Technical Support for the Enduring Regime

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In accordance with the terms of reference set out in our service agreement with Ofgem dated 6th August 2012, this report documents our analysis in relation to the offshore transmission owners under the Enduring Regime.

The scope of work is as set out in the service agreement. Those terms of reference comprise the agreed scope of our enquiries, directed at those issues which Ofgem determined to be critical.

This report takes into account the particular instructions and requirements of Ofgem. It was prepared solely for the purpose of providing supporting data to Ofgem in assessing the policy options for the Enduring Regime and should not be relied on for any other purposes.

This report is not intended for, and should not be relied on, by any third party and no responsibility is undertaken to any third party.

Our work commenced on 23rd February 2012 and this Report was provided on 27th November 2012.

Our report may not have considered issues relevant to any third parties. Any third parties that make use of our report do so at their own risk. Ove Arup and Partners Ltd assume no responsibility or liability to any third party in respect to the contents of this report.

Our work in connection with this assignment is partly based on reports provided by Ofgem, discussions with Ofgem and publicly available data. We have not verified these reports, discussions or data.

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1 | Introduction

1.1 Enduring Regime

1.1.1 What is the Enduring Regime

Ofgem and the Department of Energy and Climate Change (DECC) have developed a regulatory regime for offshore electricity transmission that grants licences to Offshore Transmission Owners (OFTOs) through a competitive process run by Ofgem.

The regime has been developed in two parts: the Transitional and Enduring Regime. The Transitional Regime relates to transmission assets constructed, or currently under construction by generators. All Transitional Regime projects involve the transfer of ownership of completed transmission assets to a licensed offshore transmission owner (OFTO). Transitional Regime projects were required to meet the qualifying project requirements by 31 March 2012. Projects that were not able to meet those requirements by that date will be tendered under the Enduring Regime.

Twelve projects have commenced the OFTO Transitional Regime tender process with the final transitional project due to commence a tender shortly. Six of these have completed the process and licences have been granted to OFTOs. The Enduring Regime could involve over 20 projects, associated with up to 30GW of offshore generation and billions of pounds of investment in transmission assets over the next decade.

Given the scale of the regime and importance of the transmission assets, it is important that the enduring regulatory regime, which underpins the delivery of the offshore transmission assets, is fit for purpose, capable of facilitating industry access to the investment and finance markets and ensures best value for consumers.

1.1.2 Projects

Under the Enduring Regime the scale and complexity of the transmission assets is likely to increase significantly in comparison to the Transitional Regime.

The Transitional Regime projects cover a broad spectrum of size and scale. The projects closed to date, all of which were part of the first round of tendering, have a transmission capacity of between 90MW and 184MW with corresponding asset values of approximately £30m – £110m. They generally consist of one offshore platform, with up to two transformers, connected to an onshore substation via one or two subsea cables. The later Transitional Regime projects are larger with transmission capacities up to 630MW. Some of these projects have multiple platforms and can have up to four subsea cables. All the transmission assets tendered under the Transitional Regime have used Alternating Current (AC) technology.

Under the Enduring Regime it is expected that the scale, value and complexity of the projects will increase further. The windfarms are planning to have installed capacities of up to 9GW. Many of these are likely to be serviced by multiple groups of transmission assets which may become interlinked. The Enduring Regime may also see the introduction of Direct Current (DC) transmission technology. Each group of transmission assets is expected to be on the scale of the later Transitional Regime assets or larger. It is anticipated that a typical single transmission system could have a capacity of 1000MW.

1.2 OFTO build and Generator build

The Enduring Regime will allow OFTO assets to be developed under two possible options. During the early stages of developing the windfarm (when agreeing their Bilateral Connection Agreement (BCA) with the National Electricity Transmission System Operator (NETSO)), a generator can choose to either build the transmission assets and then transfer these to an OFTO, known as a Generator build, or request an OFTO to build the transmission assets, known as an OFTO build.

The Generator build option builds on the approach that has been used for the Transitional Regime. The OFTO build approach has not been used under the Transitional Regime and introduces additional complexity, requiring the OFTOs to procure and construct as well as operate the assets. For this to be an attractive and feasible option for the generators, it needs to ensure that technically appropriate assets are built without delaying delivery of the windfarm project.

1.2.1 Ofgem policy development

The policy for the Enduring Regime has been presented to stakeholders through the following recent publications and consultations

- **August 2010** – DECC/ Ofgem consultation document
- **October 2010** – DECC/ Ofgem statement
- **November 2010** – DECC/ Ofgem consultation document
- **December 2010** – Government Response
- **December 2011** – Ofgem consultation document
- **February 2012** – Ofgem stakeholder briefing event
- **April 2012** – Arup / TNEI stakeholder workshop
- **May 2012** – Ofgem consultation document
- **July 2012** – Arup / TNEI stakeholder workshop 2

1.3 Arup and TNEI's Scope

The scale and complexity of the projects within the Enduring Regime, combined with the introduction of the OFTO build option, create a significant number of technical considerations to ensure that the Enduring Regime is capable of meeting stakeholder objectives. Arup and TNEI's role has been to advise Ofgem on a number of topics relating to Ofgem's policy development, primarily for their May 2012 consultation (although Ofgem exercised its own discretion in determining its proposed policy positions). Listed below are the key topics that Arup and TNEI have been asked to consider and advise on (this report is divided into components covering each of these topics – with this report setting out the high level findings in relation to each topic);

- **OFTO build tender timing** – an assessment of the optimum timing for an OFTO tender within the delivery programme of an offshore windfarm;
- **Seabed surveys** – an assessment of the need for generators to be provided with guidance for how seabed surveys should be undertaken and an indication of how this might be achieved;
- **Tender specification** – identification of items that could be included in the tender specification under OFTO build;
- **Permissions, consents and permits** – summary of the consents associated with windfarm development and the implications for an OFTO build tender;
- **Supply chain** – a consolidation of publicly available information regarding supply chain constraints for the manufacture of transmission asset components;
- **Phased projects** – consideration of the technical issues associated with windfarms being developed in discrete phases;
- **Construction risks** – assessment of risks to the OFTO during the construction phase under OFTO build; and
- **Asset lifespan** – assessment of the lifespan of different components within offshore windfarms and transmission assets.

2 | Tender timing

2.1 Significance

Under the Generator build option, as used in the Transitional Regime, the generator's construction programme for the transmission assets is largely independent of the OFTO tender process. The main consideration is to run the Invitation to Tender (ITT) stage and appoint a Preferred Bidder once there is sufficient certainty on the detail of the constructed transmission assets, and to ensure the OFTO licence is granted at the point when the assets have been constructed and are operational.

The OFTO build option adds complexity to the OFTO tender process. The OFTO build tender process must align with the delivery programme of a windfarm whilst allowing the OFTO bidders to have sufficient information to provide competitively priced bids for the assets.

2.2 Objective

The aim of this work stream was to produce a timeframe for the OFTO tender process under OFTO build which would fit within the delivery programme of a windfarm. The proposed timing was based on fulfilling the following criteria:

- The tender process should allow the OFTO to produce a fixed price bid for the construction of the assets wherever possible. This requires a significant level of design and survey information to have been produced;
- Determining and appointing the OFTO must not impact the timescale in which windfarm assets are delivered;
- The OFTO should be able to have significant influence over the components and services needed to procure and produce the transmission assets; and
- In order to introduce innovation where possible the OFTO should be able to design the assets to the greatest extent possible, within the requirements of the windfarm and planning consents.

2.3 Approach

To understand how an OFTO tender process could fit into the delivery of a windfarm, a generic windfarm delivery programme has been produced for an indicative Enduring Regime project (i.e. transmission assets and associated windfarm assets). The transmission assets were assumed to have a transmission capacity of 1000MW, consisting of two AC collector platforms, one DC converter platform and a 100km DC cable connecting to an onshore substation.

The generic delivery programme was developed considering the procurement, design, manufacture/fabrication, installation and commissioning of each key component within the windfarm and transmission assets. Through analysis of the interrelationships, the critical path and activity float was identified.

It was identified that a key scheduling decision made by the generator is the point at which the Front End Engineering Design (FEED) is undertaken. There are broadly two different options for the delivery programme; FEED can either be undertaken during the consent applications (Early FEED) or after consents have been granted (Late FEED). The FEED process can be expensive, so a generator must decide if it wants to expose itself to the associated potential aborted work, should consent not be granted or require a modified design.

The back end of the OFTO tender process was assumed to last 13 months; six months for ITT submission, three months for bid evaluation and four months from preferred bidder appointment through to OFTO licence grant. Four potential tender process timings were identified. These were assessed against each of the delivery programs (Early and Late FEED) with the aim of identifying the extent to which they fulfilled the criteria for the tender process, which led to the assessment of eight different alternatives. These are illustrated in (Appendix 1a to 1d and 2a to 2d).

Using the results from that analysis, it was possible to identify potential timings for the OFTO tender process considering the generic wind farm delivery programme.

2.4 Conclusion

Programme options

FEED activities are required in order to allow procurement to commence and consequently, an Early FEED leads to earlier procurement of the key components. To enable the OFTO to have a significant influence or undertake the procurement process as part of an early FEED programme, the OFTO tender process would need to start earlier. This creates two key challenges. Firstly this would lead to the OFTO ITT process needing to start very early in the generator's conceptual design, meaning that there would not be a significant quantity of design information to allow the production of a fixed price bid. Secondly, consideration has to be given to the relationship between the procurement process and consent. An early FEED would create the possibility that OFTO Licence Grant needs to occur before consent grant, when the project is still uncertain, in order to ensure the transmission assets could be constructed in line with the windfarm delivery programme. Consequently if the generator is to undertake early FEED, fulfilling the criteria of the OFTO tender process is challenging.

The Late FEED delivery programme allows greater flexibility to the OFTO tender process as the result of a longer period between consent and the commencement of procurement activities. However, a later FEED will probably lead to a longer overall delivery timescale, although there is indication that this is an approach which generators may follow due to the lower risk of aborted work associated with an unsuccessful consent application.

The timing of the FEED significantly influences the risk/uncertainty to the OFTO and its ability to influence the development and procurement of the transmission assets. Therefore, stress testing the timing and scope of the FEED process with industry may be useful.

Price certainty and procurement involvement

Given the nature of the wind farm development, cost uncertainty does not decrease significantly from early design activities until major supply contracts are signed, or key installation activities are completed. In order for the OFTO to have greatest cost certainty when bidding, it would probably be necessary to have major supply contracts signed by the generator prior to OFTO Licence Grant. However, this would result in the OFTO having little or no influence over either the design or procurement of the assets, and OFTOs are also likely to price in additional risk associated with taking over supply contracts negotiated by the generator.

In order for the OFTO to have significant influence on the procurement process, the OFTO needs to be selected prior to signing of major supply contracts, but this may result in lower cost certainty at the ITT stage.

Recommended OFTO tender timing

Based on the analysis that was undertaken against the eight preliminary options, a recommended approach has been developed that allows the OFTO to undertake FEED and procurement activities. The recommended tender timing is illustrated in Appendix 3.

The final recommended OFTO programme shows activities to be undertaken by the generator in green at the top of the page and the OFTO bidding and procurement activities are shown in blue. After licence grant, the remaining activities to deliver the transmission assets would be undertaken by the OFTO.

OFTO bidding and procurement activities

The proposed tender timing includes the OFTO undertaking the following design, bidding and procurement activities;

- OFTO supply chain engagement – OFTOs may decide to form consortia with companies from the supply chain during this time, or may engage across a range of potential suppliers;
- OFTO FEED and procurement – it is proposed that the OFTOs undertake their own FEED activities during the ITT stage of the OFTO build tender. When sufficient design work has been undertaken, the OFTO will put together its fixed price bid at the end of the ITT stage (eg through working with the supply chain consortia, or by seeking tenders for the provision of equipment from the supply chain; and
- OFTO detailed design – During this time the OFTO will undertake any detailed design that is required. The need for this activity will depend on the nature of the relationship between each OFTO and their suppliers.

OFTO tender process

To enable the OFTO to undertake its own FEED and procurement activities, the suggested tender process timing has been adapted;

- The ITT stage starts at approximately the point of consent application;
- The ITT submission stage ends, and the OFTO should produce a fixed price bid, just after consent grant. This will probably be around one year after the start of the ITT stage; and
- After approximately three months of bid evaluation the Preferred Bidder will be announced (unless Ofgem decide to run a Best and Final Offer (BAFO) stage). This will be followed by approximately four months of process to close activities before the OFTO Licence Grant.

At the point of licence grant, it is anticipated that the OFTO will sign all the major supply contract and financing documents.

Our recommended tender timing allows completion of the assets in line with the late FEED generic schedule. However, by following this approach, and allowing the OFTO to undertake its own FEED, it allows the OFTO to have a significant impact on design, create a fixed price bid and introduce innovation through its involvement in the design process.

3 | Seabed surveys

3.1 Significance

There is currently no standard scope, extent or interpretation for geophysical information provided by generators under the Transitional Regime. The level of information provided may create delays in the OFTO tendering process where, for example, generators may have to undertake surveys to prove the suitability of cable burial and risk assessments. Appropriate surveys and geotechnical investigations represent some of the key documents to be provided to the OFTO bidders under the Enduring Regime, whether it is under the OFTO build or Generator build route.

History shows that since offshore cable burial has become a standard practice, rates of damage to cables have dramatically dropped. To bury a cable and ensure it is adequately protected, a good understanding of the shallow seabed conditions is essential.

Inadequacies in the survey and geotechnical documents provided to the installation contract as part of the contract documents can lead to increased liabilities to the project owner and increase the opportunity for the Contractor to claim variations under the contract.

3.2 Objective

The key objective of this work stream was to determine whether industry standard guidance defining the requirements for geophysical surveys and geotechnical investigations would be beneficial to the OFTO tender process, and if so, how this might be taken forward.

3.3 Approach

The overall approach to this task was to establish the requirements of the data with respect to content and time, establish current guidance and the importance of the OFTO being provided with appropriate information. These steps are outlined in more detail below;

- outline how geotechnical and geophysical information is used in the development of cable routes and foundation design;
- summarise the current availability of information to OFTO bidders during a tender exercise;
- outline the current level of guidance;
- identify the consequences of inappropriate and incomplete information being provided to the bidders; and
- outline the reasons for providing standard survey guidance.

3.4 Conclusion

The Information

The seabed information comes in two types: geotechnical and geophysical data, which are described below;

- Geotechnical information – this is obtained from intrusive investigations undertaken in discrete locations, meaning it can be only undertaken in specific locations. The investigations drill, push or dig the seabed.
- Geophysical information - this is obtained through continuous scanning of the seabed from above. Geophysical investigations can cover the whole of the cable route and corridor. This is done using equipment installed or towed by a ship or Remotely Operated Vehicle (ROV)

Offshore Site Investigation and Geotechnics Group (OSIG) have defined a process flowchart for offshore site investigations (SI) for offshore renewable energy projects.

