OFTO Availability Incentive

October 2012

Transaction Advice

ARUP tnei enterprise with energy

26th October 2012

Arup Corporate Finance Ltd
13 Fitzroy Street
London
W1T 4BQ
www.arup.com

Offshore Transmission
Ofgem
9 Millbank
London
SW1P 3GE

Dear Sirs,

Availability Incentive Enhancement Options for Enduring Regime

In accordance with the terms of reference set out in the service agreement dated 6th August 2012, we enclose the final report documenting our analysis in relation to the availability incentives of offshore transmission owners.

The scope of work is as set out in our service agreement. Those terms of reference comprise the agreed scope of our enquiries, directed at those issues which you 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 in relation to the availability incentive and should not be relied on for any other purposes.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Yours faithfully

Arup Corporate Finance Ltd

Important notice

Our work commenced on 31st July 2012 and the finalised report was provided on 26th October 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. Arup Corporate Finance Ltd assumes 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.

If Ofgem receives any request under the Freedom of Information Act 2000 for disclosure of information provided by us, please notify us on receipt of requests and prior to any disclosures.

Executive Summary

Background

- Ofgem and the Department of Energy and Climate Change (DECC) have developed a regulatory regime for the construction and operation of offshore transmission assets. The regime is being delivered in two parts: transitional and enduring.
- Ofgem commenced the first Transitional Regime round (TR1) tender for transmission links worth £1.1bn for nine projects in July 2009. To date six Round 1 projects have reached Financial Close. Ofgem is continuing to run Transitional tenders. The Enduring Regime is expected to start in 2013.
- The Transitional Regime includes an incentive mechanism which adjusts the OFTO revenue based on performance against availability targets. The current availability incentive is considered appropriate for the Transitional Regime. However, going forward, Ofgem is taking the opportunity to revisit the availability incentive. Arup and TNEI have been engaged by Ofgem to assist in the identification of enhancements to the availability incentive for the OFTO Regime. The selected enhancements will be proposed to the OFTO stakeholders and be subject to further analysis. We do not expect that these would apply to the Transitional Regime.

Approach

- Identification of appropriate enhancements to the availability incentive has been undertaken following the process described below;
  - **Assessment of the Transitional Regime incentive** – To provide a more comprehensive understanding of the current availability incentive, an assessment was undertaken which investigated how potential future OFTO configurations would be impacted by the current incentive. This was undertaken by calculating the lost revenue for a sample of asset configurations and outage types.
  - **Option identification** – Through consideration of potential benefits of enhancements, the objectives of the availability incentive and an understanding of OFTO operational behaviour and commercial drivers, a list of nine availability enhancement options was identified.
- **Qualitative option appraisal** – The nine options were assessed against the evaluation criteria which were chosen to reflect Ofgem's objectives. The criteria addressed three key areas;
  - **Behaviour** – will the enhancements incentivise the correct OFTO behaviour, such as prompt repair of component failures and undertaking the required planned maintenance;
  - **Asset risk profile** – will the enhancements impact the investment risk profile of OFTOs; and
  - **Practicality** – will the enhancements introduce significant complexity, which could discourage investors, prove costly to implement and cannot be implemented robustly.

Conclusions

- This process identified three suitable enhancements options, in addition to the Status Quo incentive (as used in the TR2 licence), which were considered to have a positive impact on the behaviour of OFTOs, so refining the mechanism to further improve performance. These enhancements are not considered to result in a material negative impact on the risk profile of the assets or add significant complexity.
- **Status Quo incentive** – The Status Quo incentive is a successfully implemented incentive against which the other enhancement options can be assessed
- **Capacity weighting** – The Capacity Weighting mechanism is based on the Transitional Regime Incentive mechanism, but gives a proportionally higher penalty for higher capacity outages. This could provide incentivisation for an OFTO to plan for low capacity outages, so maintaining the greatest possible transmission capacity at any time.
- The aim of this measure is to encourage more small capacity outages compared to fewer large capacity outages, but in some situations a large capacity outage will be required. Consequently, the weighting profile will have to be appropriately configured to ensure the incentive does not encourage the deferral of high capacity planned maintenance. It would also add complexity of the availability mechanism.

Executive Summary

- **Maintenance Type Weighting** – The Maintenance Type Weighting is based on the Status Quo incentive mechanism but penalises unplanned outages to a greater extent than planned outages. This could provide increased incentivisation to OFTOs to undertake sufficient planned maintenance to avoid unplanned outages.
- This enhancement does have a potential negative impact on the practicality of the availability incentive. It increases complexity because of the need to treat planned and unplanned maintenance differently in the incentive mechanism. It also creates the possibility of OFTOs reporting outages wrongly to reduce the penalties.
- **Capacity Weighting for planned maintenance and Maintenance Type Weighting for unplanned maintenance ('Combined Enhancement') –** The Combined Enhancement incorporates the strengths, and weaknesses, of the other two options. It applies a capacity weighting to planned maintenance and provides greater penalties to unplanned maintenance, but maintains a linear relationship between unplanned unavailability and penalties. This should incentivise low capacity planned maintenance and encourage OFTOs to undertake sufficient planned maintenance to avoid unplanned outages.
- However, potential disadvantages include the need to treat planned and unplanned maintenance separately, and, by incorporating two enhancements, it will lead to a greater departure from the Status Quo incentive than either would individually. Additionally, the weighting profile will have to be appropriately configured to ensure the incentive does not encourage the deferral of high capacity planned maintenance.

Contents

1. Introduction – Background

The current availability incentive has proved successful for the Transitional Regime. However, going forward, Ofgem is exploring the opportunity to implement enhancements

Background

- Ofgem and the Department of Energy and Climate Change (DECC) have developed a regulatory regime for the construction and operation of offshore transmission assets. The regime is being delivered in two parts: transitional and enduring.
- Ofgem started the first transitional round (TR1) tender for transmission links worth £1.1bn for nine projects in July 2009. There was strong competition in these tenders from five consortiums representing significant investment capacity. Three consortiums were selected in August 2010 as preferred bidders on £700m of transmission links to seven wind farms. To date six Round 1 projects have reached Financial Close.
- Ofgem is currently running the tenders for the Offshore Transmission Owner (OFTO) second transitional round (TR2) projects. The four projects in this tender are worth c. £1bn.
- The tenders for the Enduring Regime are expected to start in 2013 and will apply to some of the Crown Estate Round 2 wind farms and all of the Round 3 wind farms (expected to total some 30GW). The regime is expected to encompass the construction, ownership and operation of c. £14bn of transmission assets.
- A key difference for the Enduring Regime is the introduction of the OFTO build option, where an OFTO will build, own and operate the transmission assets. Consequently, during development of the windfarm, a developer can choose between following a generator build or OFTO build approach.
- The OFTO build option has the potential to increase technical innovation in the construction of offshore transmission and also support the integration of the transmission links for a number of wind farms where that is economic and efficient.
- For future tenders, the scale and complexity of the projects is expected to develop significantly from those involved in the Transitional Regime.
- Responses from previous OFTO consultation processes have been considered in the analysis, but they are not discussed explicitly in this report.

Objectives of the OFTO Regime

- Ofgem and DECC have set the following objectives for the OFTO Regime[1];
  - to deliver fit for purpose transmission systems to connect offshore generation and support significant carbon savings;
  - to provide best value to consumers; and
  - to attract new entrants to the sector.
- In addition, the OFTO Regime is intended to support the creation, over time, of a secure offshore transmission system and promote the development of integrated, innovative networks as part of the National Electricity Transmission System.
- An OFTO receives its revenue as a licence payment that is based on their Tender Revenue Stream (TRS). This is adjusted through an availability incentive mechanism that considers OFTO performance. Through the transitional rounds the availability incentive mechanism has proved successful and has helped Ofgem achieve its objectives. However, going forward, Ofgem is exploring the opportunity to implement enhancements to the existing availability mechanism.
- Arup and TNEI have therefore been engaged by Ofgem to identify appropriate enhancement options to the availability incentive for the OFTO Regime.

[1] Reference: Ofgem, Offshore electricity Transmission: Consultation on the tender exercises under the enduring regime, December 2011

1. Introduction – Availability Incentive

The objectives of the availability incentive are to maximise availability, ensure rapid outage remediation, align OFTO incentives with consumer interests and create a risk profile that ensures efficient cost of capital

OFTO incentivisation

- To become an OFTO the relevant party must enter into a licence granted by Ofgem. This places requirements on an OFTO as an offshore transmission operator. Many of the requirements relate to their performance, of which one is to achieve high availability.
- The OFTO licence incentivises the OFTO to achieve high availability through two mechanisms;
  - Formal licence obligations;
    - Obligation to provide transmission services;
    - To operate assets in line with industry best practice;
    - To minimise the effect and duration of any transmission outage and report details of any service reduction over 21 days; and
    - Provide written statement of compliance with best practice if availability is below 80% in a year or 85% over two years.
  - Availability incentive mechanism;
    - Loss of revenue if an availability target is not met; and
    - Increased revenue if an availability target is exceeded.
- If an OFTO fails to satisfy the formal licence obligations, Ofgem can take enforcement action, including eventual licence revocation.

