary demand only which is derived from local substation supply provision and backed up by diesel generation. No information on offshore power station demand has been provided.	Demand Group relevant to this project is unknown. Billateral agreement given for entry without power station demand.	
8.11	Switching Arrangements	Switching arrangements for demand groups	No information provided.	Demand Group relevant to this project unknown.	
8.12 - 8.15	Variations to Connection Designs	Demand connection design variation	No information provided.	Demand Group relevant to this project unknown.	
9	Operation of an Offshore Transmission System	Normal operational criteria and post-fault restoration of system security.	No information on system studies provided as evidence of system response.	Not able to determine compliance at this stage.	Could be a compliance issue
10	Voltage Limits in Planning and Operating an Offshore Transmission System	Planning and operational timescale voltage limits.	No information on system studies provided as evidence of system response in the event of a secured event or operational switching.	Not able to determine compliance at this stage.	Could be a compliance issue

[14] 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

A7. System Operator – Transmission Owner Code (STC) [15] Compliance Assessment

STC Reference		Requirement	Info Provided	Assessment Comment & Result	Compliance Action
C Part 1: 3	Services Capability Specification	Provision of transmission services to NGET.	Bilateral agreement with NGET contains site specific technical conditions to include mandatory Ancillary Services.	No information provided re actual service capability at this stage	Verification of services required
C Part 2	Transmission Outage Planning	Coordinated development of outage proposals and plans with NGET.	No specific information provided in relation to coordination with NGET requirement. Good provisions made however for dealing with planned outage contingencies.	Expected to be in place at a later stage of project development	Not a compliance issue at this stage of project assessment
C Part 3: 3	Requirement to Enter into an Interface Agreement	Connection Sites and new connection sites require a Transmission Interface Agreement or Embedded Transmission Interface Agreement as appropriate.	No information is expected at this stage	A Transmission Interface Agreement will be required to be established in due course between OFTO and NGET	Not a compliance issue at this stage of project assessment
C Part 3: 5	Black Start	A TO shall comply with OC9.4 and OC9.5 of the Grid Code.	See comments under Grid Code Compliance sheet	See comments under Grid Code Compliance sheet	See comments under Grid Code Compliance sheet
C Part 3: 7	Provision of Training	As required to discharge obligations.	No information is expected at this stage	Expected to be in place at a later stage of project development	Not a compliance issue at this stage of project assessment
D Part1: 2.1	Transmission Investment Plans	A TO shall develop and maintain a single investment plan for current year and subsequent 6 years.	No evidence provided of future transmission investment planning beyond project completion.	Future transmission investment position requires to be determined	Not a compliance issue at this stage of project assessment
D Part 1: 2.2.6.1	Transmission System Technical Criteria and Planning Assumptions	Compliance with: Connection Conditions 6.1, 6.2, 6.3 and 6.4. Planning Code 6.2.	See comments under Grid Code Compliance sheet	See comments under Grid Code Compliance sheet	See comments under Grid Code Compliance sheet
D Part 1: 2.2.6.3	Transmission System Technical Criteria and Planning Assumptions	Compliance with Section K of STC.	See comments under Section K below	See comments under Section K below	See comments under Section K below
D Part 1: 2.2.6.4	Transmission System Technical Criteria and Planning Assumptions	Transmission apparatus manufactured to IEC Standards.	See comments in Equipment & System Design sheet.	See comments in Equipment & System Design sheet	See comments in Equipment & System Design sheet
D Part 1: 2.2.6.5	Transmission System Technical Criteria and Planning Assumptions	Any transmission apparatus located offshore is suitable for a marine environment.	DIR stated that all relevant equipment is fit for purpose in a marine environment.	Compliant	None.
D 2.3	Co-ordination of Transmission Investment Planning	To consider the implication of planned changes NGET investment plans	No evidence that relevant future NGET investments plans have been under consideration.	Impact of relevant future NGET investment plans require due consideration	Impact of relevant future NGET investment plans require due consideration
D Part 1: 2.6	Connection Site Specification	Description of connection assets and clear boundary. Description of technical design and operational criteria.	No specific information provided in relation to this requirement	Would expect this to be in place.	Verification required.