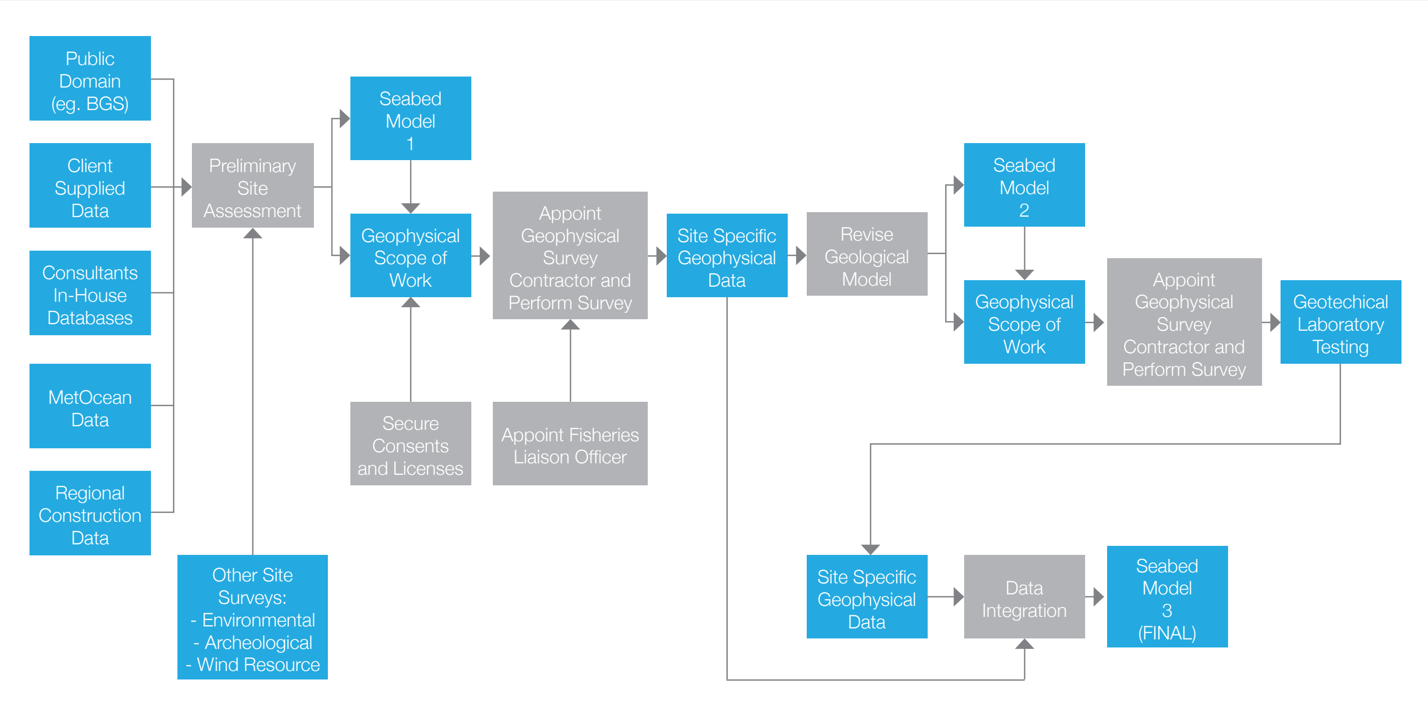


Figure 1 - Offshore site investigation flowchart

Firstly, a geological desk study will provide a geological understanding at a regional scale. Then, a geophysical survey should be carried out to refine the geological model. A geotechnical survey will then be carried out to correlate the geophysical data and obtain soil and rock properties. The extent of this survey will depend on the variability identified in the refined geological model. The integration of all the data will result in a final geological model which can be used in an assessment of required burial techniques and burial depth.

Current Guidance and Importance of Information

Currently some guidance is offered by the Offshore Site Investigation and Geotechnics Group (OSIG) and by the Department for Business Enterprise & Regulatory Reform (BERR, since renamed to BIS). However, there are no standard guidelines for offshore surveys and deliverables for the UK at planning, design, and construction phases of the development of offshore windfarms.

The lack of standards and guidance in the subsea surveys could lead to the following issues associated with missing information during tender exercises;

- Time is taken by the generator answering requests from bidders and by the Preferred Bidder in the identification of missing information and reviewing unnecessary documents
- Uncertainty around the risk of cable damage, requiring mitigation measures to be included in bids which may be unnecessary
- Uncertainty around ongoing operational costs, such as cable reburial, requiring mitigation measures to be included in bids which may be unnecessary
- Mispricing of risks due to lack of information. For example, though lack of information one bidder may assume cable reburial is required when another may assume it is not. Cable reburial, being an expensive activity, can lead to significant variation in operational costs

Currently, the lack of guidance risks leading to studies with unclear objectives (such as a cable burial assessment which mixes cable damage risk and installation feasibility) or activities being completed in the wrong order (such as cable risk assessment after cable installation). The consequences for bidders are similar to that of missing data: it could lead to unnecessary pricing of risks and required mitigation. Undertaking activities incorrectly could also lead to additional costs and timescale requirements for the generator. For example, assessments and investigations may need to be repeated and incorrect assessments may not lead to cost efficient installation.

Finally, there is currently a lack of consistency in geotechnical and geophysical information provided, and subsequently how seabed assessments and the resulting burial and risk assessments are undertaken. This potentially creates challenges when investors are trying to ensure that the assets have been correctly designed. For example, if an investor is exposed to cable risk assessments using two different methodologies, it could reduce confidence in their appropriateness.

Furthermore, under the OFTO build option, the importance of appropriate geotechnical investigation and geophysical survey information can be further considered against;

- The need for bidders to be able to assess accurately at the ITT stage the risks and installation costs to increase the level of price certainty available to inform their bids; and
- The need for the appointed OFTO to procure a cable installation contractor given the associated risk profile. An inappropriate survey may require the OFTO to undertake surveys and investigations prior to installation of the cable, additional to those which an installation contractor would always be likely to undertake. This additional work may take up to a year, which may have an impact on the programme of delivery of the transmission assets.

Future Guidance

To alleviate challenges that have been experienced in the transitional Round 1 and Round 2 OFTO tenders, as well as potential challenges for the Enduring Regime, generators could be provided with guidance on what investigations and assessments are required; how each of these should be undertaken; the order in which they should be executed and which documents should be provided to bidders.

Some of the component parts of this guidance already exist, particularly at a detailed level of specifying how investigations should be undertaken. The guidance provided to generators could incorporate or reference these documents, including;

- OSIG (SUT) Society for Underwater Technology "Guidance notes on site investigations for offshore renewable energy projects". This document defines a process flowchart for SI for offshore renewable energy projects and guidance on the geotechnical and geophysical surveys needed.
- Bundesamt für Seeschifffahrt und Hydrographie (BSH) Ground Investigation for Offshore Windfarms, 25/02/2008, provides technical guidance on the geotechnical and geophysical investigations needed at each stage
- NORSOK "Common Requirements - Marine Soil Investigation" gives guidance on offshore site investigation
- BERR Review of cable techniques and environmental effects applicable to the offshore windfarm industry, technical report, January 2008 provides guidance on the selection of the burial tools, both for technical feasibility and impact on the environment.
- For the substation platform, most of the survey stages are similar to that of the cable and intrusive investigation requirements, as well as design, are defined in codes such as;
- Det Norske Veritas DnV-OS-J101, October 2007 and Det Norske Veritas Classification notes 30.4, February 1992 give guidance on the design of foundations for offshore structures.
- API RP 2A WSD, Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms, December 2000 give guidance on the design of foundations for offshore structures.

Effect on windfarm delivery timescale and cost

Standard seabed survey guidance should not cause additional time or cost requirements to the generators that are currently following good industry practice. Some generators who have been extensively involved with transitional tenders have made some progress and tend to be aware of the surveys and studies that are required. With additional guidance, these generators will be more abreast of the relevant documents required by the OFTO.

Those generators which are not currently following good practice could benefit from reduced costs and timescales. This would be created by removing the need for repeated assessments and undertaking higher quality analysis. Providing standard seabed survey/study guidance could enable a smoother and more efficient process both for the generator and the OFTO.

4 | Tender specification

4.1 Significance

Under the OFTO build tender process, the bidders must be provided with a specification, which will state the requirements for the assets, against which they must bid.

To produce a fixed price bid, the bidder will have minimum requirements of what information is required during the ITT stage. This will include technical details of the proposed transmission assets and the relevant environmental and geotechnical information. Under a Generator build, the generator would produce the necessary information in a programmed aligned with the overall construction and delivery programme of the assets. The availability of information to facilitate the tender process under OFTO build therefore needs to be considered.

4.2 Objective

The criteria for the Tender Specification is that it both leads to the construction of technically appropriate assets and places the minimum possible constraints on the bidder/OFTO, so giving it the opportunity to introduce innovation and make design choices whilst allowing the bidder to provide a fixed price bid wherever possible. The objective of this study was to identify the requirements that could be included in the Tender Specification in order to ensure that the bidder/OFTO is able to meet these objectives and deliver assets that will be technically appropriate and within the limitations of the various consents and agreements.

Given the requirements that will be included in the tender specification, it was necessary to identify which information might not naturally be available during the ITT stage. This will ensure that a generator intending to follow the OFTO build approach could bring forward the required activities (if necessary) to ensure any required information is available.

4.3 Approach

To produce the tender specification the minimum requirements were identified from the Town and Country Planning Act (TCPA), Environmental Impact Assessment (EIA) and Bilateral Connection Agreement (BCA). This will ensure the constructed assets comply with all relevant consents and agreements (subject to any subsequent conditions attached to those consents). In addition, the minimum design information was identified that would be required to deliver technically appropriate transmission assets for the respective wind farm. For example the rating and number of turbines would be required to allow an OFTO to specify the required harmonic filtering equipment.

To understand the need for generators to bring forward specific activities to produce information required by the OFTO, the generic wind farm delivery programme was assessed to understand when key design decisions and definition of project parameters/requirements were required by. This was compared to our proposed OFTO tender timings, indicating when information may or may not be available.

4.4 Conclusion

The tables below provide a list of the requirements that would need to be included in the Tender Specification in order to ensure that the OFTO is able to deliver assets that will be technically appropriate and within the limitations of the various consents and agreements. With each requirement of the tender specification the source or the reason why it is required is referenced.

General Information

Information	Source/Reason for requirement
Planned windfarm delivery program (where interaction with transmission assets)	Windfarm delivery requirement
Required completion date	Windfarm delivery requirement
Number of platforms	EIA
Location of platforms	EIA
External details of platforms	EIA
Onshore substation location	Town and Country Planning Act application/ EIA
External details of onshore substation	Town and Country Planning Act application/ EIA
Details of transmission cable corridor (onshore and offshore)	EIA

Limitations from the EIA

Information	Source/Reason for requirement
Cable burial depth	EIA
Cable burial techniques	EIA
Heat production at sea	EIA
Drilling on landing	EIA
Visual impact from onshore substation and offshore platform	EIA
Onshore foundations	EIA
Offshore foundations	EIA

Electrical Design

Information	Source/Reason for requirement
Rating and number of turbines (range)	Needed for harmonic design
Number of cable arrays per platform (or capacity per platform)	Needed for platform design
Details of generator reactive support to be provided	Needed for reactive power design
Details of onshore and offshore interface points	Needed for general asset design
Voltage requirements at interface points	Needed for general asset design
Required TEC	BCA
Site specific specifications from BCA	BCA
Other technical requirements from BCA	BCA
Windfarm SCADA requirements	Needed for SCADA/ cable offshore design
Required service life of assets	Needed for general asset design
Ownership boundary of OFTO plant and apparatus at onshore substation	BCA
Anticipatory build requirements for further phases	Needed for general asset design
Cable crossing requirements (where available)	EIA/ Needed for cable installation assessment
Details of technical codes and standards to which assets must be built (Grid Code etc, structural, etc)	Needed for general asset design
Required life span of assets	Needed for general asset design
Onshore landing point	Town and Country Planning Act application/ EIA
Other requirements from the EIA including, working methods and material types	EIA

Information Timing

The assessment into the timing of the design information indicates that the key information which may not to be produced in time for the ITT stage of an OFTO build tender (according to the timetable proposed in Chapter 2) could be geotechnical and geophysical offshore information. This information will be used in the design of the offshore platforms, assessment of cable burial during installation and deburial over the life of the project.

5 | Permissions, consents, permits

5.1 Significance

The generator will be responsible for applying for the required consents and permissions for the transmission as well as the windfarm assets, under both the OFTO build and Generator build options under the Enduring Regime. Considering the proposed timings of the OFTO build tender process given in Chapter 2, the consent applications will be submitted at approximately the same time as the ITT stage commences and the OFTO Licence is likely to be granted after the main consents have been granted. Consequently, the OFTO will be responsible for delivering the transmission assets within conditions set by the consents.

The OFTO design and delivery will therefore be defined and limited by the consents and permits obtained by the generator.

5.2 Objective

Considering this relationship between consents and the generator, the objective of this element of the study was to outline the flexibility which exists within these consents and how this may impact the design and construction options available to the OFTO.

5.3 Approach

To define the impact of the consents on the OFTO the following information for each of the key consents, permits and agreements has been assessed;

- What makes each consent applicable to offshore transmission assets?
- What is the nature of the information requirement to obtain the consent. For example, how much detail is required about the planned designs or construction techniques?
- What is the anticipated stage during the windfarm (generation and transmission assets) delivery programme that the consent would be obtained? and
- What are the obligations and restrictions that are likely to be placed on the windfarm by the consent or agreement?

5.4 Conclusion

Offshore wind farms have complex consenting requirements as the assets are a combination of offshore and onshore developments as well as connecting electricity cables. The table below provides a summary of consents or agreements that are required for the development of the OWFs.

Consents or Agreements	Relevance
Marine Licence	Licence to undertake marine works, deposit or remove material from the seabed below Mean High Water Springs or in any tidal river to the extent of tidal influence.
Development Consent Order (DCO)	Planning permission for Nationally Significant Infrastructure Projects (NSIPs) eg. a Round 3 OWF.
Habitats Regulations Assessment (HRA)	Decision by a competent authority that a project will have no adverse effect on a European or Ramsar site either alone or in-combination with other plans or projects.
Section 36 Consent	Permission to construct and operate electricity generation assets.
Planning Permission	Planning permission for onshore infrastructure down to Mean Low Water.
Crown Estate Lease	Lease agreement that allows the development, construction and operation of an OWF in UK waters out to 200 nautical miles, the UK Continental Shelf Limit.
Port / Harbour Agreements	Agreement with a port / harbour authority to construct and operate OWF assets within the statutory limits of a port or harbour.
Crossing Agreements	Agreement with a third party to enable OWF cables to cross cables or gas pipes located on the seabed.
Wildlife Licence	Licence to undertake activities normally prohibited under wildlife legislation.