Objectives of the availability incentive

- Ofgem has the following key objectives for the availability incentive;
  - **Maximise system availability** – There are obligations in the OFTO licence to provide transmission services in line with good industry practice. The availability incentive should fine tune and further encourage this behaviour.
  - **Ensure rapid remediation of outages** – A degree of system outages will always be unavoidable. Therefore, the incentive mechanism must encourage behaviour that limits lost electricity transmission as a result of these events.
  - **Align OFTO incentives with consumer interests** – Consumers are a significant stakeholder in offshore transmission but can not actively ensure that their interests are protected. The availability incentive should align OFTO interests with those of the consumer.
  - **Create an investment risk profile that ensures efficient cost of capital** – Offshore transmission assets represent a low risk investment that have proven to be attractive to third party investors. The availability incentive must encourage appropriate behaviour without significantly increasing the investor investment risk profile.

Need for new availability mechanism

- The Status Quo mechanism is considered appropriate for the transitional regime. Up to this point six licences have been granted and reporting against the availability mechanism is ongoing.
- Going forward, Ofgem is taking the opportunity to revisit the availability incentive, which allows a number of issues to be addressed;
  - The future projects are likely to be larger and more integrated projects. Consequently, there may be increasing scope for different maintenance strategies to be followed;
  - The increased complexity will provide the opportunity in some projects to reroute power, so minimising the impact of an outage. Consequently, it may be beneficial for the future mechanism to incentivise re-routing of power; and
  - It may not be appropriate to penalise the OFTO for outages that do not impact the generator's ability to export power, such as low capacity outages when electricity transmission is low in summer months.

1. Introduction – Report Structure

This report provides an assessment of the Status Quo availability incentive, indentifies a list of potential enhancements and through a qualitative assessment recommends three potential enhancements

Report structure

- This report has been split into the following sections;
  - **Section 2. Transitional Regime Availability Incentive** – This section provides a description of the availability mechanism that has been used in the second round of Transitional Regime tenders. For illustrative purposes, it also analyses how eight different OFTO configurations which may be deployed in the future would be impacted by the current incentive. This was undertaken by assessing the lost revenue for each configuration under a selection of possible planned and unplanned outages. The configurations and outages are detailed in Appendix 1.
  - **Section 3. Option identification** – This section identifies a list of availability enhancement options and provides details of the key strengths and weaknesses for each.
  - **Section 4. Qualitative option appraisal** – Given the objectives of the OFTO Regime availability incentive a list of assessment criteria was produced against which the different enhancement options were assessed. This chapter concludes on which options may be the most suitable going forward. These will be proposed to OFTO stakeholders and considered under further analysis.
  - **Appendix 1** – Details are provided for the OFTO configurations and outages that were used as part of the revenue analysis in Section 2.

Terminology

- The report has been written using the following terminology;
  - **Status Quo mechanism** – This refers to the availability incentive used in the second round of Transitional Regime (TR2) tenders.
  - **Enhancement option** – This refers to any of the options assessed for altering the availability incentive for future projects.
  - **Risk Profile** – The risk profile of an OFTO is assumed to be the perceived risk associated with investing in these assets. It is a combination of the types of risk to which an investor is exposed and their scale. An increase in the risk profile is assumed to represent an increase in the scale of the risks. This may lead to increases in the TRS tendered by bidders.
  - **Asset configuration** – This refers to eight different OFTO asset configurations that have been identified as representative of future projects. These are detailed in Appendix 1. The asset configurations are used in the revenue analysis of the Status Quo mechanism in Section 2.
  - **Outage event** – Nine different planned and unplanned outages have been chosen as a representative sample that could be experienced by the asset configurations. These are detailed in Appendix 1.
  - **Outage type** – Refers to the difference between planned and unplanned maintenance.
  - **Weighting profiles** – Some enhancement options change the relationship between unavailability and penalties compared to the Status Quo mechanism. This relationship is termed a weighting profile.
  - **Lost Transmission** – This is electricity that would have been produced by a windfarm, and could have been transmitted to the onshore grid, if there had not been an outage.
  - **Redundancy** – For the purposes of this report, redundancy represents the minimum possible proportion of transmission capacity lost through an outage. Therefore, an OFTO configuration with greater redundancy will lose less capacity through equipment failures. It does not relate to the operation of components above their stated capacity.

Contents

2. Transitional Regime Availability Incentive

Analysis has been undertaken into how future OFTOs would be impacted by the Status Quo mechanism. This involves calculating OFTO lost revenue from a selection of different outages

Status Quo availability incentive mechanism

- The availability incentive mechanism used in the second round of Transitional Regime projects (TR2) produces adjustments to the tender revenue stream (TRS) based on performance against an availability target.
- The default target availability is 98%. Meeting the target over an annual period leads to the OFTO receiving 100% of its TRS. Exceeding the target leads to a positive adjustment; failure to meet the target leads to a deduction.
- Negative adjustments, from failing to meet the target, are capped at 10% of the TRS in any year, but the remaining unavailability penalties can be carried forward for up to 4 years. This could result in an additional 10% revenue loss in each of the subsequent 4 years, leading to the maximum loss of 50% of one year's revenue over a 5 year period.
- The result of this is the smoothing of lost availability over a five year period, so mitigating the cashflow risks for rare but significant equipment failures. Exceeding the availability target leads to bonus payments, which are up to 5% of the TRS each year.
- The availability mechanism calculates the lost availability of transmission capacity (in MWh) compared to the total that is available during an annual period. Monthly performance factors weight the unavailability of each month, with greater penalties during winter months when electricity generation is likely to be at its greatest. Within one month, each unit of lost availability has an equal value. Therefore, the mechanism does not consider lost electricity transmission or the lost capacity in each outage, although it does require the lost capacity of each outage to be reported.

Examples

- If availability is 100% in year 5, for example, this will lead to a 5% increase in the revenue received by the OFTO for that year, assuming there are no penalties passed on from the previous year.
- However, if an OFTO suffered a six month unplanned outage, leading to less than 50% availability for the year, a penalty of 10% of TRS would be applied in that year and the following four years depending on subsequent performance, although, this can be reduced by exceeding the target in subsequent years and using the bonuses received to pay off penalties earlier. The total revenue impact would remain 50%.

Lost Revenue Analysis

- To provide a further understanding of the Status Quo mechanism, an analysis was undertaken to investigate how future OFTOs would be impacted by the Status Quo mechanism. This involved calculating how OFTO revenue would be affected in different situations.
- There are two key variables that affect this analysis. First, the OFTO configuration; its level of redundancy may affect the penalties it receives from a specific outage. Consequently, eight different asset configurations have been identified to represent those that may be deployed in the relatively near future. These are detailed in Appendix 1.
- Secondly, the type of outage. Planned outages are generally short and regular, whereas, unplanned outages are longer and less frequent. The different types of outage need to be taken into consideration when assessing how the Status Quo mechanism may impact OFTO revenues. Four planned and five unplanned outages have been selected to be assessed. Between these outages there is variation in the duration and the lost capacity that will be experienced by specific OFTOs. These are detailed in Appendix 1.

Approach

- The lost revenue assessment calculates the revenue impact for each configuration as a result of each outage event. Using this information it is possible to compare the scale of penalties between configurations and how planned and unplanned maintenance is impacted differently.
- To calculate the lost revenue for each configuration and outage the Ofgem Status Quo Regulatory Instructions and Guidance (RIGS) model has been adapted. This approach allowed the analysis to be based on a commonly understood starting point.

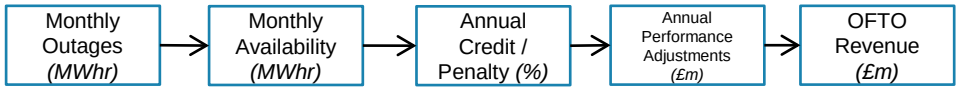
Status Quo revenue model

- In the licence, OFTO revenue consists of four main components: base transmission revenue, pass through revenue adjustment, performance availability adjustment and revenue restriction correction factor. The amendments to the model only impact the performance availability adjustment component of the calculation.