D Part 1: 2.7	Transmission Interface Site Specification	as above	No specific information provided in relation to this requirement	Expected to be in place at a later stage of project development	Not a compliance issue at this stage of project assessment
D Part 1: 2.8	Embedded Transmission Site Specification	as above	N/A	N/A	N/A
D Part 1: 3	Default Planning Boundary	Guidance on planning boundaries. Check appropriateness of developer proposed boundaries.	The DIR does not refer to default planning boundaries.	Regulated asset boundary is stated to be 33kV busbar which aligns with the default position.	Not a compliance issue as proposed GEP boundary represents the default position
D Part 2: 2	NGET Construction Application	Requirement is to have a TO Construction Agreement	No information in respect to Construction Application has been provided.	There is a CUSC Construction Agreement 10 November 2005 in place.	Not a compliance issue at present
D Part 2: 3	Construction Planning Assumptions	Issued to TO to assist in preparation of Construction Offer.	No information has been provided to this effect	It is expected that a TO Construction Agreement will be in place in due course	Not a compliance issue at present
D Part 2: 4	TO Construction Offer	Each TO that receives a NGET Construction Application must notify NGET if it intends to submit a TO Construction Offer.	No information has been provided to this effect	Will be applicable on the appointment of an OFTO	Not a compliance issue at present
D Part 2: 5	Acceptance of TO Construction Offer	Offer will remain open for at least 6 months.	No information has been provided on Construction Offer	Will be applicable on the appointment of an OFTO	Not a compliance issue at present
D Part 2: 10	Communications Plant	NGET and TO to agree provision of communications equipment.	No information has been provided to this effect.	Will be applicable on the appointment of an OFTO	Not a compliance issue at present
D Part 2: 11 to 13	Site Rules	Provision of Safety Rules for all site types to be submitted prior to Completion Date of Construction Agreement.	No information has been provided to this effect	Will be applicable on the appointment of an OFTO	Not a compliance issue at present
G 2.2	Transmission Owner Safety Requirements	TO shall comply with the relevant appendix of Operating Code 8 and Appendix 1 of the Connection Conditions of the Grid Code.	See Grid Code compliance sheet	See Grid Code compliance sheet	See Grid Code compliance sheet
K2.1	Reactive Capability and Voltage Control	Reactive power capability at the Interface Point may be provided by a combination of plant owned by the OFTO and plant owned by the generator(s).	Provision of reactive power capability is a combination of onshore compensation equipment, WGTs and shunt reactors on Galloper platform.	Design approach is valid. Capability has been stated in DIR to have been extensively studied to ensure compliance with current Grid Code at the onshore connection point.	Compliant
K2.2 to 2.5 and Appendix KB	Reactive Capability and Voltage Control	Active and reactive power transfer criteria at Interface Point. Also limit on control facilities.	Reactive compensation control mode has not been specified.	The specifics on reactive and voltage control capabilities haven't been provided. Supplementary information received to indicate compliance at the onshore connection point but not at the GEP (GGOWL/OFTO interface).	Could be a compliance issue.
K3.1.1, 3.1.2, App A, 3.1.3 and 3.1.4	Fault Ride Through Capability	<miscellaneous requirements on FRT capability>	No information has been provided	Not able to make an assessment	Could be a compliance issue
K4	Additional Damping Control Facilities fro DC Converters	TO shall ensure each converter is fitted with sub-synchronous resonance damping controls. Or other power oscillation damping controls as specified in TO Construction Agreement or Transmission Interface Site Specification.	N/A	N/A	No compliance issue
K5.1 and 5.2	Additional Damping Control Facilities fro DC Converters	OFTO to provide continuous real-time frequency indication to Generator for Interface Point where DC converters employed.	N/A	N/A	No compliance issue
K5.3	Additional Damping Control Facilities fro DC Converters	DC converter frequency operating capabilities.	N/A	N/A	No compliance issue
K5.4	Additional Damping Control Facilities fro DC Converters	Operating frequency response for each Offshore Transmission System and constituent components.	N/A	N/A	No compliance issue
K5	Neutral Earthing Requirements	At 132kV and above the HV winding shall be star connected with suitable star point earth connection. Earthing and LV winding arrangement to comply with Grid Code CC 6.2.1.1 (b).	See comments under Grid Code Compliance sheet	See comments under Grid Code Compliance sheet	See comments under Grid Code Compliance sheet