For many of the consents, an EIA resulting in the production of an Environmental Statement (ES) is the mechanism required to illustrate the environmental implications of constructing and operating a windfarm, and therefore is a key factor in obtaining the consents.

As the ES is the principal document used to define the basis of many of the consents, the level of design certainty required to complete an EIA can be considered as representative of the design certainty required to obtain consent. By defining limits on the environmental impact of the consented windfarm, the design is subsequently defined or constrained. For a windfarm EIA the 'Rochdale Envelope' approach may be applied. This requires that the generator assesses the likely envelope of environmental impacts, including the cautious worst case possible scenario, for each environmental receptor. The project will then be constructed such that the impacts remain within the defined envelope of predicted impacts.

For example, a generator may specify the maximum number of subsea transmission cables that will be installed in the ES and the consent will be obtained on this basis. If the completed windfarm has less than or equal to the maximum transmission cables, the windfarm will be within the requirements and conditions of the consents.

The following list provides examples of the limits allowed for when assessing environmental impacts, by applying the Rochdale Envelope;

- Location and maximum dimensions of the windfarm;
- Maximum number and locations of offshore platforms;
- Maximum cable burial depth and "worst case" installation techniques;
- Offshore cable corridor width and maximum number of cables; and
- Selection of substation foundation and foundation types.

This approach allows a generator to obtain consents prior to finalising the designs. They will, however, be restricted to the design parameter limits, and will be unable to implement designs that lead to potentially greater impacts, without the possibility that they may have to submit further ES documentation or submit a new application.

This leads to a compromise for the generator when undertaking the EIA. To ensure future flexibility, multiple designs and installation techniques can be assessed, so long as the worse-case scenario is evaluated. However, a larger and more flexible envelope can mean that undertaking the EIA is more expensive and time consuming as it must assess more possibilities and also risks the consent application being unsuccessful. If the assessment fails to meet the criteria expected of an ES by a consenting authority, it will increase the risk of consents not being granted on programme or at all.

Implications for OFTO build

It is proposed that the OFTO build ITT stage would start after the consent application documents have been submitted, and would finish after the consents have been granted. Therefore, assuming the OFTO does not re-apply for consent, the designs will be limited by those parameters and methods proposed in the ES.

Small design variations may be possible for an OFTO using the Not Environmentally Worst Than (NEWT) principle. If an OFTO could show that the impacts it was proposing were NEWT the impacts assessed by the generator's EIA, the consenting authority may not require a new or amended ES.

For the OFTO to implement material design changes outside of the limits proposed and assessed in the ES, a new or addendum ES would be required. This would be time consuming, costly, would require full consultation and may present difficulties in achieving consent during an OFTO build ITT period.

Consent Conditions

Many consents will be granted with construction or operational conditions. For example, the planning permission may require the production of traffic or noise management plans which must be followed during construction of the onshore asset; or a marine license may include the obligation to undertake seabed surveys for a certain period after construction has been completed.

Under the Transitional Regime, OFTOs are obliged to address operational conditions, such as sea bed monitoring. However, they are not involved in discharging construction conditions.

Onshore construction conditions are relevant to all large scale infrastructure projects. UK infrastructure projects are generally taken through the planning process then procured and delivered by a third party, such as a Design and Build contractor or a PFI consortium. As a result, major contracting organisations are used to discharging planning conditions and obligations prior to site works commencing. Therefore, an OFTO build bidder should be comfortable with inheriting consents and pricing the risk of dealing with the obligations.

Offshore construction conditions may also be required, generally from the Marine License. These will include requirements to produce schedules and methodologies for construction; undertake pre-construction environmental monitoring; and undertake construction within certain constraints. There will be consistency in the conditions associated with constructing offshore transmission assets. However, there may also be site specific conditions, such as those relating to environmental designations. As with the onshore conditions, major offshore contracting organisations will be experienced is discharging these conditions as required. Therefore, an OFTO build bidder with sufficient relevant experience should be comfortable in inheriting offshore consents.

6 | Supply chain

6.1 Significance

The supply chain, and in particular constraints within the supply chain, will have a significant impact on the cost and deliverability of offshore windfarms and their transmission links. The common understanding is that there are supply chain constraints in all of the key areas of Crown Estate Round 3 offshore windfarm developments.

6.2 Objective

The objectives for this aspect of the assignment were to;

- identify whether there are supply chain constraints and specifically for which elements;
- outline other suppliers worldwide who aren't currently participating in the UK/European market and for such suppliers summarise why they are not currently competing in the UK/European market and how they might be incentivised to participate in the UK/European market; and
- outline how constraint issues could be alleviated, and what, if anything, can be done to facilitate this.

6.3 Approach

The approach taken was to undertake a literature review of recently published material on the subject to make an assessment on supply chain constraints and the current thoughts on the approach to contracting and installation.

Assessments of supply chain constraints for offshore wind have been carried out by a number of organisations and consultancies, in particular in the period from 2007, including BWEA (now RenewableUK), BVG Associates, Douglas-Westwood, Ernst & Young, ODE Limited and UK Energy Research Centre. A list of references is provided. Most recently, the following have tended to be cited as key supply chain constraint risks for Round 3 offshore windfarms:

- Offshore wind turbines – in particular the supply of large wind turbines (6 MW upwards);
- Subsea export cables;
- High Voltage Direct Current Voltage Source Converters;
- Jacket installation vessels; and
- Ports and Harbours.

The contracting structures range from full EPC (Engineering, Procurement and Construction) contracts to a more multi-contractual approach. There is still debate in the industry as to the most efficient mechanism. However, whichever procurement route is chosen, offshore wind projects continue to represent highly complex development projects with supply chain constraints.

6.4 Conclusion

There are currently three main suppliers of offshore wind turbines: Siemens, Vestas and RePower (joint European market share of 100% in 2011). There is expected to be a shortage of supply of large wind turbines up to 2018 compared to the projected EU offshore wind market demand. The shortfall is expected to lead to either smaller wind turbines being specified (leading to higher costs per MW) or wind farm construction delays, as a result of;

- Higher costs and longer timescales for development, demonstration and verification required for larger turbines to be "bankable";
- Lack of customer and financial confidence in turbine reliability. Issues have historically been experienced with reliability, which will lead to a requirement for enhanced testing and verification, and therefore delays in product acceptance; and
- significant investment required in coastal manufacturing facilities for wind turbine manufacturers. Gamesa, Samsung, Siemens, Mitsubishi and Vestas have plans to develop UK facilities but these are subject to availability of sufficient contracts.

Converter Suppliers

There are a limited number of VSC-HVDC converter suppliers; ABB, Siemens, Alstom Grid and GE Energy Power Conversion. To date ABB and Siemens have systems installed onshore and offshore, Alstom Grid has a working prototype and an order (750 MW link in the USA expecting to be commissioned in late 2013) and GE Energy has a design. Constraints are envisaged as follows;

- due to the large investment required there is limited potential for new entrants to the market;
- each VSC-HVDC converter takes approximately 9 months to manufacture, hence production slots may need to be booked 3 or more years in advance; and
- in general, VSC-HVDC skills are less developed compared with HVAC skills, and it is generally difficult to recruit engineers with experience of HVDC converter and cable design.

Subsea Export Cable Suppliers

There are currently three established global suppliers of cross linked polyethene export cables; ABB, Nexans and Prysmian. Since 2009 there have been two new entrants; NKT and General Cable (NSW). JDR Cable Systems has also received development funding for subsea export cables.

The Crown Estate estimates that 3000km of High-Voltage Alternating Current (HVAC) and 4700km of High-Voltage Direct Current (HVDC) cables will be required for Round 3 projects. It concluded that when Round 3 construction begins in 2016 there may be a significant cable shortage unless further investment in new capacity is made. Between 2006 and 2007 the lead time for cable supply increased to 18-24 months and setting up a new facility can take up to 4 years and type testing and certifying new cable takes up to 2 years. Manufacturers located in the Far East could be used but this may be expensive in terms of transportation costs and could lead to delays.

ABB, Prysmian and Nexans are the dominant suppliers in the HVDC cable market. A number of non-European manufacturers are capable of meeting the requirements (such as J-Power Systems and Viscas Corporation) but again the distance to the factory is significant and they may find operating in the UK difficult.

Vessel Supply

The critical issue around the vessel supply chain appears to be availability of suitable vessels. As it takes 2 years to build a vessel, by the time offshore wind projects are consented it may be too late to increase vessel capacity.

Installation solutions that can be used at scale have not yet been demonstrated and vessels chosen for installation to date have not been optimal with large semi-submersible vessels being costly. Sheerleg cranes are unable to work in conditions with wave heights over 0.75 m and are therefore unsuitable for large projects further from shore. Dynamically positioned heavy lift vessels are generally over-specified with regard to crane capacity, limited in terms of deck area and have day rates up to 50% higher than a comparably sized jack-up. Purpose designed vessels for installing jackets may be more cost-effective (up to 20% cheaper than current best option), however new investment is needed and current constraint is likely to impact on projects. A 500 MW AC topside will weigh approximately 1,400 tonnes and the substructure will weigh approximately 750 tonnes. There are four dedicated installation vessels in Europe that can lift these: SHL “Stanislav Udin” and “Oleg Strashnov”, Saipem “S7000” and Hareema “Thialf”. There are a further six dedicated vessels around the world that could lift a substation, but these vessels do not currently work in Europe. They do not tender for European work as they are established in other parts of the world. There are four other vessels that are adequate but not appropriate in many weather conditions and hence can add considerably to project risks.

Many transport and installation vessels are adapted from the oil and gas industry, which means they are generally not optimised for offshore wind. Due to higher oil and gas margins, they are also often only available at high charter rates.

There is a shortage of cable laying vessels with the three major European cable manufactures only having access to one large vessel each.

Entry of low cost players such as China, South Korea and India may have an impact as their costs are lower than those of European players – in particular labour costs and in some cases lower cost raw materials and/ or finance costs.

Offshore Wind Turbine Manufacturers

The Crown Estate predicts that the European offshore wind turbine market will support a minimum of six competitors by 2020, with two of these predicted to have a significant cost base in low cost countries.

Five new entrants from low cost countries have or have planned offshore wind turbine demonstrations: Mitsubishi (MPSE), Samsung HI, Sinovel, Goldwind and XMEC Darwind. Whilst low cost manufacturers can demonstrate lower overall wind turbine costs (for example Sinovel wind turbines are 10% cheaper compared with European wind turbines), high transport costs can offset much of this saving. However there is precedence with Sinovel having exported onshore wind turbines to Brazil.

Whilst ten countries have announced interest in investing in offshore wind manufacturing facilities in Europe, including some from low cost countries, it is unlikely that many of these will actually invest. Investment in new wind turbine facilities in Europe is still likely to be dominated by European players; however wind turbine suppliers are starting to source components from low cost countries. Many of these components can be shipped more easily than assembled wind turbines and low cost components help to drive down the costs of European-produced turbines. For example, Vestas produces bedplates and generators in China in addition to Europe.

The Crown Estate predicts that increased competition will reduce wind turbine prices by 15% by 2020 compared with 2011 prices and will reduce support structure prices by 7% by 2020 compared with 2011.

Should supply constraints not be met by new players then new technology or a combination of both may be the answer. For example, floating wind turbine foundations are being developed and designed suitable for wind turbines up to 8MW. These turbines would alleviate installation vessel constraints by using more widely available and smaller TUG vessels in their installation process and would decrease installation times as they are less weather dependent. Using concrete rather than steel would reduce maintenance requirements and therefore number of crew vessels.

The use of self installing platforms overcomes some of the challenges of substation installation by removing the requirement for heavy lifting vessels (and therefore reduces cost of heavy lifting vessels and supply chain constraints) increasing the weather window available for installation and hence reducing the risks.

Suitable port facilities in the UK are limited. They are also seen as more expensive than most mainland European ports and lack facilities and space required for offshore wind. In 2010, the government announced a £60m investment in port facilities to attract turbine manufacturers to the UK; however, this investment is currently on hold.

Contracting Strategy

Contracting strategy is expected to have an impact on supply chain constraints, but as yet with offshore wind being a relatively young industry there is still debate as to whether the EPC or multi-contractor approach is optimal.

The EPC approach reduces the interfaces and complexity of the project, but one study has shown that EPC contracts may be 20% more expensive than multi-contractor projects due to the risks that must be borne by the EPC contractor.

A developer following a multi-contractor approach may have to control over 300 direct supplier contracts. The benefit of this approach is that it may enable parallel installation of multiple windfarms, so reducing the delivery schedule.

7 | Phased projects

7.1 Significance

To date the Transitional Regime has involved relatively small projects with simple designs (eg. point to point radial connections to a windfarm constructed in a single phase of development). Many Enduring Regime projects, due to their size and complexity, are likely to be constructed in phases and/or stages and consequently the Enduring Regime will need to consider the impact of a phased build. In the December 2011 Consultation Document, Ofgem defined the following terms;

- **Site/ zone -** the transmission assets within a site or zone licensed by the Crown Estate;
- **Phase -** a grouping of transmission assets to be built out over a period of time, where the grouping is defined by certainty on build out, eg. Final Investment Decision and/or key contractual commitments. A phase may include stages;
- **Stage -** transmission assets built out incrementally in a discrete group within a phase.

In the same document Ofgem proposed, for phased projects, running a separate tender exercise for each committed phase within a site/zone with the intention to ensure an ongoing competitive process for determining an OFTO, with each tender exercise attracting favourable funding terms and best value bids.

7.2 Objective

The objective of this section of the study was;

- to evaluate how a range of both technical and design factors might impact on different types of future projects under the range of different build options; and
- how this impacts on providing the best value to consumers through the competitive tender process.

Technical Factors	Project Design Factors
The degree to which the same OFTO entity across all phases could realise economies of scale	Whether the project is staged or phased
Need for additional isolation & switching equipment if a separate OFTO is appointed for each phase	The relative degree of certainty that a future phase will go ahead (taking into account FIDs, placing contracts, submitting consents)
Health & safety/access considerations (eg. to a port, to boats) across separate OFTOs for each phase	Degree to which stages or phases are electrically separate
To what extent there is a need to obtain multiple consents and property rights for each phase	The time period between construction and operation of phases.