2. Transitional Regime Availability Incentive

Analysis has been undertaken into how future OFTOs would be impacted by the Status Quo mechanism. This involves calculating OFTO lost revenue from a selection of different outages

- The Ofgem Status Quo revenue model follows the calculation steps below;



- The calculation determines the availability based on the outages during a given year. The achieved availability is compared against the default target (98%), so deriving any penalties or bonus payments. Any unpaid penalties are accrued and passed onto the following year subject to the 50% cap.
- The Status Quo payment model bases the penalty awarded on unavailability (in MWh). The unavailability is converted into a percentage by comparing unavailability (in MWh) to the maximum possible transmission capacity during a year. The 100% of the TRS is awarded to the OFTO if it achieves an availability target of 98%.

Calculation output

- The output is the lost revenue for each configuration and outage type.
- The lost revenue provided is the total from a specific event over a 5 year period. All configurations are assumed to have an equal tender revenue stream (TRS) of 100, which an OFTO receives if it achieves 98% availability. An OFTO may achieve a bonus of up to 5% of TRS if the availability target is exceeded. The 50% lost revenue cap results in an OFTO losing 55% of the maximum revenue for one year, which results in a penalty of 55. This consists of a 10% cap on TRS for five successive years, plus a lost bonus of 5% in the first year.
- The revenues should not be considered in absolute terms, but on a relative basis only. Consistent assumptions have been chosen to allow this comparison.

Modelling assumptions

- A number of assumptions have been made in the analysis;
  - It is assumed that each event occurs in the first month of the fifth year and no penalties have been passed forward from previous years;
  - It is assumed any outage leads to a reduction in availability from the 100% maximum. This leads to a situation where an OFTO can lose 15% of its potential TRS before the 10% lost revenue cap. This consists of the 10% lost revenue cap from the target availability and a 5% bonus for achieving greater than the target availability;
  - Each OFTO is assumed to have the same TRS. This assumption would not reflect reality, where there would be variations between the different configurations. However, it does allow for a clearer comparison between different configurations. The TRS for each OFTO is normalised at 100. As a result, the lost revenue provided by the analysis is equal to the lost revenue as a percentage of the TRS;
  - Each outage event is considered to be isolated and independent. The results only relate to the lost revenue associated with a specific outage;
  - The monthly performance weighting is assumed constant throughout the year. This means that the modelling does not consider the season in which an outage event occurs; and
  - It is assumed that none of the components are operated above their stated capacity.

Revenue model references

- The revenue comparison model was developed based on the following documents available on Ofgem website;
  - Generic Offshore Transmission Owner (OFTO) Licence (Version 1.2); and
  - Illustrative Offshore Transmission Owner (OFTO) revenue model for version 1.2 of the generic OFTO licence (http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=28&refer=Networks/offtrans/rttt)
- The revenue modelled has been amended to incorporate the various scenarios, asset configurations and enhancement options.

2. Transitional Regime Availability Incentive

Unavailability is a function of lost transmission capacity and outage duration. Outage duration is constant across the different OFTOs, but the lost capacity varies significantly

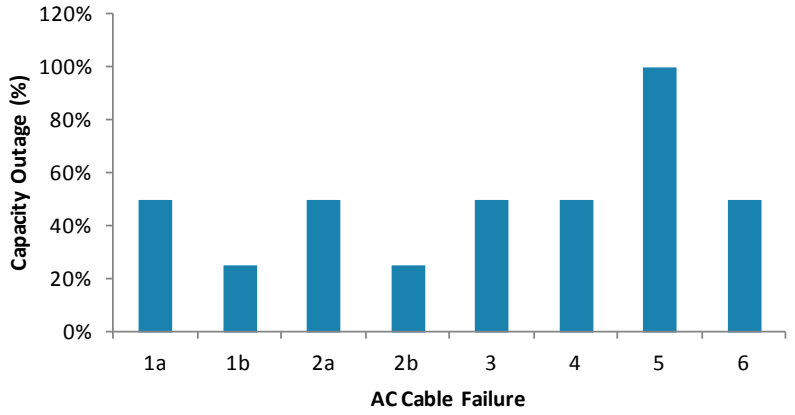
Status Quo mechanism - lost capacity variation

- The revenue model combines outage duration and capacity to calculate penalties. Each type of outage has a given duration, but lost capacity due to an event is dependent on the asset configuration. The lost capacity and duration is detailed in the adjacent table for each outage and configuration. Details of the configurations and outages are provided in Appendix 1.
- For the purpose of this analysis, the impact of an isolated component outage is considered. For example, in a four transformer asset, transformer maintenance will mean an outage in one transformer. Therefore, if asset configuration 1a (simple AC link with 1 AC cable per platform) is subjected to planned transformer maintenance it will lose 25% of its total transmission capacity.
- Should a particular outage lead to multiple possible outcomes the worst case is considered. An example would be planned circuit breaker maintenance for a configuration with a DC connection. As asset configuration option 2a (simple DC link with one AC cable per AC platform) has redundancy within its AC circuits, it will lose 50% capacity when one AC cable circuit breaker is undergoing maintenance. However, the entire system loses 100% of its capacity when a DC cable circuit breaker has an outage. Consequently, the results of the DC cable circuit breaker has been chosen in this situation.
- The table illustrates that the lost capacity can vary significantly for a given outage across the different configurations. This is highlighted by the adjacent figure which shows the variation in lost capacity for an unplanned AC cable failure. As the duration of each outage is identical, using the Status Quo mechanism the outages will lead to significantly different penalties between asset configurations.

Outage durations and lost capacities

Capacity Outage (% Lost)									
Option	Outage (Hours)	1a	1b	2a	2b	3	4	5	6
Planned									
Transformer Maintenance - Minor	12	25%	25%	25%	25%	50%	25%	-	25%
Tap-changer Replacement	48	25%	25%	25%	25%	50%	25%	-	25%
Circuit Breaker Maintenance	1	50%	25%	100%	100%	50%	100%	100%	100%
Converter Maintenance	72	-	-	100%	100%	-	100%	-	100%
Unplanned									
Transformer Failure - Minor	720	25%	25%	25%	25%	50%	25%	-	25%
Circuit Breaker Failure	720	50%	50%	100%	100%	50%	100%	-	100%
AC Cable Failure	4320	50%	25%	50%	25%	50%	50%	100%	50%
DC Cable Failure	4320	-	-	100%	100%	-	100%	-	100%
Converter Failure	720	-	-	100%	100%	-	100%	-	100%

Lost capacity during unplanned AC cable failure



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2. Transitional Regime Availability Incentive

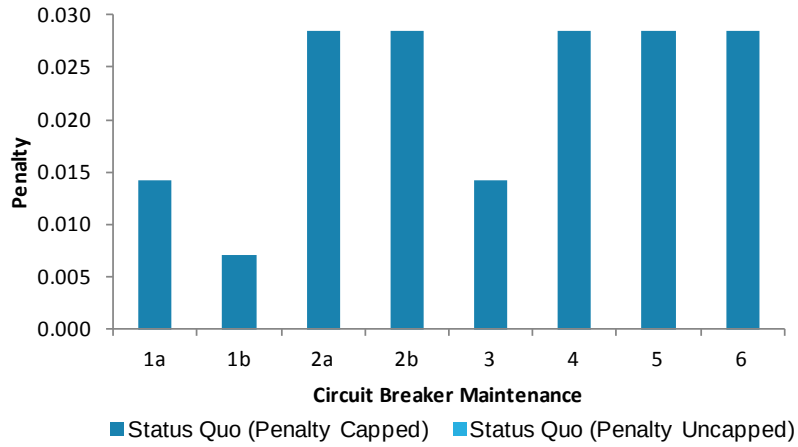
Using the Status Quo mechanism there is clear variation in the scale of penalties across the different configurations for given outages

Status Quo mechanism - penalties awarded

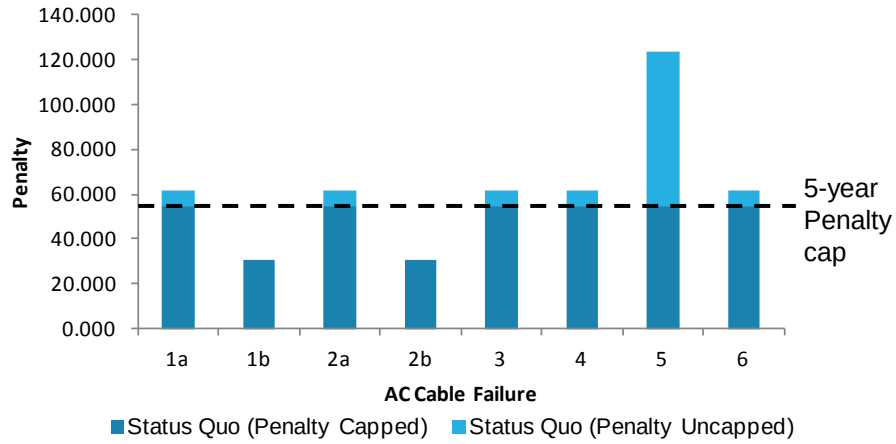
- Given the linear relationship between unavailability and penalties incurred, percentage lost revenue (as detailed in the table below) follows a similar pattern to lost capacity.
- The adjacent figures show the percentage lost revenue for circuit breaker maintenance and severe unplanned AC cable failure events. For the cable failure event it illustrates that the lost revenue cap restricts further lost revenues and the potential size of a penalty.
- The AC cable failure is assumed to require 6 months to repair, this represents an upper bound duration for a failure of this kind. It would lead to many of the configurations immediately reaching the 50% lost revenue limit over 5 years.
- Under the Status Quo mechanism there is a clear variation in the scale of penalties across the configurations. The incentive mechanism is starting from a point where OFTOs with greater redundancy, such as the configuration 1b, will receive lower penalties. This variation may be exaggerated through the introduction of enhancements that favour lower capacity outages.