[15] 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[16] 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.	No information provided to this effect.	Not able to assess compliance in relation to voltage and freq variation. Provision made for harmonic filters to meet the harmonic limits at the onshore connection point at Leiston. A period of harmonic monitoring planned to take place prior to the wind farm connection.	Need compliance information
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.	No information provided to this effect.	Not able to assess compliance due to lack of information	Need compliance information on earth fault factor, voltage rise, fault clearance times, appropriate protection provision and settings
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.	See STC compliance Section K for reactive power, voltage control and neutral earthing.	CC6.3.2 e) No information on short circuit ratio and frequency. Information in relation to reactive transfer on Galloper when energizing with no generation points out that a reactive transfer would be greater than allowed under CC 6.3.2.	Some compliance aspects associated with the STC, Section K need to be confirmed. See STC Section K for compliance comment.
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.	CC6.4.2 Three 33/132kV transformers at Inner Gabbard have an associated earth neutral transformer and earthing resistor. The transformers on Galloper do also have an associated earthing transformer. CC6.4.3 Provision of low frequency relays by Network Operator (OFTO) to be determined. CC6.4.4 No operational metering details	Neutral earthing arrangements are compliant. Not able to access compliance for low frequency relays. Operational metering requirement is for embedded generation only and therefore not applicable in this case	Need compliance information on low frequency 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.	N/A at this stage of project development	N/A at this stage of project development	Not a compliance issue
PC	Planning Code.				
PC6.2	Planning standards in relation to Scotland.	Appendix C lists technical and design criteria.	N/A as development is in England	N/A as development is in England	N/A as development is in England
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 SQSS	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	All equipment was stated to be fit for purpose for operation in marine environment.	compliant
			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.	No information provided at this stage	Details would be determined as project moves into implementation and operational phase	No compliance issue at this stage
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 as development is in England	N/A as development is in England	N/A as development is in England
OC9	Contingency Planning.				
OC9.4	Black Start	The implementation of recovery procedures following a total shutdown or partial shutdown.	According to Bilateral Agreement, App F5 provision of black start facility is not required.	Black start not required	None
OC9.5	Re-Synchronisation of Desynchronised Islands.	Requirements, strategies and planning for re-synchronisation following a total or partial shutdown.	According to Bilateral Agreement, App F3 splitting/islanding schemes are not applicable but need to interface with NGET substation synchronising system.	Synchronisation signal only required	Signal provision to be verified.

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

A9. Distribution Code[17] Compliance Assessment

Not applicable.

[17] 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

Risk area	Description of risk	Severity	Potential consequences	Score explanation	Procurement Stage	Delivery & Construction stage	Operational stage
Offshore Design	Limited information has been provided to date on offshore substation foundation and deck design, landfall and crossings design, cable routing, loading and stability.		Potential implications for operational and maintenance needs, technical life and risk exposures.	Additional information would be helpful.		x	x
Electrical design	The project is very well designed but it hasn't been clearly documented (eg design studies conducted haven't been provided) why certain design solutions and ratings have been adopted.		Potentially over-engineered and hence more expensive.	An additional explanation would be helpful so as to provide the potential bidders with a more informed view on the project rationale and cost effectiveness.		x	x
Boundary of ownership	The offshore substation is envisioned as a hub for transport to and from the wind turbine generators.		The envisioned functionality will require right of access to be agreed between OFTO and developer if the ownership of the offshore substation rests with the OFTO.	Access to third parties should be contractually covered, and resulting arrangements and liabilities should be covered.			x
Operational costs	The offshore substation will have an helicopter platform and emergency living quarters.		The additional functionality may add to logistics and operational costs.	The consequences of these additional functionalities will on one side provide some extra options in relation to accessibility. However, the costs associated with them should also be taken into account.			x
Operational Costs	It is not clear whether the logistics costs (eg transport to and from the substation) are included.		If costs for logistics are not included, then the operational costs are likely to rise.	Logistics costs have not been mentioned.			x
Environmental issues	The Greater Gabbard area is known for fishing esp trawl fishing. Although cables are buried, their actual burial depth may change on certain places due to scour. A trawl could then be pulled over the cable. As the offshore windfarm potentially acts like an artificial reef the area may increasingly become more attractive for fishermen.		Cable damage by fishing could lead to serious damage with a prolonged repair time.	It will be hard to prevent the fishing activities over the connection cable. However a 2m burial depth reduces this risk. A report was made in support of this assessment.			x
Decommissioning	It is not clear whether decommisioning instructions and fund are in place.		There is a general description but no detailed decommissioning plan available; costs and provisions are not mentioned	If ownership of the offshore substation rests with the OFTO, then the decommissioning of the substations would be the OFTO's responsibility.			x
Operation and Maintenance plans	The O&M plans and manuals are under development (expected July 2009).		Draft plans are expected to be in place at this stage so that O&M requirements are clear from the outset.	In the light of construction works expected to be completed by the end of 2010, it is deemed important to have draft operational and maintenance manuals in place as soon as possible.	x	x	x
Operational and ownership boundary	The proposed operational boundary differs from ownership boundary		More clarity on boundaries and responsibilities is needed so as to better inform asset transfer discussions.	Operational and maintenance boundaries need to be resolved early in the process as they may impact treatment of shared assets and codes compliance.			x