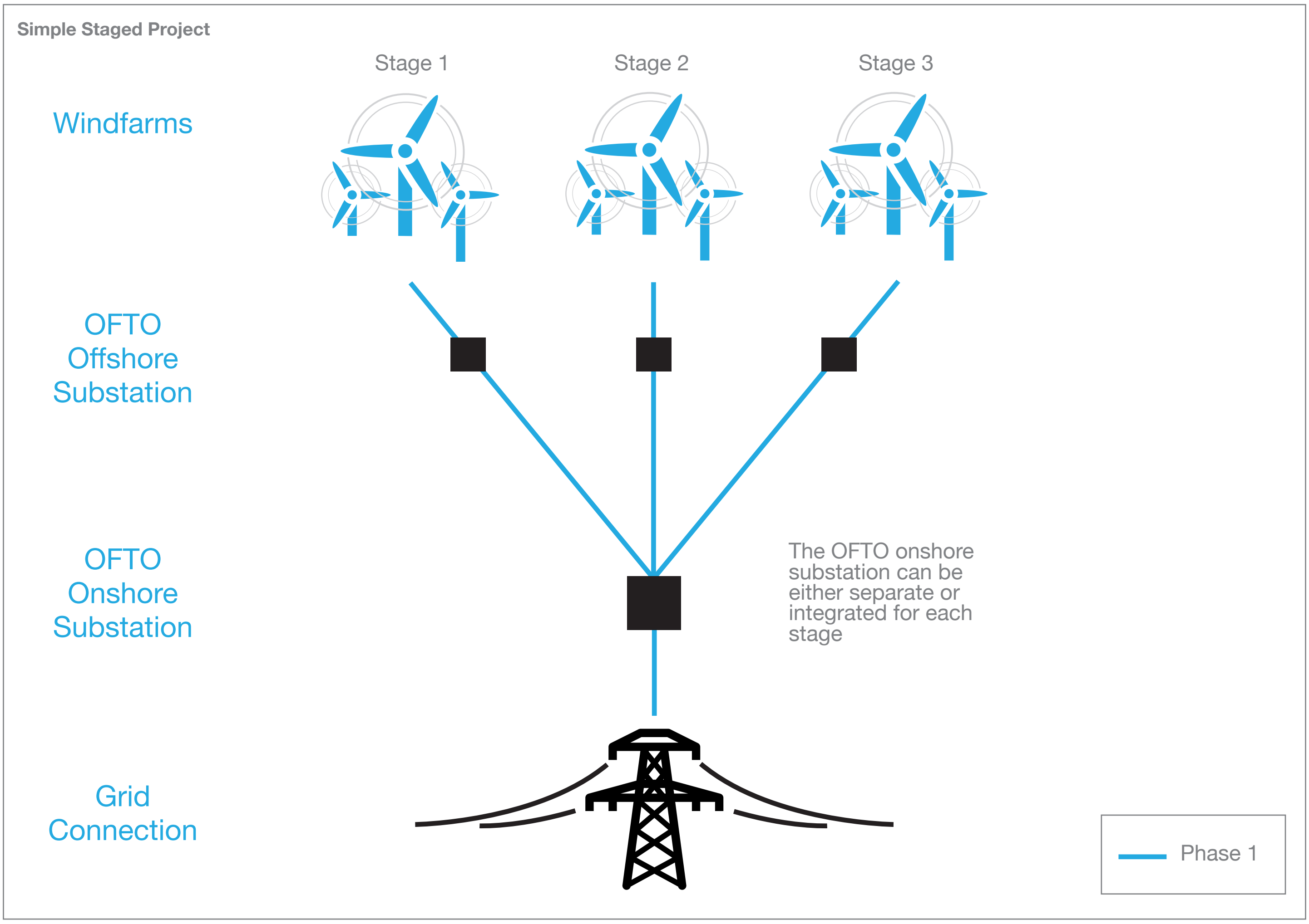


Figure 2 - Simple Staged Project

7.3 Approach

The approach adopted was to assess the factors against a range of different types of future projects; 'simple' staged, 'simple' phased, and 'integrated' phased, for a range of different build options;

- Generator build, where a single generator builds the assets across all phases;
- OFTO build, where potentially multiple OFTOs might build the assets across all phases; or
- using a mixture of build options across different phases.

Simple Staged Project

A simple staged project is assumed to consist of one phase built in one or more stages. Multiple offshore platforms would be utilised connected to one point onshore.

Simple Phased Project

The simple phased project would consist of multiple phases each with one or more stages but connected to a single onshore point of connection.

Integrated Phased Project

The integrated phased project would consist of multiple phases each with one or more stages. Phases would be connected together both onshore and offshore with the possibility of multiple onshore connection points.

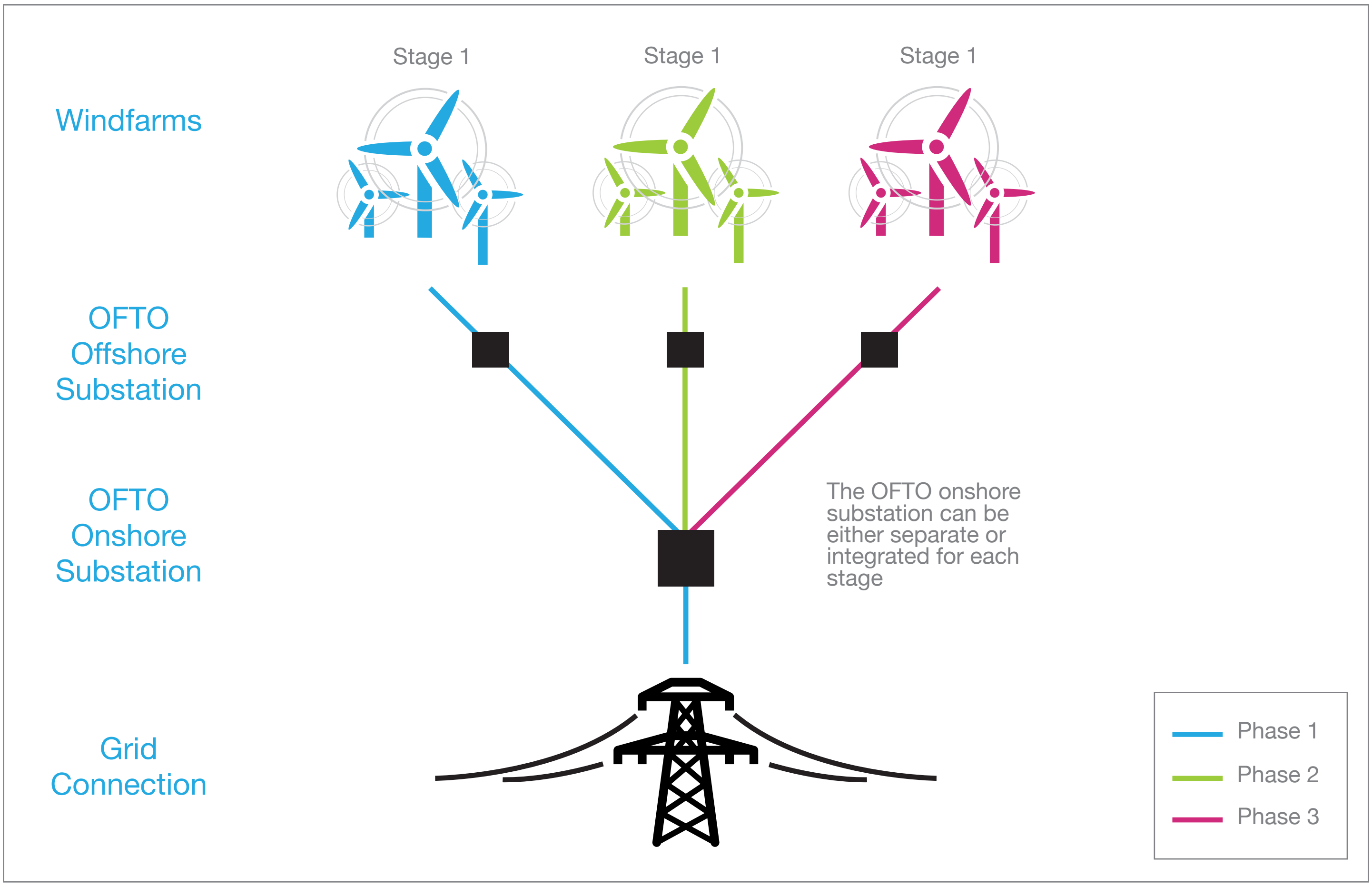


Figure 3 - Simple Phased Project

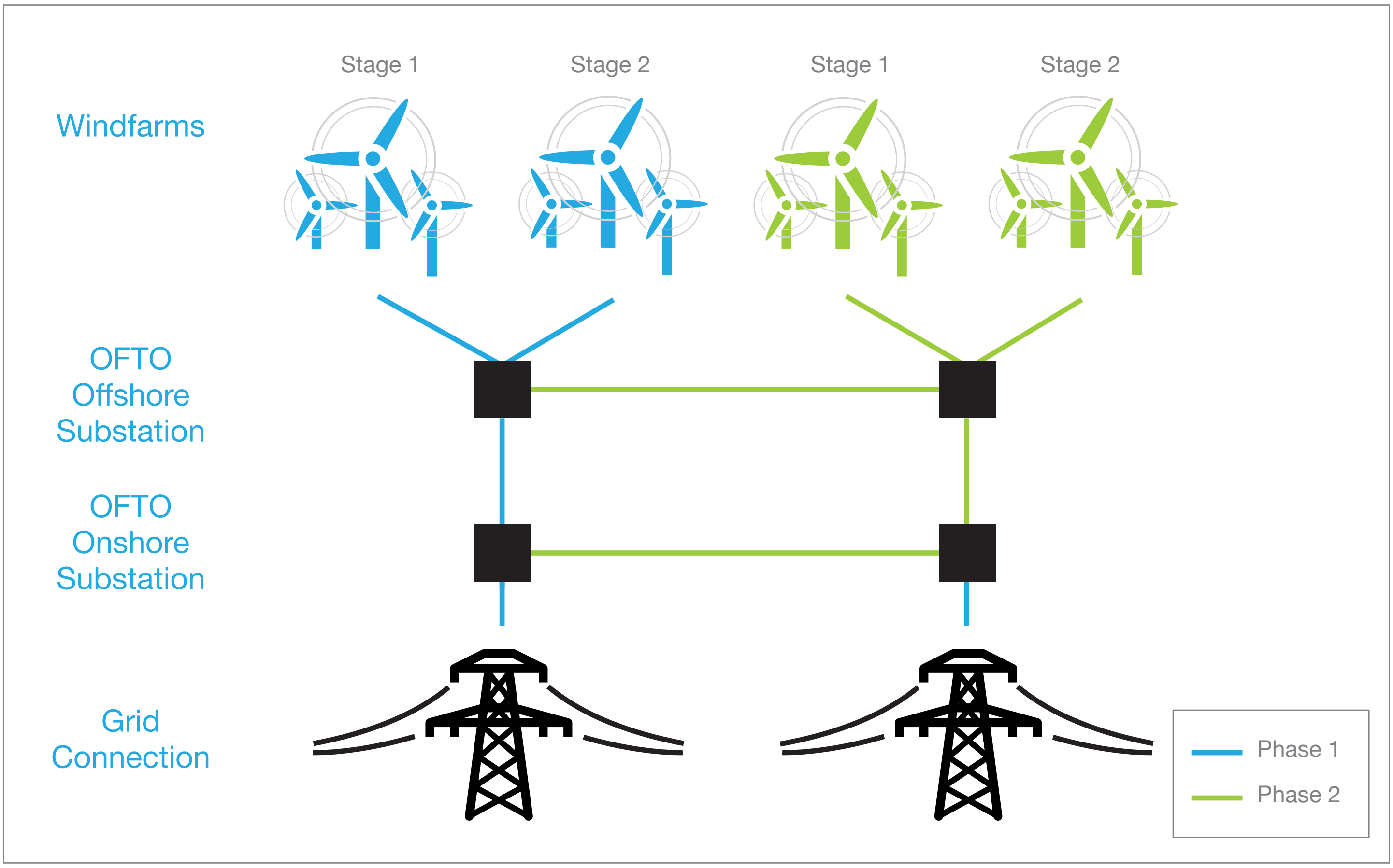


Figure 4 - Integrated Phased Projects

7.4 Conclusion

Economies of Scale

Economies of scale are unlikely to be the main driver for designing future phases. Capital cost and hence purchasing power and financing are likely to be bigger factors. A common design, whilst having the possibilities of economies as a secondary benefit, primarily reduces risk and therefore delays.

A single OFTO across all phases to some degree may realise economies of scale under OFTO build where multiple OFTOs could not; however, this is potentially reduced by uncertainty on the need for and/or design of future phases at the point at which earlier phases are being taken forward. This is largely dependent on the size of the windfarm, the certainty of future phases and their timing. Relatively small savings may be achieved due to the market power held by manufacturers over the OFTOs.

Interface Management

Issues surrounding operation, construction and the need or otherwise for additional isolation, on health and safety grounds, are expected to be ones of interface management.

Irrespective of project type it is not envisaged that additional isolation will be required where there is a tender for each phase above what is required for the safe operation of the system. Multiple OFTOs will mean multiple interfaces with the likelihood of common assets. Common assets present additional challenges such as agreeing responsibility for these assets and ensuring any availability incentive is fit for purpose. Some of these challenges could be managed through commercial negotiations between OFTO parties.

Operational risk would increase in proportion to the number of parties involved. However the risk exists even with a single OFTO as co-ordination and co-operation with the generator would still be required. Interface issues with all but the most complex designs are generally likely to be limited to the onshore substation.

Design

The design of the electrical transmission system will ultimately be governed by the generator's needs and grid connection requirement. National Electricity Transmission System Security and Supply Standards (NETS SQSS) will remain an important baseline for ensuring adequate and efficient design.

The design will be a single integrated solution irrespective of final ownership, so significant additional equipment or design change is not envisaged should one or more OFTOs be involved. Interface issues would predominantly be a matter of commercial agreement and operational procedure in a similar way to those which currently exist between an OFTO, generator and NGET.

Multiple phases on a single windfarm could require significant anticipatory build, such as the grid interface, for the first phase. This would have to be planned at a high level by the generator during concept design prior to OFTO involvement. This approach could be similar under Generator build or OFTO build.

The inclusion of a grid interface within the ownership of a single OFTO does impact how the availability mechanism might be imposed on the OFTO. Further consideration of how the availability incentive would operate is required.

Port Constraints

Under OFTO build tenders for each phase, issues may exist in the port due to space constraints specifically during construction. Studies will have been undertaken as part of consenting to confirm that the construction programme is achievable but this would be based on Generator build. This could become more complicated under OFTO build if co-ordination across OFTOs would be required. However, generator movements are likely to outweigh those required by the OFTO.