Penalty Awarded								
Option	1a	1b	2a	2b	3	4	5	6
Planned								
Transformer Maintenance - Minor	0.086	0.086	0.086	0.086	0.171	0.086	-	0.086
Tap-changer Replacement	0.342	0.342	0.342	0.342	0.684	0.342	-	0.342
Circuit Breaker Maintenance	0.014	0.007	0.029	0.029	0.014	0.029	0.029	0.029
Converter Maintenance	-	-	2.053	2.053	-	2.053	-	2.053
Unplanned								
Transformer Failure - Minor	5.133	5.133	5.133	5.133	10.267	5.133	-	5.133
Circuit Breaker Failure	10.267	10.267	20.534	20.534	10.267	20.534	-	20.534
AC Cable Failure	55.000	30.801	55.000	30.801	55.000	55.000	55.000	55.000
DC Cable Failure	-	-	55.000	55.000	-	55.000	-	55.000
Converter Failure	-	-	20.534	20.534	-	20.534	-	20.534

Lost revenue due to planned circuit breaker maintenance



Lost revenue due to an unplanned AC cable failure



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3. Option Identification

Option identification involved consideration of the objectives of the availability incentive, additional benefits of enhancements and an understanding of OFTO operational behaviour and commercial drivers

Option Identification

- The first stage of our work was to identify enhancement options and produce a list of potential alternatives.
- The following page provides the list of enhancement options with a brief description. The objective has been to produce adaptations to the current availability incentive mechanism, as opposed to making fundamental changes. As a result, each of the options either adds to the Status Quo mechanism or makes alterations to how it operates. Consequently, the enhancement descriptions highlight the differences from the Status Quo.
- The option identification process involved consideration of additional benefits that could be achieved through introducing enhancements to the Status Quo mechanism, the objectives of the availability incentive and an understanding of OFTO operational behaviour and commercial drivers.
- Following identification of the enhancement options an initial assessment of the key advantages and disadvantages was undertaken. This process aimed to confirm the merits of the different options.
- The options identified represent those which are considered to be potentially suitable at the current time. However, as the OFTO regime evolves it may become appropriate to further explore refinements to the availability incentive.

3. Option Identification – Enhancement Options

Nine enhancement options have been identified in addition to the Status Quo mechanism. All are either additions or variations to the Status Quo

- Below is the list of options that have been identified as potential enhancements to the availability mechanism for the OFTO Regime, this includes the Status Quo mechanism;
- **1. Status Quo** – Considers only units of unavailability (in MWh). Each unit of unavailability is weighted equally regardless of the total lost capacity, length of outage or lost transmission.
- **2. Capacity weighting** – Considers only units of unavailability, but gives a proportionally higher penalty for higher capacity outages. This mechanism would not consider lost transmission.
- **3. Penalty reduction mechanism based on lost transmission** – Based on the Status Quo mechanism (No.1), but reduces penalties that do not have an impact on electricity transmission. For example, at a time of no energy generation, OFTO outages would not lead to a penalty. Alternatively, if the OFTO was 85% available at a time of 90% wind generation, only 5% of the lost OFTO unavailability would be penalised.
- **4. Capacity weighting with penalty reductions** - This would apply the Penalty Reduction Mechanism (No. 3) to the Capacity Weighting (No. 2). It would lead to proportionally greater penalties for higher capacity outages, but the penalties would be amended based on the lost electricity transmission.
- **5. Capacity weighting for planned outages and penalty reduction of unplanned outages** – For planned outages a larger capacity outage would lead to a proportionally higher penalty. For unplanned outages, unavailability would be weighted equally, but penalties would be reduced based on the amount of lost electricity transmission.
- **6. Duration weighting for unplanned outages** – Considers the units of unavailability (MWh), but gives a proportionally higher penalty for longer duration unplanned outages. The greater the outage length, the greater the penalty for each unit of unavailability. This mechanism would not consider the lost capacity of each outage or the lost potential transmission.
- **7. Penalty deduction mechanism based on generators scheduled unavailability** – Based on Penalty Reduction Mechanism (No. 3) but reduces penalties for planned maintenance outages that are timed during a maintenance window(s) designated by the generator. For example, the generator could specify a point with significant advanced warning where the OFTO could undertake planned maintenance without being penalised.
  - This could allow the generator to accurately control when an OFTO undertakes maintenance, whilst providing the OFTO with sufficient warning.
- **8. Capacity weighting for planned maintenance and duration weighting for unplanned maintenance** – Based on Status Quo mechanism and considers only the units of lost availability. Gives a proportionally higher penalty for larger capacity planned outages. Gives a proportionally higher penalty for longer duration unplanned outages.
- **9. Maintenance type weighting** – Based on the Status Quo mechanism (No. 1), but penalises unplanned outages to a greater extent than planned outages.
- **10. Capacity weighting for planned maintenance and maintenance type weighting for unplanned maintenance** – Based on the Status Quo mechanism (No. 1), but gives a proportionally higher penalty for larger capacity planned outages and penalises unplanned outages to a greater extent that planned outages.

Assumptions

- It is assumed that all mechanisms will include a monthly performance weighting as included in the current incentive, so this has not been considered in the analysis.
- All mechanisms include a 50% revenue impact cap for outages in one year, spread over 5 years giving a 10% annual cap on revenue impact.

Planned and unplanned maintenance

- It is generally considered that proactive and comprehensive planned maintenance can lead to a reduced risk of unplanned failures. Options No. 9 and 10 have been developed to provide OFTOs with incentivisation to undertake sufficient planned maintenance.

3. Option Identification – Initial Assessment

The table below provides the key advantages and disadvantages for each of the enhancements

- The following table provides details of the key advantages and disadvantages of each enhancement option that has been identified. This process provided an initial assessment of the options and confirmation that they merit further consideration. The Status Quo mechanism has been provided to allow comparison.

Incentive	Advantages	Disadvantages
1. Status Quo	• Simple and understood by the industry • Provides efficient cost of capital, as leads to well priced bids • There would be no material distinction between the status quo and future incentives • No generation risk: OFTO revenue is independent of the electrical output of the wind farm	• Does not account for more integrated networks, where power may be rerouted, as there is no incentive to reroute power where possible • Penalises OFTOs for outages that do not affect the generator's ability to export. It reduces OFTO revenue where there is no lost transmission. This could potentially increase TRS, but without providing value to the consumer. • Does not incentivise the OFTO to undertake smaller capacity outages where possible, so reducing the risk of lost transmission
2. Capacity weighting	• Considers available capacity, which directly impacts the generator's ability to export electricity. Where an OFTO is able to change it's behaviour, it will benefit consumers by encouraging greater available capacity at any given time, so maximising output • Provides OFTOs with more incentive to avoid large capacity failures, compared to the Status Quo, so may encourage more proactive asset management • Is a relatively simple change to the Status Quo, assuming a uniform amendment.	• Penalises OFTOs for outages that do not affect the generator's ability to export. It reduces OFTO revenue where there is no lost transmission. This could potentially increase TRS, but without providing value to the consumer. • If it was decided to vary the mechanism with asset configuration it may add complexity and reduce transparency • May be difficult to develop an appropriate weighting profile as the impact on different asset configurations will vary. Although the Status Quo mechanism does currently produce variation to a lesser extent.