Consents

To date consenting for the transitional projects has followed a fairly consistent pattern and there is no reason why this couldn't work for phased projects under the Enduring Regime. The legal mechanisms used to pass the obligations to multiple OFTOs may become more complicated, but it should still be possible. As many of the consents cover both the generation and transmission assets, to date the generator has retained these, but passed obligations to OFTOs in the Transfer Agreement under the Transitional Regime. Property rights are similar, under the Transitional Regime, the generator generally retains ownership of the land the substation is built on, which is then leased to the OFTO. In such a case the OFTO generally owns the buildings that are built on the land and has responsibility for their decommissioning. For multiple OFTOs, different parts of the substation could be leased to the different OFTOs and areas which are shared could remain operated as well as owned by the generator. Preparation of standard consents and property rights agreements, or specifications may alleviate some of these issues.

Timing

When considering project design factors it was considered that staged construction is due largely to seasonal constraints on installation, consent conditions and sheer weight of numbers of turbines. The number of turbines that can be installed in any one year is limited by manufacturing capability, storage, laydown areas and vessels. As stages generally relate to the construction programme electrical separation is not a priority.

For phased projects, the construction timing can result in the need for greater resources over a limited period, which would to a degree be further complicated by the appointment of multiple OFTOs under OFTO build. The shorter the time period between construction and operation of phases, the more traffic movements on site and the greater the port requirements. However the OFTO scope of work is much smaller than that of the generator, and thus overall co-ordination is not be expected to be a significant issue.

The below tables summarise the above conclusions according to their impact on the type of project and the technical and project design factors.

Technical Factors

Factor	Simple Staged	Simple Phased	Integrated Phased
The degree to which a single OFTO entity could realise economies of scale	- Medium chance of economies of scale being realised under OFTO build, but subject to certainty and construction timetable - Actual saving are unlikely to be significant compared to total expenditure	- Medium chance of economies of scale being realised under OFTO build, but subject to certainty and construction timetable - Actual saving are unlikely to be significant compared to total expenditure	- High chance of economies of scale being realised under OFTO build, but subject to certainty and construction timetable - Actual saving are unlikely to be significant compared to total expenditure
Need for additional isolation and switching equipment if separate OFTOs are appointed	- None expected	- None required, but may be desired to have separate operational facilities	- None required, but may be desired to have separate operational facilities
Health & safety/access considerations across multiple OFTOs	- Low overall - Separate system offshore and onshore - Higher probability of O&M being port based	- Medium overall - Separate system offshore with common onshore substation - Higher probability of O&M being offshore based and hence Health and Safety risk within ports is lower	- Medium overall - Large windfarms with high traffic movement require increased co-ordination. Shared assets will be both onshore and offshore making operation more complex - The scale of the windfarm makes generator O&M likely to be offshore reducing port access issues
To what extent is there a need to obtain multiple consents and property rights	- Low - Single consent for whole project	- Low - Single consent for whole project likely	- Low - Phases consented separately

Project Design Factors

Factor	Simple Staged	Simple Phased	Integrated Phased
Staged or Phased Project	- No Impact	- No Impact	- No Impact
Degree of certainty of phases	- Uncertain though likely to be consented as a single project	- Uncertain	- Uncertain. Individual phases likely to consented on a phase by phase basis
Electrical separation	- Very high level of separation - Independent offshore and onshore assets	- High level of separation - Independent offshore asset connected at a single onshore substation	- Medium level of separation - Possible multiple connection points onshore and offshore
Time period between construction of phases	- N/A	- No variation between build options. Timing of phases will be a financial decision - Economies of scale achieved may be greater with shorter gaps between phases - Greater need for multiple consents with longer gaps between phases to allow for design flexibility	- No variation between build options. Timing of phases will be a financial decision - Economies of scale achieved may be greater with shorter gaps between phases - Greater need for multiple consents with longer gaps between phases to allow for design flexibility

8 | Construction risks

8.1 Significance

There are a significant number of delivery risks associated with the construction of an OFTO transmission asset. Consequently bidders under OFTO build are likely to price in contingencies for the residual risks and consideration needs to be given to the value of these contingencies to the consumer. The contingencies will be largely driven by the quality of information provided to bidders and the competitive tension of the bidding process (which should incentivise the level of contingencies to be maintained at an appropriate level). For risks which cannot reasonably be managed by the OFTO, or their contractors, the use of OFTO licence solutions to transfer some of the balance of the risk to the generator or to all users of the transmission network is an alternative possibility to be considered.

8.2 Objective

Our objective was to identify and summarise the key construction risks involved in the delivery of offshore transmission assets, and the means by which these risks are typically managed or mitigated by the generator through project planning, contract and procurement strategy, contingencies etc.

In consideration of the OFTO build option and the responsibility of the OFTO to construct and deliver the transmission assets, the objective was also to consider the appropriateness of the OFTO to retain some or all of the risk.

8.3 Approach

Construction risks were been divided into the following categories;

- Offshore Platform – Structure and Foundations
- Offshore Platform – Topside and Electrical Components
- Export Cable
- Onshore Substation
- Other General Construction risks
- Other Commercial/Financial risks

Under each of the above categories the key risks were identified and the means by which these risks are typically managed or mitigated by the developer were summarised. Finally, consideration was given to the appropriateness of the OFTO or the consumer to retain some or all of the risk.

8.4 Conclusion

In general, it is concluded that the majority of the procurement risks should sit with the OFTO under OFTO build, in order to ensure that the OFTO is incentivised to manage the risk in an effective manner. Similarly it is also concluded that for construction risks the interface between employer (whether it be the generator or OFTO) and the contractor should remain largely unchanged. The risks should lie with the party best able to manage that risk.

However, there are some risks, which considering their nature are difficult to manage either by the OFTO or contractor, and risk allocation options merit further consideration for the benefit of the consumer. These are discussed below;

Geotechnical Risk

Under an OFTO build, OFTOs are likely to be provided with geotechnical and geophysical information by the generator prior to bidding, along with a cable risk assessment. Due to the potential for variability of ground conditions, OFTOs may price in contingencies for the risk of problematic installation. The degree to which this happens will vary with the level of confidence the OFTO has in the geotechnical information and the bidding approach or risk appetite of the OFTO.

A full pass through of contract overruns under the OFTO licence may not incentivise the OFTO to procure and negotiate the contract appropriately and optimise pass through of risk to the contractor. Conversely, full allocation of risk to the OFTO, with the corresponding contingencies, may not represent best value for the consumer. Further work should therefore consider the possibility of developing a mechanism by which partial risk transfer, supported by a transparent approach to contingencies, can be adopted for geotechnical risks.

Weather risk

The variability of weather conditions means that the associated risk is likely to be priced into OFTO bids to varying degrees. If the cost associated with weather downtime was passed through, the price of bids would likely be reduced; however the OFTO would lose the incentive to manage the risk appropriately. OFTOs retaining an element of this risk would ensure that weather conditions are more efficiently utilised. Further work should therefore consider the possibility of developing a mechanism by which partial risk transfer, supported by a transparent approach to contingencies, can be adopted for weather risks.

Metal and Commodity Price Risk

Within the industry it is common for suppliers to pass price risk for precious metals and other commodities onto the customer. The OFTO would therefore be subject to this risk, which is largely outside their control and for which the required level of contingencies within the OFTO bid may not represent value of money to the consumer. For this reason there may be merit in undertaking further work to determine how specific commodity price risks are managed during the OFTO tender process.

9 | Lifespan

9.1 Significance

The lifespan, or useful life, of the transmission and windfarm assets has implications for OFTOs, generators and Ofgem. For an OFTO or generator, knowing the useful life of the assets allows replacement times and costs to be estimated. For Ofgem, the useful lives of the assets are a significant variable in determining the length of the OFTO revenue term.

Under the Transitional Regime the length of an OFTO's revenue stream is 20 years. The projects under the Enduring Regime will have differing characteristics; the assets are likely to be significantly larger and more integrated; there are likely to be technical developments, such as the implementation of HVDC links; and under an OFTO build the assets will not be constructed by the Developer.

9.2 Objective

The objective of this section is to provide an indication of the lifespan of the different components within an offshore windfarm and how assets work together to give an overall asset lifespan. It relates to transmission assets that are the primary export link between a windfarm and the onshore grid. This technical information will feed into Ofgem's analysis of an appropriate revenue term for Enduring Regime projects.

9.3 Approach

We assessed the likely lifespan of transmission assets and have provided details on the useful life of the different components that make up transmission and windfarm assets.

The useful life of the windfarm assets have also been considered as this influences whether the transmission assets will be utilised for the full period of their useful life.

9.4 Conclusion

The useful lives of the transmission assets and windfarm assets have been considered separately.

Transmission assets

The cable is designed with a nominal asset life of 40 years. Its actual operational life will be dependent on the running temperature in consideration of the design temperature of 90°C. An approximate rule of thumb is that for every 10°C of variation above the 90°C, the operational life will be halved. Conversely, DTS measurement and operational experience currently indicate that the cables are generally operating below their design considerations and are likely to have a life in excess of 40 years. Appropriate installation and regular inspection is a key aspect to ensuring a reliable and adequate life. An area that may require further consideration is the potential risk of mechanical failure, such as the J tube entry which may be designed for a 20 year life. However, this can generally be mitigated by a change in design requirements, or cable protection measures such as rock dumping. Increasing the revenue term beyond 20 years is therefore not likely to be limited by the cable life and should not lead to a significant change in operational assumptions and overall risk profile.

The offshore platforms are generally designed with a fatigue life greater than 25 years. However, some monopiles to date have been designed with a fatigue life of 20 years. Offshore jackets in the oil and gas industry have been operating for up to 60 years with frequent inspection, crack monitoring and remedial works where necessary. Given the greater redundancy in some jackets it should be more achievable to extend the life of the jackets beyond 20 years compared to extending the life of monopiles. However, given the relatively low levels of dynamic loading and overturning moments on the substation in comparison to the turbine monopole, an extension of the asset life is likely to be more feasible on the substation rather than the turbines. This would need to be supported by frequent inspections and remedial works for any cracks before they propagate, which would lead to increased operational costs and may have implications to the viability of operating the assets beyond 20 years.

The high voltage electrical equipment is generally designed for an operational life greater than 20 years.

Therefore, an increase to the OFTO revenue term will be unlikely to lead to changes in design specification. The same equipment would be provided and any component failures during the life of the OFTO would simply be replaced. Transformers deteriorate over time based on operating at normal full load temperature. Operating them above full load would cause the insulation to deteriorate more quickly and thus reduce the lifespan of the transformer (50% for every 6C above normal). Operating below full load tends to extend their lifespan though repeated cyclic loading can reduce life through mechanical movements in the windings due to thermal changes. Distribution transformers, which generally operate at low load (less than 50% rating), have been in operation for in excess of 60 years. It would be expected that offshore transformers, which spend most of their time below full load, would also last for greater than 40 years even with a design life of 20 to 25 years. Installation conditions such as wave-related vibration, humidity and the saline environment may have impacts on the life-time, and good routine maintenance is essential to ensure a long design life.

Experience in the electricity industry suggests switchgear will remain operational for well above 40 years providing it is maintained. Power stations still utilise original switchgear from the 1960's. As a general rule circuit breakers are infrequently operated and thus are under no stress. Moving parts can be lubricated and insulation in the form of gas replenished/ replaced. Correct maintenance procedures should be able to detect premature failures and replace parts before they fail in operation.

Onshore reactive compensation equipment such as SVCs, Statcoms and Reactors are standard power system equipment installed within normal environmental and installation conditions. These are generally designed for operational lives in excess of 20 years, and consist of a number of smaller components. The provision of spare parts across the entire life-time may be an issue for some of the controllers and power electronics.

HVDC links for offshore windfarms contain a significant number of small components such as controllers, power electronics and DC capacitors, in addition to the prime components of cables, transformers and switchgear. These are individually more maintainable than the larger single units, however a suitable spare parts strategy will be required in the event that the original equipment manufacturers cannot guarantee equivalent part availability across the entire lifetime. Finally, there are a number of auxiliary components/ systems with a component life of 20 years or less against which bidders are likely to include a lifecycle cost to allow for replacement. Any increase in the revenue term should therefore lead to a corresponding increase in the lifecycle fund. For example, increasing the revenue term beyond 20 years would result in SCADA hardware becoming a lifecycle item.

Windfarm assets

Modern wind turbines are typically designed to work for 120,000 hours throughout their estimated life-span of 20 years. This equates to the turbine operating for approximately 66% of the time for two decades. It is possible that the windfarm assets will operate past the planned 20 year life, but this requires load patterns to be within the expected limits and appropriate maintenance regimes to be applied. Confirming that windfarm assets will operate beyond 20 years will require asset inspections after a significant period of operation, particularly for rotating equipment. Consequently, at this point in time, there is uncertainty around the likelihood of windfarm assets operating beyond 20 years.

Wind turbines contain many of the same major electrical components as the transmission equipment, such as transformers, converters and medium-voltage cables. Therefore, these will have similar asset life characteristics regardless of revenue term. The same equipment would be provided and any component failures would be rectified where economically viable. The working lives of these components will vary with the load profile during operation and maintenance regime, but it is expected that many of these components could operate beyond 20 years.

The least reliable components in a wind turbine are typically rotating parts such as gearboxes, bearings, shafts and rotor hubs. It is these components that are most likely to be the limiting factor in the life expectancy of a wind turbine. The lifespan of these assets will depend largely on operational load profiles and their maintenance regime. Due to the relative immaturity of the offshore wind industry, there is not enough operational information to state that an offshore wind turbine will operate beyond 20 years, although this may be possible.

The asset life of a turbine could be impacted by the ability or willingness of manufactures to support equipment operating over its planned asset life. It is possible that the required components may not be available when certain rotating parts start to reach the end of their useful lives. While some components may be technically replaceable, they may not be economical to do so towards the end of the project lifetime if high cost heavy lift vessels are required for the repair.

The wind turbine blades and towers are generally designed to specific fatigue loads and, consequently, life expectancy. At present it is not clear what additional inspection, repair and replacement options are available, and whether these would be cost effective towards the end of the project life.

The foundations and offshore structures used by wind turbines are similar to those used in the transmission assets; they have generally been designed for between 20 years to 25 years. However, due to the greater overturning moments produced by turbines, there will be significantly less redundancy. Consequently, it is anticipated that turbine foundations and structures would have a lower likelihood of exceeding their design lives. Under the Enduring Regime, it is expected that design lives will be 25 years or longer. Those assets with lower design lives would require frequent inspection to confirm their ability to operate past this point. Turbines that required grouting remediation are the least likely to exceed their design life.

Useful Life summary

Given the correct maintenance regime and loading profiles, it is possible that both the transmission and windfarm assets could operate beyond the current OFTO revenue term of 20 years. However, at this point in the development of offshore windfarms there is also uncertainty regarding the influence of the specific environmental and installation conditions of the assets.

It is anticipated that the electrical components, cables, structures and foundations would have a high chance of operating past the current OFTO project life. Whereas the rotating components of windfarms are expected to be the most likely to have shorter life expectancy, or greater repair and replacement requirements. Ultimately the lifetime of the windfarms will be governed by a combination of technical repair options, and the economic cost of repair.

Were the OFTO revenue term to be extended the probability of a failure event would be theoretically higher during the life of the project. A change in the asset life may therefore lead to a potential change in bidding assumptions on component failure and increased maintenance during the latter years.

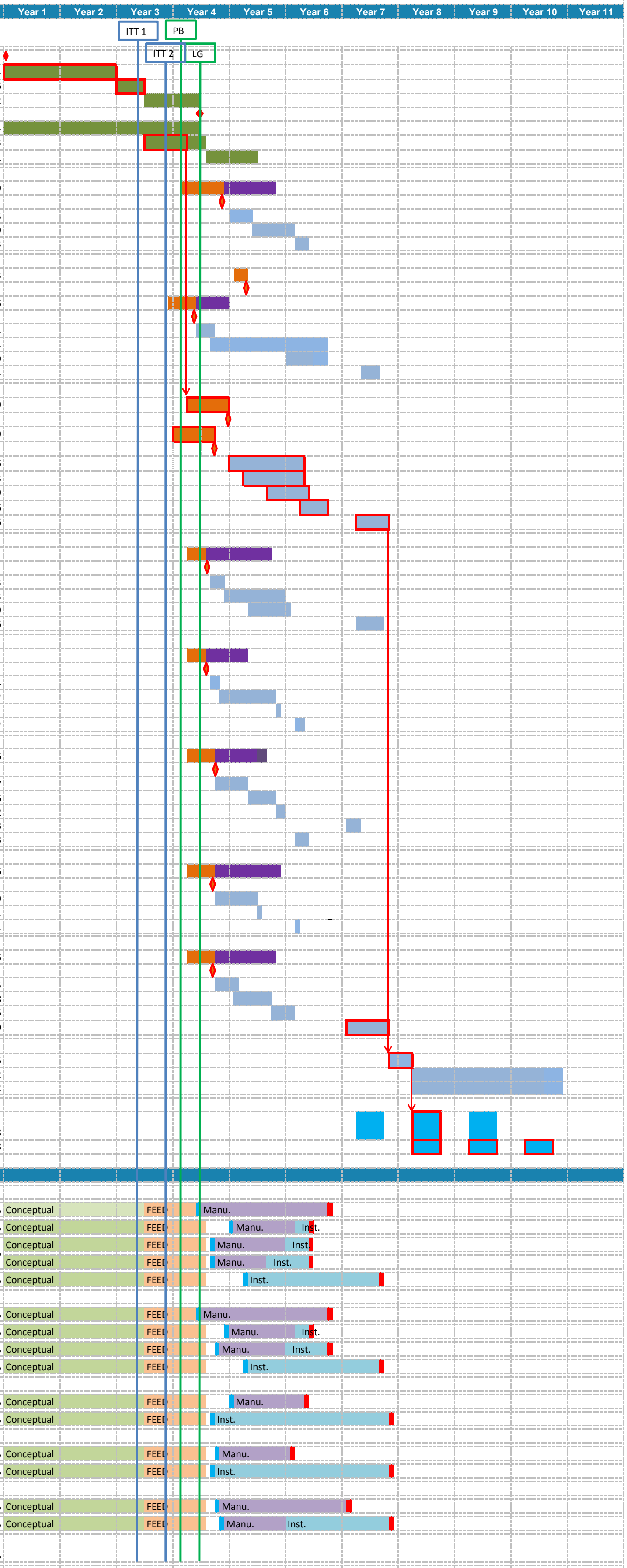
In summary, a relatively small extension to the OFTO revenue term is not likely to exceed the operational life of the system and prime components of the transmission assets. However, due to the uncertainty associated with the lifespan of wind turbines, extending the OFTO project life beyond 20 years may create a situation where the OFTO revenue term may exceed the technical or economic operational life of the windfarm assets. If this situation occurred, it may not represent value to consumers as an OFTO would receive revenue after operation of the windfarm has ceased.

Appendix 4 gives more details on the asset lifes of different components that constitute the transmission and generation assets within a windfarm.

Appendix 1 | Early FEED delivery programs

1A - Early Feed - LG at consent grant

The UK Offshore Windfarm Development Process



	Duration
Site Allocation	
Environmental Impact Assessment	24
Environmental Statement	6
Consent Application	12
Investment Decision	
Conceptual Design Phase	4
FEED	13
Detailed design	11
Platform Base Frame (HVAC and HVDC)	
ITT	9
Contract Award	
Design	5
Production	9
Installation	3
Platform Topside (HVAC and HVDC)	
Topside Installer ITT	3
Topside Installer Contract Award	
Topside Structure ITT	6
Topside Structure Contract Award	
Design	4
Production	24
Install equipement	9
Installation	4
DC Cables	
Manufacturer ITT	9
Manufacturer Contract Award	
Cable Installation Supplier ITT	9
Cable Installation Contract Award	
Design	16
Manufacture	13
Shipping	9
Offshore Installation (Campaign 1)	6
Offshore Installation (Campaign 2)	6
AC Cables	
ITT	4
Contract Award	
Design	3
Manufacture	13
Shipping	9
Installation	6
Transformers (Onshore and Offshore)	
ITT	
Contract Award	
Design	4
Manufacture	12
Shipping	1
Installation	2
Convertors (Onshore and Offshore)	
ITT	6
Contract Award	
Design	7
Manufacture	6
Shipping	2
Onshore Installation	3
Offshore Installation	3
Switchgear (Onshore and Offshore)	
ITT	6
Contract Award	
Manufacture	9
Shipping	1
Installation	1
Onshore Substation	
ITT	6
Contract Award	
Design (Elec)	5
Design (Civil)	8
Const. (Civil)	5
Equip. Installation	9
Commissioning and Handover	
Energisation	5
Compliance Testing	32
Performance Testing	32
Windturbines	
Install templates and piles	18
Install and hookup WTGs	18

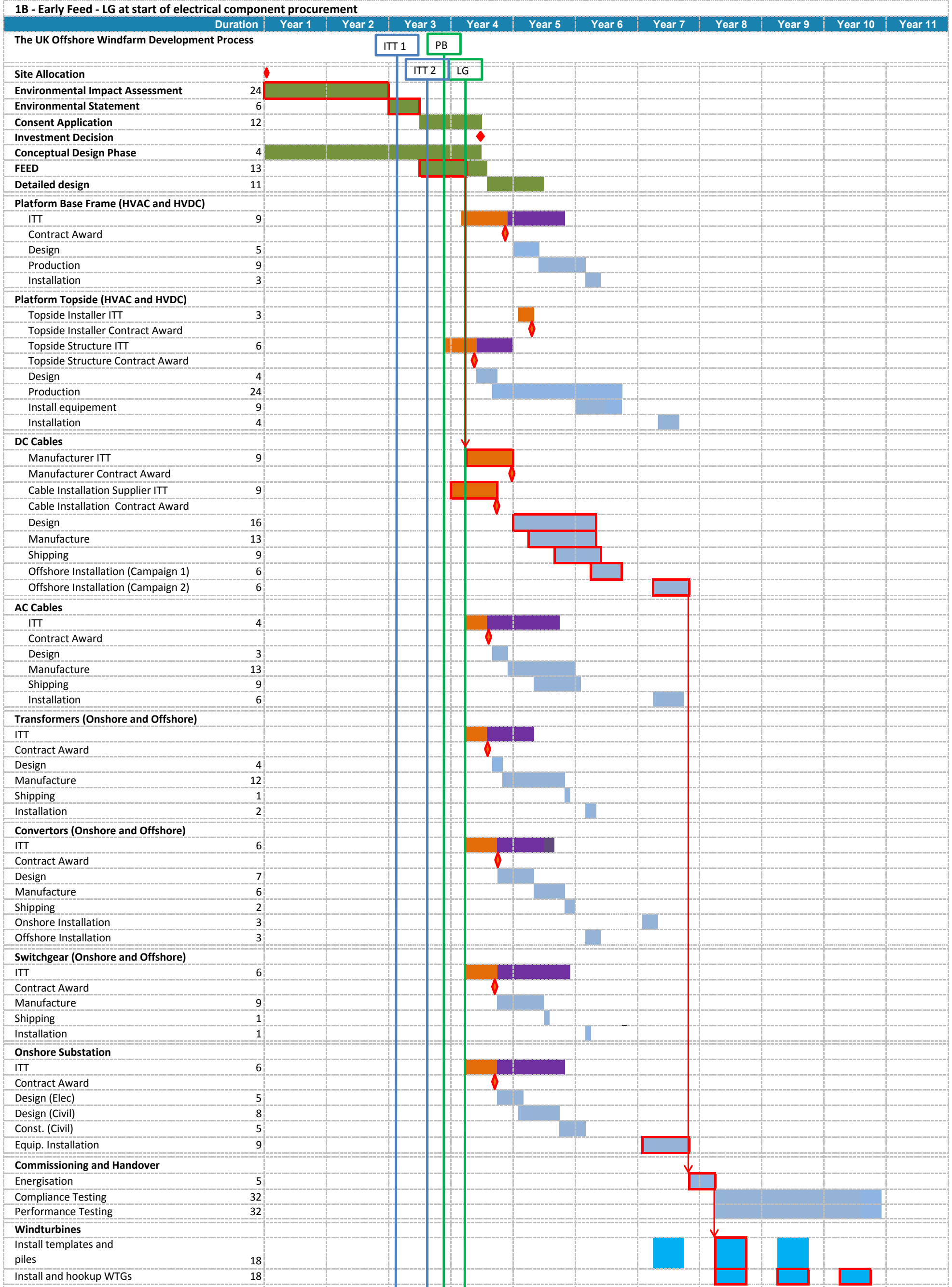
Component	Indicative Value	(%)
AC Platform		
Topside	60.00	8.3%
Substructure	22.00	3.0%
Transformers	40.00	5.5%
Switchgear		
Installation	44.00	6.1%
DC Platform		
Topside	60.00	8.3%
Substructure	20.00	2.8%
Converter	100.00	13.9%
Installation	30.00	4.2%
DC Cable		
Suppy	80.00	11.1%
Installation	30.00	4.2%
AC Cable		
Suppy	45.00	6.2%
Installation	15.00	2.1%
Onshore Substation		
Substation	10.00	1.4%
Converter	100.00	13.9%
Development and Insurance	65.60	9.1%
Total	721.60	

Price Certainty at Stage End	(+/-)
Concept Design (beginning)	35%
Concept Design (end)	30%
FEED (end)	25%
Award of Contracts (cables)	20%
Award of Contracts	15%
Manufacture (end)	5%
Installation (end)	5%
End of Contract	0%

Key

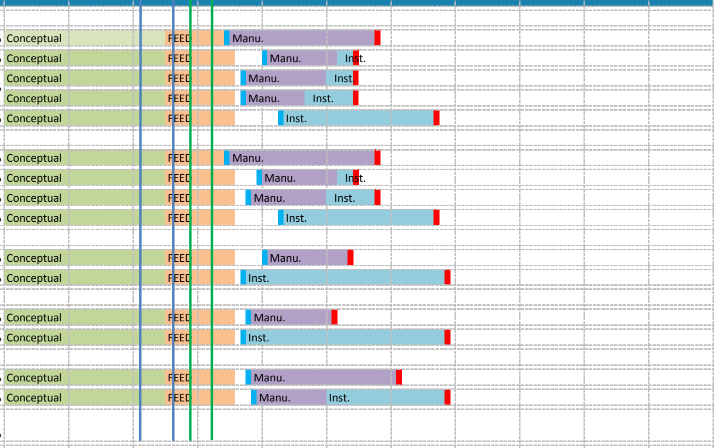
ITT1	Start of ITT stage
ITT2	ITT submission
PB	Preferred bidder appointment
LG	License grant

1B - Early Feed - LG at start of electrical component procurement



Key

ITT1	Start of ITT stage
ITT2	ITT Submission
PB	Preferred bidder appointment
LG	License grant



Component	Indicative Value	(%)
AC Platform		
Topside	60.00	8.3%
Substructure	22.00	3.0%
Transformers	40.00	5.5%
Switchgear		
Installation	44.00	6.1%
DC Platform		
Topside	60.00	8.3%
Substructure	20.00	2.8%
Converter	100.00	13.9%
Installation	30.00	4.2%
DC Cable		
Suppy	80.00	11.1%
Installation	30.00	4.2%
AC Cable		
Suppy	45.00	6.2%
Installation	15.00	2.1%
Onshore Substation		
Substation	10.00	1.4%
Converter	100.00	13.9%
Development and Insurance	65.60	9.1%
Total	721.60	

Price Certainty at Stage End	(+/-)
Concept Design (beginning)	35%
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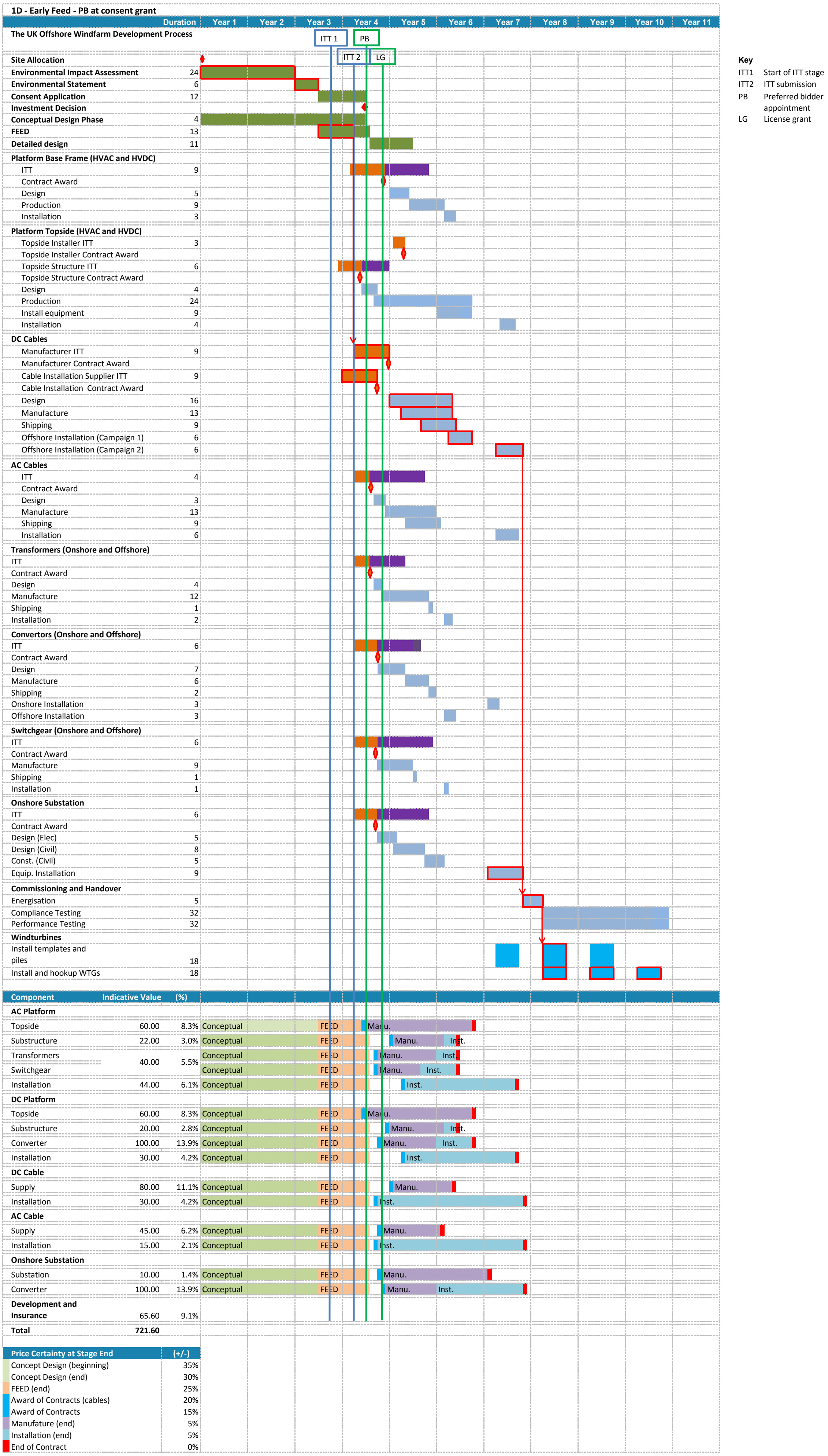
FEED (end)	25%
Award of Contracts (cables)	20%
Award of Contracts	15%
Manufacture (end)	5%
Installation (end)	5%
End of Contract	0%