3. Option Identification – Initial Assessment

The table below provides the key advantages and disadvantages for each of the enhancements

Incentive	Advantages	Disadvantages
3. Penalty reduction mechanism based on lost transmission	• Takes into account outage impact on lost transmission. This could incentivise the OFTO to align outages with times of expected low electricity generation, and to reroute power where possible, with the hope to achieve penalty reductions	• Windfarms generally operate constantly running maintenance programs, so there may not be times of significant wind farm unavailability, with which the OFTO can coordinate • Unplanned maintenance at times of low generation may be fixed less promptly, compared to the Status Quo, if penalties are to be reduced • The OFTOs will not be flexible enough with their planned outages to accommodate sudden changes in either actual or short term forecast changes in electricity production • Calculating lost transmission may not be simple or robust. It may also increase the reporting requirements on OFTOs, generators and Ofgem • May introduce downside risk to OFTOs due to aggressive bidding strategies. This would result from OFTOs including penalty reduction in bids, so OFTO bids incorporating generation risk
4. Capacity weighting with penalty reduction	• Considers available capacity, which directly impacts the generator's ability to export electricity. Where an OFTO is able to change it's behaviour, it will benefit consumers by encouraging greater available capacity at any given time • Takes into account outage impact on lost transmission. This could incentivise the OFTO to align outages with times of expected low electricity generation, and to reroute power where possible, with the hope to achieve penalty reductions • Provides OFTOs with more incentive to avoid large capacity failures, compared to the Status Quo, so may encourage more proactive asset management	• Would add significant complexity • If it was decided to vary the mechanism with asset configuration it may add complexity and reduce transparency • Windfarms generally operate constantly running maintenance programs, so there may not be times of significant wind farm unavailability, with which the OFTO can coordinate • Unplanned maintenance at times of low generation may be fixed less promptly, compared to the Status Quo, if penalties are to be reduced • The OFTO will not be flexible enough with their planned outages to accommodate sudden changes in either actual or short term forecast changes in electricity production • Calculating lost transmission may not be simple or robust. It may also increase the reporting requirements on OFTOs, generators and Ofgem • May introduce downside risk to OFTOs due to aggressive bidding strategies. This would result from OFTOs including penalty reduction in bids, so OFTO bids incorporating generation risk

3. Option Identification – Initial Assessment

The table below provides the key advantages and disadvantages for each of the enhancements

Incentive	Advantages	Disadvantages
5. Capacity weighting for planned outages and penalty reduction for unplanned outages	• Takes into account lost capacity in planned maintenance. This will incentivise low capacity outages, so maximising the ability to transmit electricity at any given time • Does not penalise the OFTO for unplanned outages which do not affect electricity transmission • Would incentivise the re-routing of electricity where applicable	• Would add significant complexity • Requirement to distinguish between planned and unplanned outages in the incentive mechanism would increase complexity • If it was decided to vary the mechanism with asset configuration it may add complexity and reduce transparency • May penalise OFTOs less for unplanned outages, which is not appropriate. Maintenance reduces the risk of unplanned failures, so provides the wrong incentive • Unplanned maintenance at times of low generation may be fixed less promptly, compared to the Status Quo, if penalties are to be reduced • Calculating lost transmission may not be simple or robust. It may also increase the reporting requirements on OFTOs, generators and Ofgem • May introduce downside risk to OFTOs due to aggressive bidding strategies. This would result from OFTOs including penalty reduction in bids, so OFTO bids incorporating generation risk
6. Duration weighting for unplanned outages	• Direct incentive on OFTOs to repair unplanned outages more quickly • It could, depending on the detail of the mechanism, be a relatively simple change from the Status Quo	• Penalises OFTOs for outages that do not affect the generator's ability to export. It reduces OFTO revenue where there is no lost transmission. This could potentially increase TRS, but without providing value to the consumer. • Does not account for more integrated networks, where power may be rerouted, as there is no incentive to reroute power where possible • Reporting against this mechanism could be complex and may require significant changes to the reporting processes that are currently being employed
7. Penalty reduction mechanism based on generators scheduled unavailability	• Allows the developer to define when periods of unavailability may be more acceptable, either considering wind farm unavailability or times of expected low generation • Keeps generation risk purely with the generator • Gives the OFTO advance warning to which it may be able to react	• Windfarms generally operate constantly running maintenance programs, so there may not be times of significant wind farm unavailability • Complexity will be added to the Status Quo mechanism to implement this enhancement • May not lead to improved behaviour over the Status Quo mechanism as OFTOs are already incentivised to undertake maintenance in summer months

3. Option Identification – Initial Assessment

The table below provides the key advantages and disadvantages for each of the enhancements

Incentive	Advantages	Disadvantages
8. Capacity weighting for planned maintenance and duration weighting for unplanned maintenance	• Takes into account lost capacity in planned maintenance. This will incentivise low capacity outages, so maximising the ability to transmit electricity at any given time • Direct incentive on OFTOs to repair unplanned outages more quickly	• Would add significant complexity • Reporting against the duration mechanism could be complex and may require significant changes to the reporting processes that are currently being employed • Requirement to distinguish between planned and unplanned outages in the incentive mechanism would increase complexity • Penalises OFTOs for outages that do not affect the generator's ability to export. It reduces OFTO revenue where there is no lost transmission. This could potentially increase TRS, but without providing value to the consumer.
9. Maintenance type weighting	• Incentivises OFTOs to undertake preventative and predictive maintenance. A proactive planned maintenance regime will lead to fewer unplanned outages, which can cause more significant unavailability • Relatively simple change to the current availability incentive	• Requirement to distinguish between planned and unplanned outages would increase reporting complexity • Penalises OFTOs for outages that do not affect the generator's ability to export. It reduces OFTO revenue where there is no lost transmission. It increases OFTO risk, so potentially TRS, but without providing value to the consumer. • Does not account for more integrated networks, where power may be rerouted, as there is no incentive to reroute power where possible • It may lead to mistakes in reporting maintenance types, so impacting penalties
10. Capacity weighting for planned maintenance and maintenance type weighting for unplanned maintenance	• Considers available capacity, which directly impacts the generator's ability to export electricity. Where an OFTO is able to change it'sbehaviour, it will benefit consumers by encouraging greater available capacity at any given time, so maximising output • Incentivises OFTOs to undertake preventative and predictive maintenance by reducing penalties for planned and unplanned outages • Provides OFTOs with more incentive to avoid large capacity failures, compared to the Status Quo, so may encourage more proactive asset management	• Penalises OFTOs for outages that do not affect the generator's ability to export. It reduces OFTO revenue where there is no lost transmission. This could potentially increase TRS, but without providing value to the consumer. • If it was decided to vary the mechanism with asset configuration it may add complexity and reduce transparency • May be difficult to develop an appropriate weighting profile as the impact on different asset configurations will vary. Although the Status Quo mechanism does currently produce variation • Requirement to distinguish between planned and unplanned outages in the incentive mechanism would increase complexity • It may lead to mistakes in reporting maintenance types, so impacting penalties

Contents

4. Qualitative Option Appraisal

The appropriateness of enhancements for the OFTO Regime was appraised using a selection of assessment criteria. These considered OFTO behaviour, investment risk profile and incentive practicality

Qualitative Option Appraisal

- To assess which of the enhancement options is the most suitable for the OFTO Regime a qualitative assessment has been undertaken. This required production of a series of assessment criteria that reflect Ofgem's objectives for the availability incentive.
- Each of the enhancement options has been assessed against the criteria using the Status Quo mechanism as a benchmark.
- The aim was to assess which enhancements could lead to improvements against the criteria without leading to material negative impacts. This analysis does not attempt to rank the enhancements and only provides a comparison to the Status Quo, not the other options.
- The analysis indicated which options may be the most appropriate enhancements to the OFTO Regime. These will be presented to OFTO stakeholders and subject to further analysis.
- To allow the different availability incentive options to be assessed, the following criteria have been identified. The following pages provides an assessment matrix that assesses each incentive against the criteria relative to the Status Quo mechanism.

Assessment criteria

- **Incentive to avoid unplanned repairs** – Does the enhancement encourage the OFTO to undertake appropriate maintenance during the life of assets, so avoiding unplanned maintenance?
- **Incentive to undertake prompt repairs/maintenance** – Does the enhancement encourage rapid maintenance or repair of unplanned failures?
- **Incentive to undertaken appropriate planned maintenance** – Does the enhancement encourage planned maintenance to be undertaken in a manner which reduces lost electricity transmission, such as lower capacity outages and maintenance at a time of low generation?
- **Encourages appropriate risk transfer** – Does the enhancement transfer risks to the OFTO that it can manage?
- **Impact on risk profile** – Could the enhancement have an impact on the OFTO investment risk profile with respect to the Status Quo?
- **Clarity of mechanism** – How complicated is the enhancement? Will it lead to the confusion of investors and other stakeholders?
- **Incentive practicality** – Are the data requirements of the enhancement practical? Can it be independently verified? Will the mechanism be robust?
- The assessment considers each option against the assessment criteria individually. The clarity and practicality of the enhancements are considered to be critically important to Ofgem, therefore any adverse movements in these criteria would need to be balanced with significant benefits in behavioural change. This consideration has played a key part in determining which enhancements are the most appropriate.