1C - Early Feed - ITT at signing of last supply contract
Duration
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10
Year 11
The UK Offshore Windfarm Development Process
ITT 1
PB
ITT 2
LG
Site Allocation
Environmental Impact Assessment 24
Environmental Statement 6
Consent Application 12
Investment Decision
Conceptual Design Phase 4
FEED 13
Detailed design 11
Platform Base Frame (HVAC and HVDC)
ITT 9
Contract Award
Design 5
Production 9
Installation 3
Platform Topside (HVAC and HVDC)
Topside Installer ITT 3
Topside Installer Contract Award
Topside Structure ITT 6
Topside Structure Contract Award
Design 4
Production 24
Install equipment 9
Installation 4
DC Cables
Manufacturer ITT 9
Manufacturer Contract Award
Cable Installation Supplier ITT 9
Cable Installation Contract Award
Design 16
Manufacture 13
Shipping 9
Offshore Installation (Campaign 1) 6
Offshore Installation (Campaign 2) 6
AC Cables
ITT 4
Contract Award
Design 3
Manufacture 13
Shipping 9
Installation 6
Transformers (Onshore and Offshore)
ITT
Contract Award
Design 4
Manufacture 12
Shipping 1
Installation 2
Convertors (Onshore and Offshore)
ITT 6
Contract Award
Design 7
Manufacture 6
Shipping 2
Onshore Installation 3
Offshore Installation 3
Switchgear (Onshore and Offshore)
ITT 6
Contract Award
Manufacture 9
Shipping 1
Installation 1
Onshore Substation
ITT 6
Contract Award
Design (Elec) 5
Design (Civil) 8
Const. (Civil) 5
Equip. Installation 9
Commissioning and Handover
Energisation 5
Compliance Testing 32
Performance Testing 32
Windturbines
Install templates and piles 18
Install and hookup WTGs 18
Component | Indicative Value | (%)
AC Platform
Topside 60.00 8.3% Conceptual FEED Manu.
Substructure 22.00 3.0% Conceptual FEED Manu. Inst.
Transformers 40.00 5.5% Conceptual FEED Manu. Inst.
Switchgear Conceptual FEED Manu. Inst.
Installation 44.00 6.1% Conceptual FEED Inst.
DC Platform
Topside 60.00 8.3% Conceptual FEED Manu.
Substructure 20.00 2.8% Conceptual FEED Manu. Inst.
Converter 100.00 13.9% Conceptual FEED Manu Inst.
Installation 30.00 4.2% Conceptual FEED Inst.
DC Cable
Supply 80.00 11.1% Conceptual FEED Manu.
Installation 30.00 4.2% Conceptual FEED Inst.
AC Cable
Supply 45.00 6.2% Conceptual FEED Manu
Installation 15.00 2.1% Conceptual FEED Inst.
Onshore Substation
Substation 10.00 1.4% Conceptual FEED Manu
Converter 100.00 13.9% Conceptual FEED Manu. Inst.
Development and Insurance 65.60 9.1%
Total 721.60
Price Certainty at Stage End | (+/-)
Concept Design (beginning) 35%
Concept Design (end) 30%
FEED (end) 25%
Award of Contracts (cables) 20%
Award of Contracts 15%
Manufature (end) 5%
Installation (end) 5%
End of Contract 0%
Key
ITT1 Start of ITT stage
ITT2 ITT submission
PB Preferred bidder appointment
LG License grant


1D - Early Feed - PB at consent grant
Duration
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10
Year 11
The UK Offshore Windfarm Development Process
ITT 1
PB
ITT 2
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Site Allocation
Environmental Impact Assessment 24
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Consent Application 12
Investment Decision
Conceptual Design Phase 4
FEED 13
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Installation 3
Platform Topside (HVAC and HVDC)
Topside Installer ITT 3
Topside Installer Contract Award
Topside Structure ITT 6
Topside Structure Contract Award
Design 4
Production 24
Install equipment 9
Installation 4
DC Cables
Manufacturer ITT 9
Manufacturer Contract Award
Cable Installation Supplier ITT 9
Cable Installation Contract Award
Design 16
Manufacture 13
Shipping 9
Offshore Installation (Campaign 1) 6
Offshore Installation (Campaign 2) 6
AC Cables
ITT 4
Contract Award
Design 3
Manufacture 13
Shipping 9
Installation 6
Transformers (Onshore and Offshore)
ITT
Contract Award
Design 4
Manufacture 12
Shipping 1
Installation 2
Convertors (Onshore and Offshore)
ITT 6
Contract Award
Design 7
Manufacture 6
Shipping 2
Onshore Installation 3
Offshore Installation 3
Switchgear (Onshore and Offshore)
ITT 6
Contract Award
Manufacture 9
Shipping 1
Installation 1
Onshore Substation
ITT 6
Contract Award
Design (Elec) 5
Design (Civil) 8
Const. (Civil) 5
Equip. Installation 9
Commissioning and Handover
Energisation 5
Compliance Testing 32
Performance Testing 32
Windturbines
Install templates and piles 18
Install and hookup WTGs 18
Component | Indicative Value | (%)
AC Platform
Topside 60.00 8.3% Conceptual FEED Manu.
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Transformers 40.00 5.5% Conceptual FEED Manu. Inst.
Switchgear Conceptual FEED Manu. Inst.
Installation 44.00 6.1% Conceptual FEED Inst.
DC Platform
Topside 60.00 8.3% Conceptual FEED Manu.
Substructure 20.00 2.8% Conceptual FEED Manu. Inst.
Converter 100.00 13.9% Conceptual FEED Manu. Inst.
Installation 30.00 4.2% Conceptual FEED Inst.
DC Cable
Supply 80.00 11.1% Conceptual FEED Manu.
Installation 30.00 4.2% Conceptual FEED Inst.
AC Cable
Supply 45.00 6.2% Conceptual FEED Manu.
Installation 15.00 2.1% Conceptual FEED Inst.
Onshore Substation
Substation 10.00 1.4% Conceptual FEED Manu.
Converter 100.00 13.9% Conceptual FEED Manu. Inst.
Development and Insurance 65.60 9.1%
Total 721.60
Price Certainty at Stage End | (+/-)
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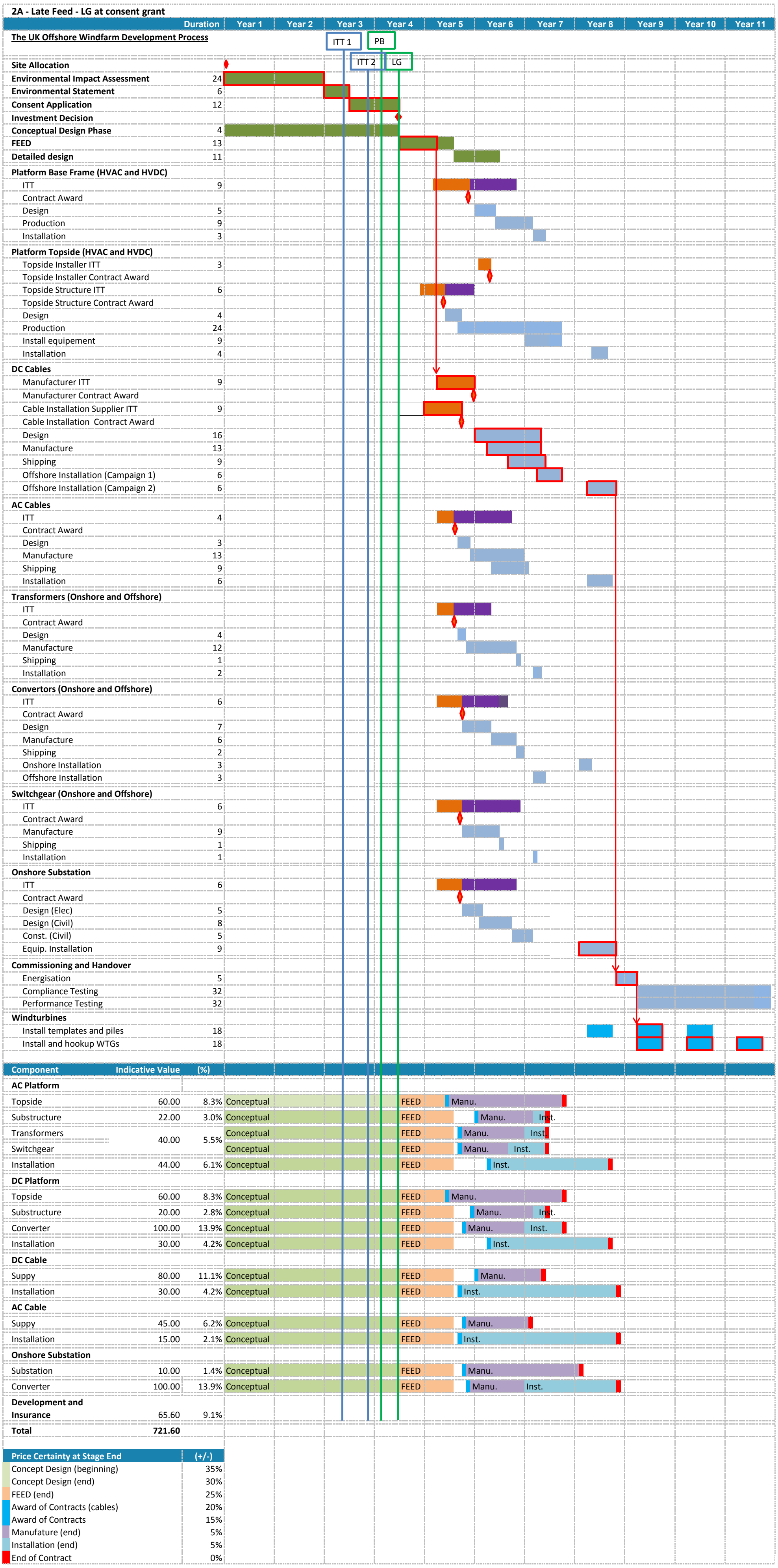
FEED (end) 25%
Award of Contracts (cables) 20%
Award of Contracts 15%
Manufature (end) 5%
Installation (end) 5%
End of Contract 0%
Key
ITT1 Start of ITT stage
ITT2 ITT submission
PB Preferred bidder appointment
LG License grant

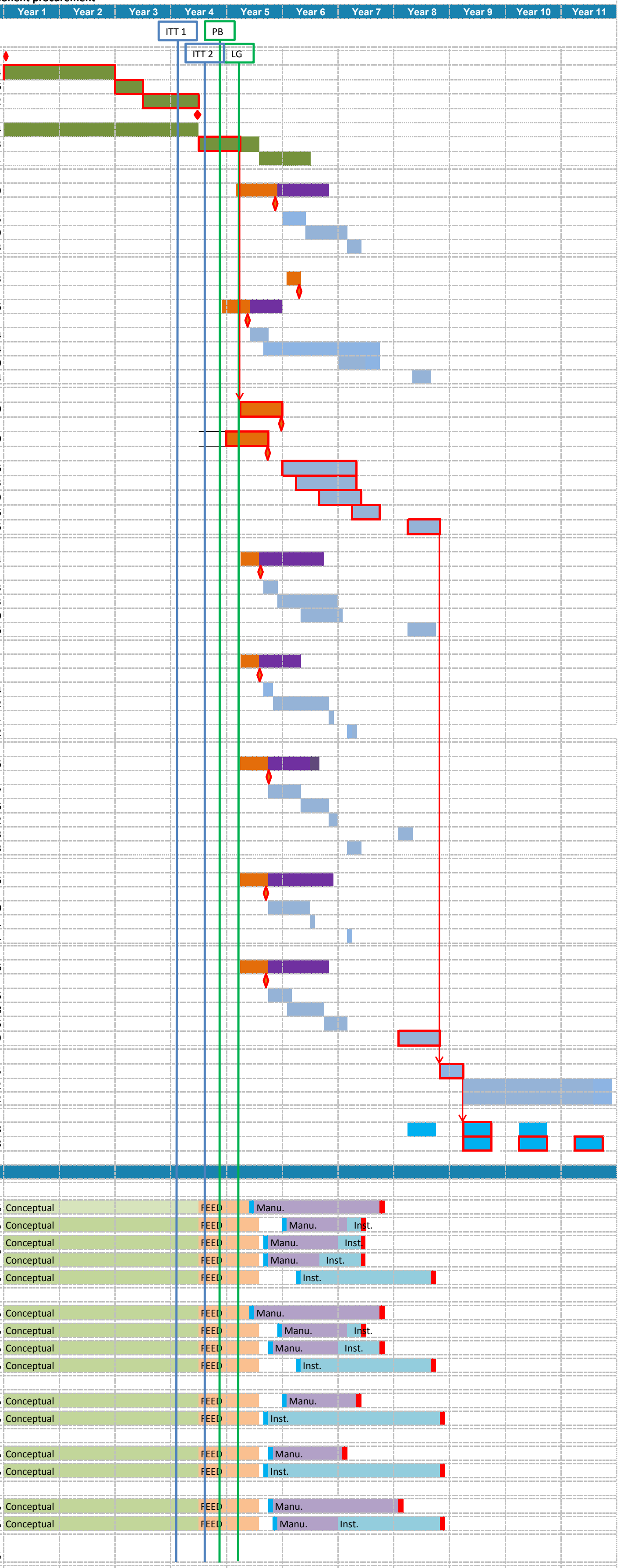
Appendix 2 | Late FEED delivery programs