4. Qualitative Option Appraisal – Incentive Assessment Matrix

The evaluation matrix below assesses each enhancement against the assessment criteria. The enhancements have been considered relative to the Status Quo mechanism

Incentive	Behaviour			Appropriate risk transfer	Investors		Incentive practicality
	Avoid unplanned repairs	Prompt repairs/ maintenance	Appropriate planned maintenance		Impact on risk profile	Clarity of mechanism	
1. Status Quo	-	-	-	-	-	-	-
2. Capacity weighting	Incentive to avoid large unplanned failures	No significant change from the Status Quo	Encourages low capacity outages	No significant change from the Status Quo	No significant change from the Status Quo	Adds minor complexity[1]	No significant change from the Status Quo[1]
3. Penalty reduction mechanism based on lost transmission	No significant change from the Status Quo	Less incentive to repair during low generation	Indirectly encourages low capacity outages	Aggressive bidding may introduce generation risk	Aggressive bidding may introduce generation risk	Adds material complexity	Requires estimation of lost transmission and multiple information sources
4. Capacity weighting with penalty reduction	Incentive to avoid large unplanned failures	Less incentive to repair during low generation	Encourages low capacity outages	Aggressive bidding may introduce generation risk	Aggressive bidding may introduce generation risk	Adds material complexity	Requires estimation of lost transmission and multiple information sources
5. Capacity weighting for planned outages and penalty reduction for unplanned outages	Incentive to avoid large unplanned failures	Less incentive to repair during low generation	Encourages low capacity outages	Aggressive bidding may introduce generation risk	Aggressive bidding may introduce generation risk	Adds material complexity	Requires estimation of lost transmission and multiple information sources

[1] Assessment of the Capacity Weighting (No. 2) assumes that all OFTOs would have the same capacity weighting profile. However, if a variety of weighting profiles were required for the different OFTO asset configurations, the impact on the mechanism clarity and practicality would be more negative

4. Qualitative Option Appraisal – Incentive Assessment Matrix

The evaluation matrix below assesses each enhancement against the assessment criteria. The enhancements have been considered relative to the Status Quo mechanism

Incentive	Behaviour			Appropriate risk transfer	Investors		Incentive practicality
	Avoid unplanned repairs	Prompt repairs/ maintenance	Appropriate planned maintenance		Impact on risk profile	Clarity of mechanism	
6. Duration weighting for unplanned outages	Incentive to avoid long unplanned failures	Directly incentivises prompt repair/ maintenance	No significant change from the Status Quo	No significant change from the Status Quo	No significant change from the Status Quo	Adds minor complexity	Problems in allocating acceptable durations
7. Penalty deduction mechanism based on generator's scheduled unavailability	No significant change from the Status Quo	No significant change from the Status Quo	Would not impact behaviour over current monthly weighting and obligation to coordinate outages	No significant change from the Status Quo	No significant change from the Status Quo	Adds minor complexity	Generator already has to provide monthly weightings
8. Capacity weighting for planned maintenance and duration weighting for unplanned maintenance	Increased incentive to avoid large capacity or long unplanned failures	Directly incentivises prompt repair	Encourages low capacity outages	No significant change from the Status Quo	No significant change from the Status Quo	Adds material complexity	Availability not currently reported by duration and planned and unplanned need to be reported separately
9. Maintenance type weighting	Incentive to avoid unplanned maintenance over planned maintenance	No significant change from the Status Quo	Encourages preventative and predictive maintenance	No significant change from the Status Quo	No significant change from the Status Quo	No significant change from the Status Quo	Additional complexity. Planned and unplanned maintenance must be reported separately.

4. Qualitative Option Appraisal – Incentive Assessment Matrix

The evaluation matrix below assesses each enhancement against the assessment criteria. The enhancements have been considered relative to the Status Quo mechanism

Incentive	Behaviour			Appropriate risk transfer	Investors		Incentive practicality
	Avoid unplanned repairs	Prompt repairs/ maintenance	Appropriate planned maintenance		Impact on risk profile	Clarity of mechanism	
10. Capacity weighting for planned maintenance and maintenance type weighting for unplanned maintenance	Incentive to avoid unplanned maintenance over planned maintenance	No significant change from the Status Quo	Encourages preventative and predictive maintenance and low capacity outages	No significant change from the Status Quo	No significant change from the Status Quo	Adds minor complexity[1]	Additional complexity. Planned and unplanned maintenance must be reported separately

[1] Assessment of enhancement No. 10 assumes that the all OFTO would have the same capacity weighting profile. However, if a variety of weighting profiles were required for the different OFTO asset configurations, the impact on the mechanism clarity and practicality would be more negative

4. Qualitative Option Appraisal – Conclusions

The qualitative assessment has indicated that the Status Quo, Capacity Weighting, Maintenance Type Weighting and Combined Enhancement mechanisms may be most appropriate for the OFTO Regime

Recommended Enhancements

- Based on the qualitative assessment of the availability incentive enhancements, the following options have been assessed to be most suitable going forward and should be presented to stakeholders and be subject to further analysis. These enhancements were considered to have a clear positive impact on the incentivisation of the OFTO, without leading to a significant negative impact compared to the Status Quo.

Status Quo

- The Status Quo provides a successfully implemented comparator against which the other enhancement options can be assessed. It may also be appropriate to apply the Status Quo mechanism for the future tenders.

Capacity weighting

- The Capacity Weighting could provide strong incentivisation for an OFTO to plan for low capacity outages and should also increase the incentivisation to avoid large capacity unplanned outages.
- In its simplest form, where all OFTOs receive the same weighting profile, this incentive will lead to a minor increase in the level of complexity. However, should different configurations receive different availability profiles, then the complexity would increase significantly.
- The aim of this measure is to encourage more small capacity outages compared to fewer large capacity outages, but in some situations a large capacity outage may be required. Consequently, the weighting profile will have to be appropriately configured to ensure the incentive does not encourage the deferral of high capacity planned maintenance.

Maintenance type weighting

- A differential weighting would allow unplanned outages to incur greater penalties that planned outages. This should provide increased incentivisation to OFTOs to undertake sufficient planned maintenance to avoid unplanned outages.
- The level of incentivisation provided to OFTOs will depend on the respective weightings of planned and unplanned maintenance.
- However, this enhancement does have a potential negative impact on the practicality of the availability incentive. It increases complexity due to the need to define and report on planned and unplanned maintenance separately. It may also lead to mistakes in reporting maintenance types, so impacting penalties.

Capacity weighting for planned maintenance and maintenance type weighting for unplanned maintenance ('Combined Enhancement')

- The Combined Enhancement incorporates the strengths of the other two enhancements. Through applying a capacity weighting it should incentivise low capacity planned maintenance and increasing unplanned penalties OFTOs should encourage preventative and predictive maintenance.
- However, combining the enhancements will lead to the negative attributes of both being brought into the availability mechanism. This will include the need to treat planned and unplanned maintenance separately, and, by incorporating two enhancements, it will lead to a greater departure from the Status Quo than either would individually, so creating greater complexity. Additionally, the weighting profile will have to be appropriately configured to ensure the incentive does not encourage the deferral of high capacity planned maintenance.

4. Qualitative Option Appraisal – Conclusions

The remaining enhancements were generally considered unsuitable because they may have significant negative impacts on incentive practicality or the investment risk profile of OFTOs

Unsuitable Enhancements

- The remaining options were considered to be unsuitable for the OFTO Regime given Ofgem's objectives.

Penalty reduction mechanism based on lost transmission

- The key aim of this mechanism is to incentivise the OFTO to reduce lost transmission by undertaking maintenance at times of low generation. However, due to the need to provide advanced warning to the Transmission System Operator regarding outages and the lead times associated with vessels and maintenance crews, an OFTO could not respond at short notice to forecast or actual low generation.
- In order to maximise the benefit of this mechanism, an OFTO would plan maintenance for summer months, so increasing the chance of it occurring at a time of low generation. Additionally, an OFTO would minimise the capacity of outages, so reducing the chance of impacting transmission and minimising penalties.
- As a result, this mechanism would not provide any additional incentive over the Capacity Weighting combined with well thought out monthly weightings, the provision for which is in the Status Quo mechanism. The Penalty Reduction Mechanism does, however, produce a number of negative impacts.
- Firstly, compared to the Status Quo, an OFTO would have less incentive to repair unplanned failures during times of low generation. Using the Status Quo mechanism, the OFTO would be penalised, but using a penalty reduction mechanism it may not. Given that wind speeds are variable and difficult to forecast, this could lead to lost transmission when generation increases.
- Secondly, OFTOs may incorporate an expected level of penalty reduction into their bids, which would introduce generation risk to the OFTO's equity case. When an expected level of penalty reduction is not achieved, due to greater than expected electricity production, this would represent a downside risk. This could have a negative impact on the investment risk profile and the appropriate risks transferred to the OFTO, generally changing the perceived investment profile of the assets by the industry.
- Finally, as lost electricity generation cannot be measured directly, it would need to be estimated. This requires accurate wind measurements and an accepted calculation.
- These reasons are applicable to all enhancements which contain a penalty reduction mechanism, meaning they have not been recommended as suitable for the OFTO Regime.

4. Capacity weighting with penalty reduction

- Combining the Capacity Weighting and Penalty Reduction Mechanisms does not provide any additional positive impacts over the Capacity Weighting on its own. However it does include all the negative aspects associated with the Penalty Reduction Mechanism.

5. Capacity weighting for planned outages and penalty reduction for unplanned outages

- This option is also a hybrid of Capacity Weighting and Penalty Reduction Mechanisms, but splits the different mechanisms between planned and unplanned maintenance. With respect to the assessment criteria, it leads to very similar impacts to Option 4.
- By reporting planned and unplanned outages separately, it leads to an additional practicality issues as the Status Quo does not make this distinction.
- As discussed above, as it includes the Penalty Reduction Mechanism, this mechanism is not considered suitable for the OFTO Regime.

4. Qualitative Option Appraisal – Conclusions

The remaining enhancements were generally considered unsuitable because they may have significant negative impacts on incentive practicality or the investment risk profile of OFTOs

6. Duration weighting for unplanned outages

- For this option to work correctly each fault type would need to be allocated an appropriate maintenance time and the OFTOs would have to report the maintenance type with each outage. This leads to significant issues with practicality. Firstly, how would an appropriate maintenance time be calculated for each outage? Secondly, it may also lead to mistakes in reporting maintenance types, so impacting penalties.
- Other issues with this option include the risk that it could incentivise fast, unsafe repairs and that it could change the way in which availability is currently reported to Ofgem.
- For these reasons all options that contain the Duration Weighting Mechanism are considered to be unsuitable.

7. Penalty deduction mechanism based generator's scheduled unavailability

- It was considered that this option would provide no additional incentivisation compared to the monthly performance weighting mechanism that is included in the Status Quo. Firstly, windfarms normally undertake a fairly consistent level of maintenance, so there are no specific times of planned low generation that would be suitable for an OFTO to undertake its maintenance. Secondly, the generator provides the current performance weighting mechanism that will take into account the expected time of low generation. Additionally, the licence obliges OFTOs to coordinate outages with the generator.

8. Capacity weighting for planned maintenance and duration weighting for unplanned maintenance

- It is possible that this option could further align OFTO behaviour with the assessment criteria. This would be achieved through encouraging both low capacity planned outages and the prompt repair of unplanned outages. However, due to the reasons explained above, the Duration Weighting Mechanism leads to significant problems with its practicality. Therefore, as explained above, this option is not considered suitable.

Contents

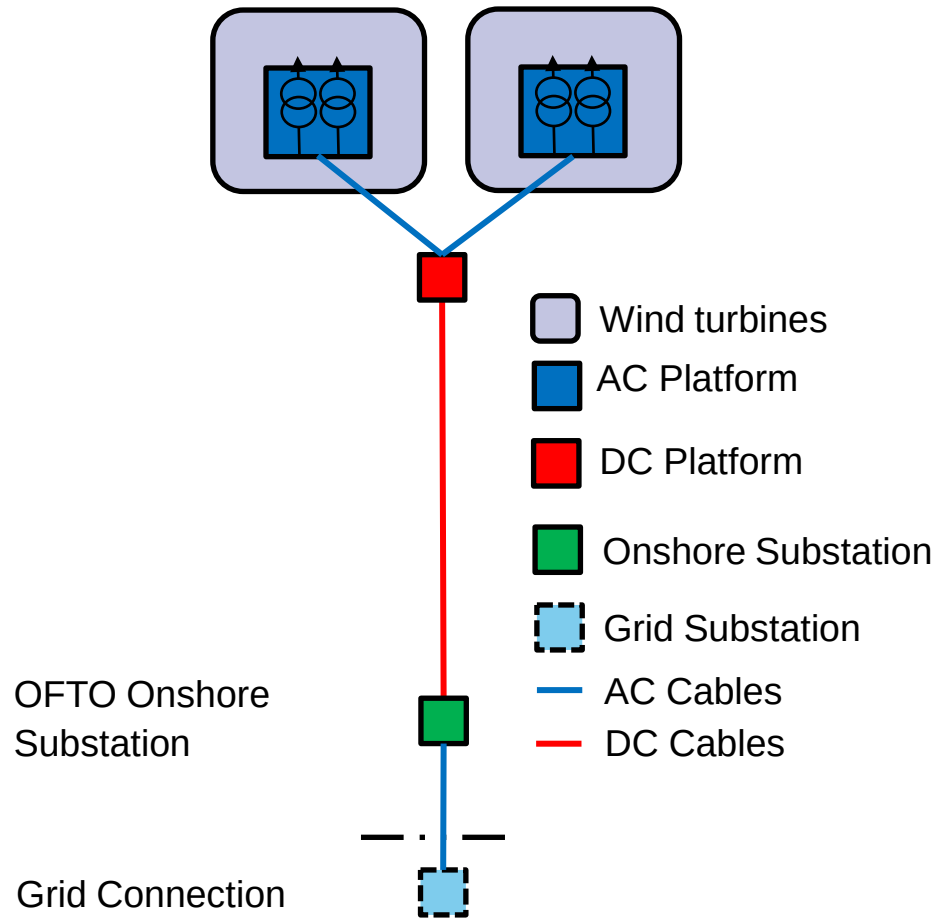
Appendix 1 – Introduction

Introduction

- For a given enhancement, the impact on the OFTO will vary depending on the asset configuration. Therefore, it is appropriate to consider a selection of asset configurations when assessing an availability incentive. This appendix presents the asset configurations that have been used during our engagement.

Asset configurations

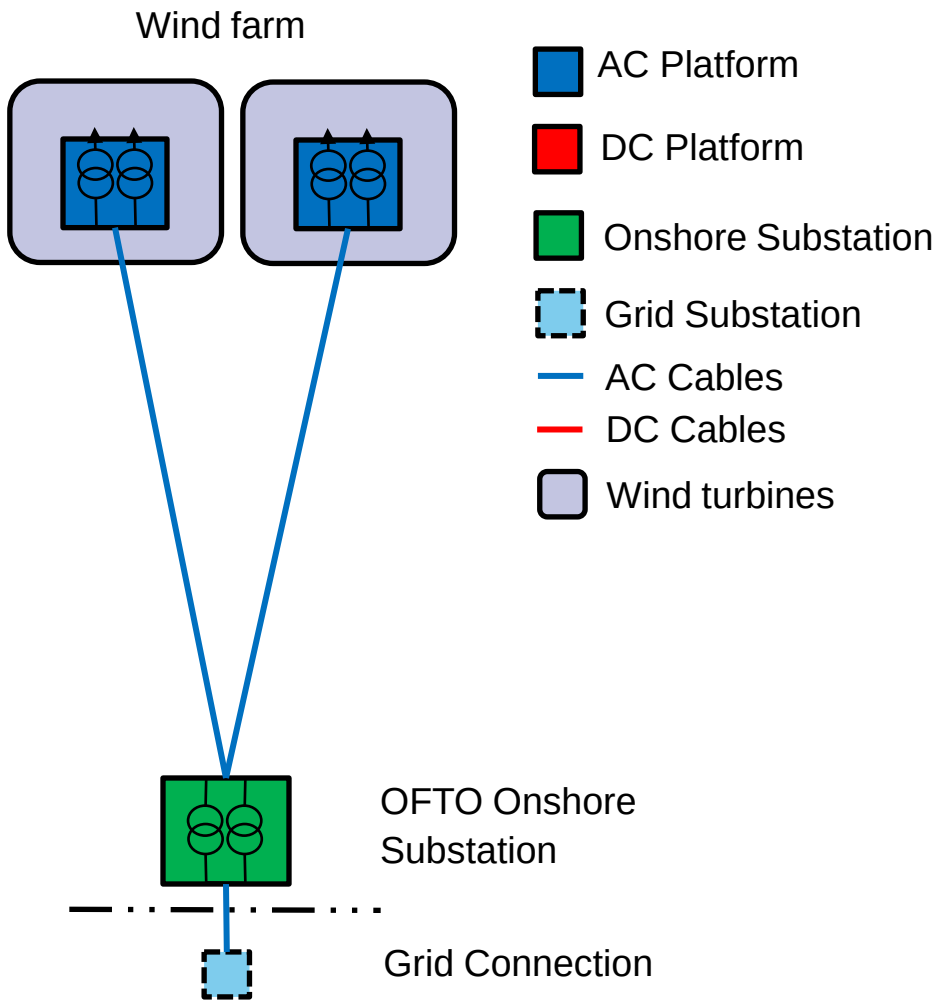
- The following pages provide high-level details of the asset configurations that have been assessed. They are illustrated using diagrams, as shown on the right, and in a summary table.
- These asset configurations have been chosen to represent the OFTO configurations that may be deployed in the early stages of the OFTO Regime.
- Each 'block' of wind turbines is assumed to represent up to 500MW of installed capacity, so the adjacent diagram could illustrate a 1000MW windfarm with a DC link to the onshore substation.