Key

ITT1	Start of ITT Stage
ITT2	ITT Submission
PB	Preferred bidder appointment
LG	License grant

2B - Late Feed - LG at the start of electrical component procurement



The UK Offshore Windfarm Development Process	Duration
Site Allocation	
Environmental Impact Assessment	24
Environmental Statement	6
Consent Application	12
Investment Decision	
Conceptual Design Phase	4
FEED	13
Detailed design	11
Platform Base Frame (HVAC and HVDC)	
ITT	9
Contract Award	
Design	5
Production	9
Installation	3
Platform Topside (HVAC and HVDC)	
Topside Installer ITT	3
Topside Installer Contract Award	
Topside Structure ITT	6
Topside Structure Contract Award	
Design	4
Production	24
Install equipement	9
Installation	4
DC Cables	
Manufacturer ITT	9
Manufacturer Contract Award	
Cable Installation Supplier ITT	9
Cable Installation Contract Award	
Design	16
Manufacture	13
Shipping	9
Offshore Installation (Campaign 1)	6
Offshore Installation (Campaign 2)	6
AC Cables	
ITT	4
Contract Award	
Design	3
Manufacture	13
Shipping	9
Installation	6
Transformers (Onshore and Offshore)	
ITT	
Contract Award	
Design	4
Manufacture	12
Shipping	1
Installation	2
Convertors (Onshore and Offshore)	
ITT	6
Contract Award	
Design	7
Manufacture	6
Shipping	2
Onshore Installation	3
Offshore Installation	3
Switchgear (Onshore and Offshore)	
ITT	6
Contract Award	
Manufacture	9
Shipping	1
Installation	1
Onshore Substation	
ITT	6
Contract Award	
Design (Elec)	5
Design (Civil)	8
Const. (Civil)	5
Equip. Installation	9
Commissioning and Handover	
Energisation	5
Compliance Testing	32
Performance Testing	32
Windturbines	
Install templates and piles	18
Install and hookup WTGs	18

Component	Indicative Value	(%)
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Installation	30.00	4.2%
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AC Cable		
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Onshore Substation		
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Converter	100.00	13.9%
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Total	**721.60**	

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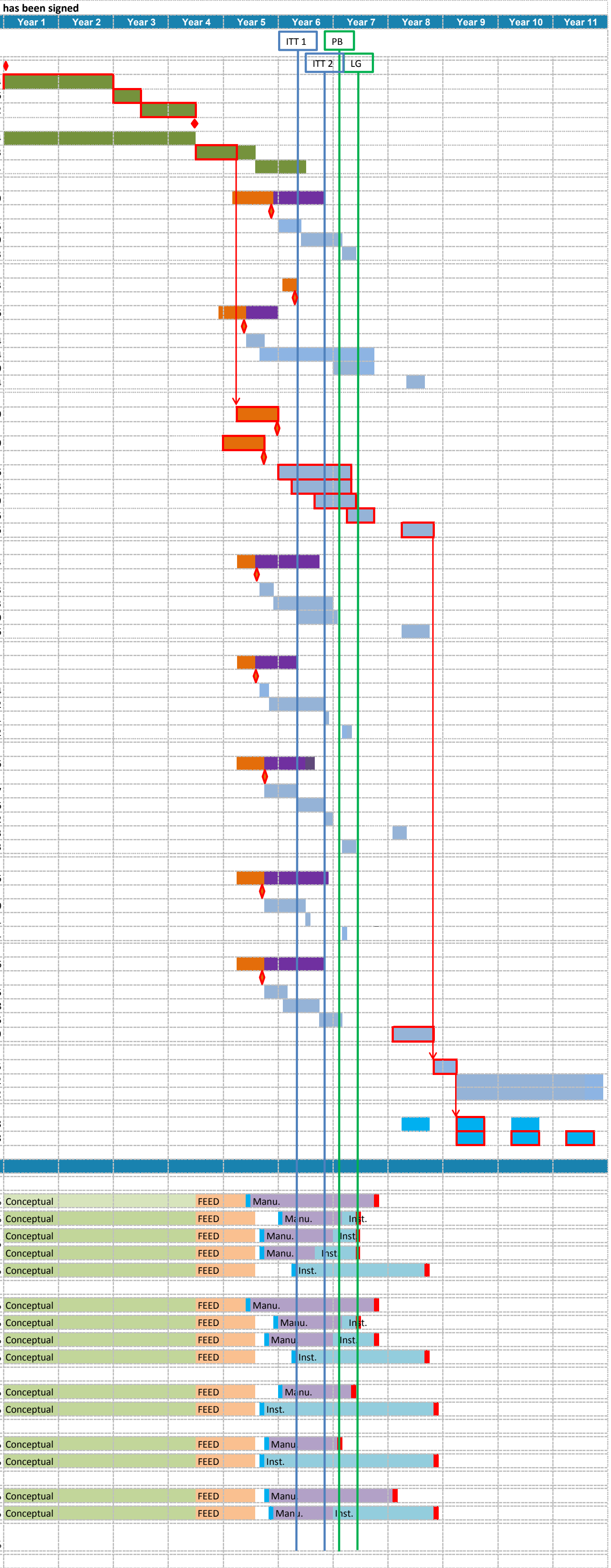
FEED (end)	25%
Award of Contracts (cables)	20%
Award of Contracts	15%
Manufature (end)	5%
Installation (end)	5%
End of Contract	0%

Key

ITT1	Start of ITT Stage
ITT2	ITT Submission
PB	Preferred bidder appointment
LG	License grant

2C - Late Feed - ITT after the last supply contract has been signed

The UK Offshore Windfarm Development Process



	Duration
Site Allocation	
Environmental Impact Assessment	24
Environmental Statement	6
Consent Application	12
Investment Decision	
Conceptual Design Phase	4
FEED	13
Detailed design	11
Platform Base Frame (HVAC and HVDC)	
ITT	9
Contract Award	
Design	5
Production	9
Installation	3
Platform Topside (HVAC and HVDC)	
Topside Installer ITT	3
Topside Installer Contract Award	
Topside Structure ITT	6
Topside Structure Contract Award	
Design	4
Production	24
Install equipement	9
Installation	4
DC Cables	
Manufacturer ITT	9
Manufacturer Contract Award	
Cable Installation Supplier ITT	9
Cable Installation Contract Award	
Design	16
Manufacture	13
Shipping	9
Offshore Installation (Campaign 1)	6
Offshore Installation (Campaign 2)	6
AC Cables	
ITT	4
Contract Award	
Design	3
Manufacture	13
Shipping	9
Installation	6
Transformers (Onshore and Offshore)	
ITT	
Contract Award	
Design	4
Manufacture	12
Shipping	1
Installation	2
Convertors (Onshore and Offshore)	
ITT	6
Contract Award	
Design	7
Manufacture	6
Shipping	2
Onshore Installation	3
Offshore Installation	3
Switchgear (Onshore and Offshore)	
ITT	6
Contract Award	
Manufacture	9
Shipping	1
Installation	1
Onshore Substation	
ITT	6
Contract Award	
Design (Elec)	5
Design (Civil)	8
Const. (Civil)	5
Equip. Installation	9
Commissioning and Handover	
Energisation	5
Compliance Testing	32
Performance Testing	32
Windturbines	
Install templates and piles	18
Install and hookup WTGs	18

Component	Indicative Value	(%)
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Converter	100.00	13.9%
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Price Certainty at Stage End	(+/-)
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Award of Contracts	15%
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Key

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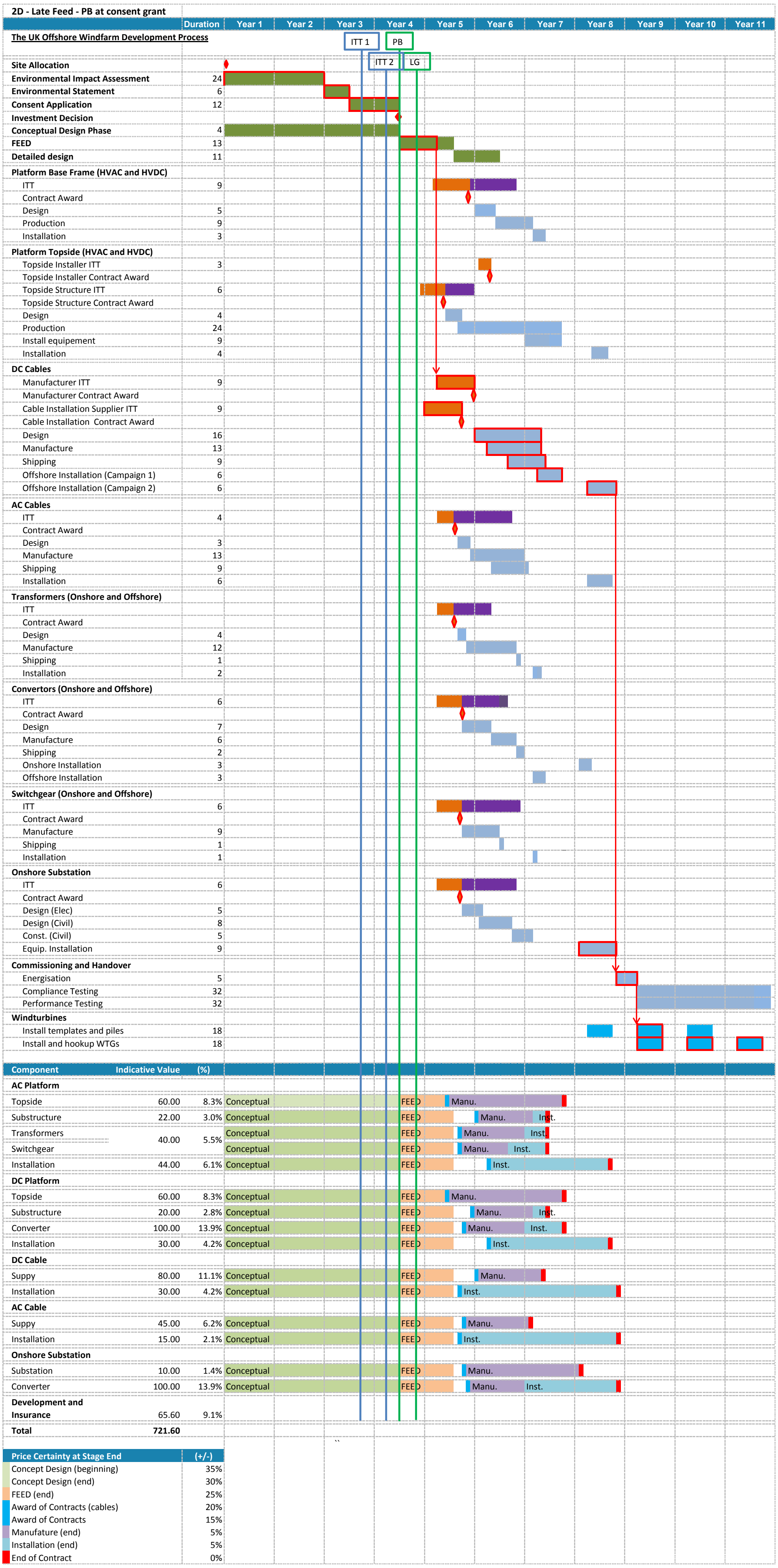

Key

ITT1	Start of ITT Stage
ITT2	ITT Submission
PB	Preferred bidder appointment
LG	License grant

Appendix 3 | Recommended tender timing

Key

ITT1	Start of ITT stage
ITT2	ITT Submission
PB	Preferred bidder appointment
LG	License grant

Appendix 4 | Asset component lifespans

Asset component lifespans

The asset components have been split into two types: the permanent items, which should last the planned asset life; and lifecycle items, which will require replacement during the operational life, assumed to be 20 years. The lifecycle items can be replaced without impacting the overall asset life of the windfarm.

The experience of utilities for main plant items such as cables, switchgear and transformers is such that lifetimes well in excess of 20 years are achieved with appropriate maintenance and minimal capital expenditure. The normal regulated asset lifetime agreed between the utilities and Ofgem for high voltage transmission assets is in the order of 40 years.

To allow any components of the windfarm or transmission assets to reach their predicted lifespan an appropriate maintenance regime must be followed. For some components this could be quite onerous. For example, the gearbox of a turbine may require a significant overhaul during its 20 year life.

The below tables summarise the expected lifespans of equipment for the HVAC, HVDC and windfarm assets.

Choosing HVDC over HVAC will have an impact on system reliability, but not lifespan. HVAC converters have more components, so statistically will experience more component failures and replacements, but the lifespans will be similar. For example, a converter will require regular valve replacement, but this will not impact overall lifespan.

OFTO HVAC Asset Lifespan

Component	Lifespan
Permanent Items	
Offshore Platforms	≥25 years
Switchgear	≥20 years
Transformers	≥20 years
Compensation equipment	≥20 years
Subsea AC cable	≥40 years
Land cable	≥40 years
Comms/SCADA hardware	~20 years
Lifecycle items	
Comms/SCADA software	<10 years
Protection and Control systems	<10 years
Diesel Generator	<20 years
Battery Systems	<10 years

OFTO HVDC Asset Lifespan

Component	Lifespan
Permanent Items	
Offshore Platforms	≥25 years
Switchgear	≥20 years
Transformers	≥20 years
Compensation equipment	≥20 years
Subsea AC cable	≥40 years
Subsea DC cable	≥40 years
Land cable	≥40 years
Comms/SCADA hardware	~20 years
Offshore Converters	≥20 years
Onshore Converters	≥20 years
Lifecycle items	
Comms/SCADA software	<10 years
Protection and Control systems	<10 years
Diesel Generator	<20 years
Battery Systems	<10 years
Converter Valves	<20 years

Windfarm Assets

Component	Lifespan
Permanent Items	
Turbine Tower	≥20 years
Turbine Foundations	≥20 years
Generator	≥20 years
Gearbox	≥20 years
General Nacelle Assembly	≥20 years
Array AC cables	≥20 years
Switchgear	≥20 years
Transformers	≥20 years
Comms/SCADA hardware	~20 years
Lifecycle items	
Comms/SCADA software	<10 years
Protection and Control systems	<10 years
Battery Systems	<10 years
Battery Systems	<10 years
Converter Valves	<20 years

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