Appendix 1 – Asset Configuration 1a and 1b

Simple AC connection

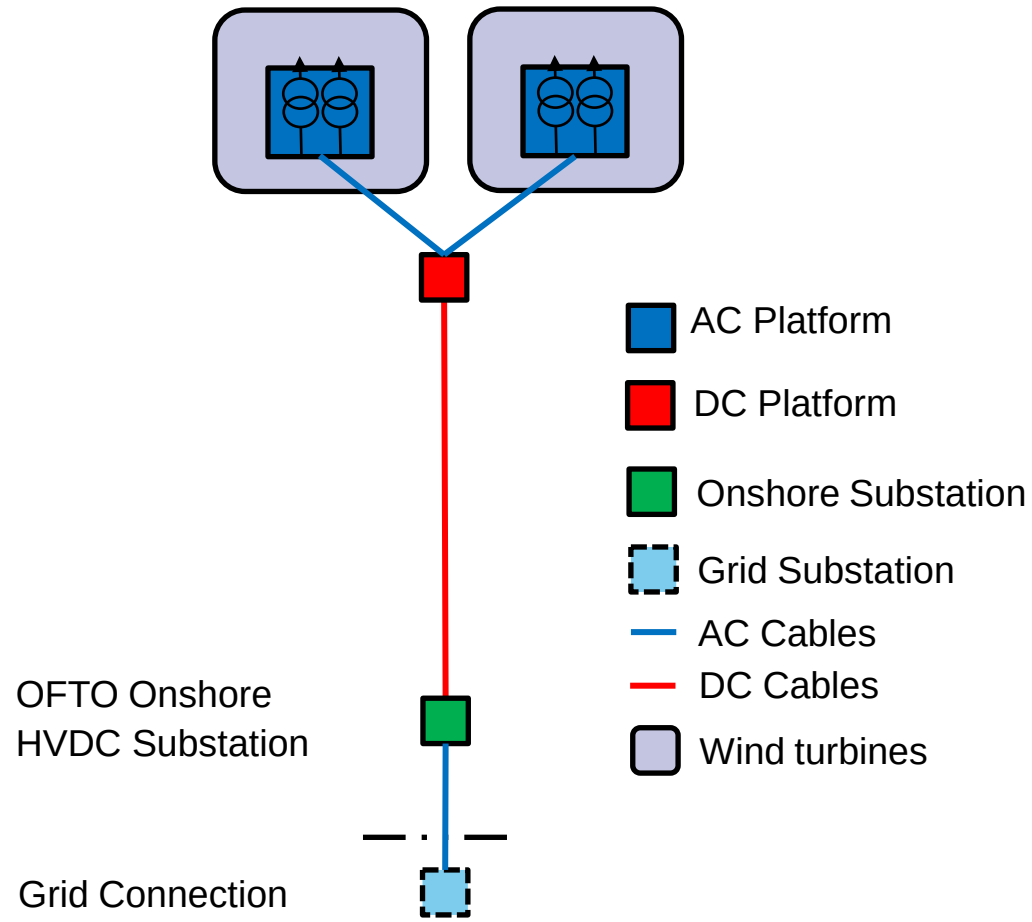
- This configuration represents the simplest AC asset configuration that is expected to be deployed as a single phase, and has been split into two sub-options.
- It is possible that this configuration could use either one or two circuits to connect each offshore platform. This would lead to a situation with one or two AC cables connecting the offshore platforms to the onshore platform. Therefore configuration 1a consists of one AC cable for each platform, and 1b having two cables for each platform.
- This simple AC connection is generally used for near to shore offshore windfarms (or phases) of nominal capacities of between 500 and 1000MW.
- For transmission lengths of less than 100km AC options may prove to be more cost effective than a HVDC solution.
- The number of cables is largely driven by both windfarm capacity and distance from shore.
- AC configurations more simple than these options have not been considered as it would be unlikely that they would be deployed as a single phase.



Appendix 1 – Asset Configuration 2a and 2b

Simple DC connection

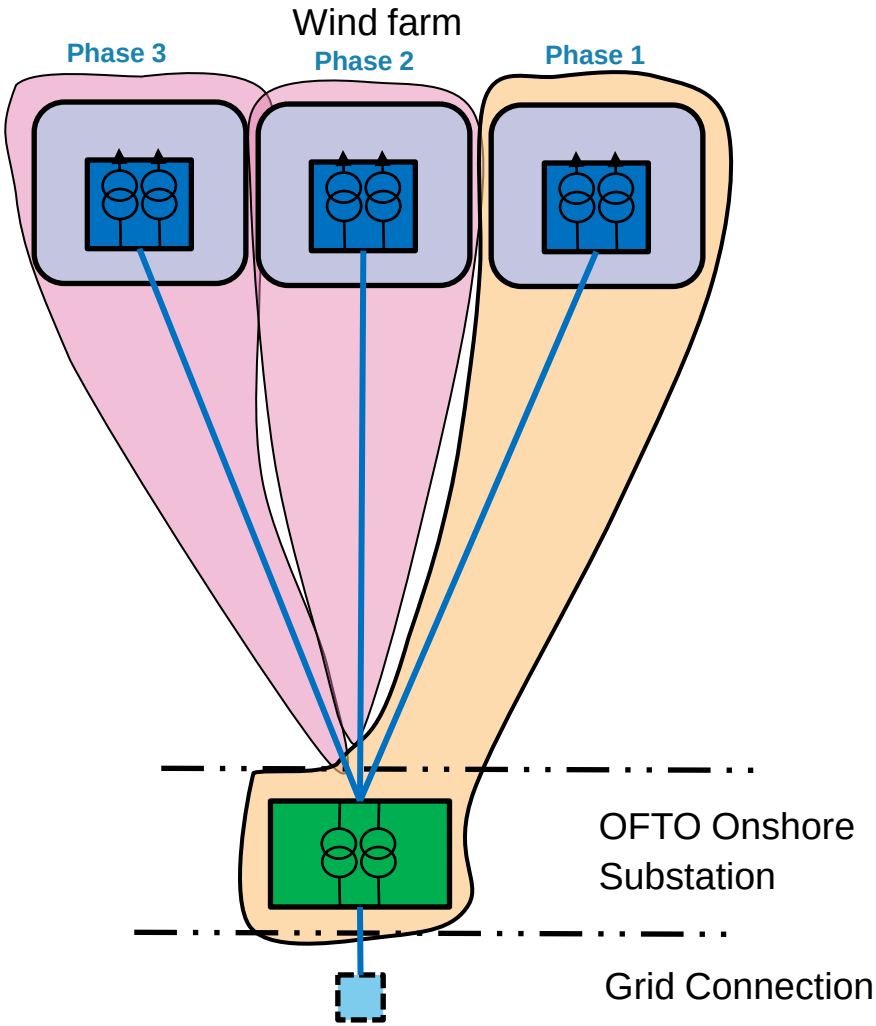
- This configuration represents the simplest DC asset configuration that would be expected to be deployed as a single phase, but there are two sub-options.
- It is possible that this configuration could use either one or two circuits to connect each offshore AC and DC platforms. This would lead to a situation with 1 or 2 AC cables connecting the offshore platforms. Therefore configuration 1a consists of one AC cable for each AC platform, and 1b having two cables for each AC platform.
- Both scenarios would each require 1 DC cable connecting the offshore AC platform to the onshore substation.
- This simple DC connection is generally used for offshore windfarms of nominal capacities of between 500MW and 1000MW where transmission distance are in excess of 80km. HVDC options may prove more cost effective when transmission distances exceed 80km.
- There is an overlap between the suitability of HVAC and HVDC links between 80km and 100km transmission distance.
- DC configurations more simple than these options have not been considered as it would be unlikely that they would be deployed as a single phase.



Appendix 1 – Asset Configuration 3

Simple AC connection with onshore anticipatory build

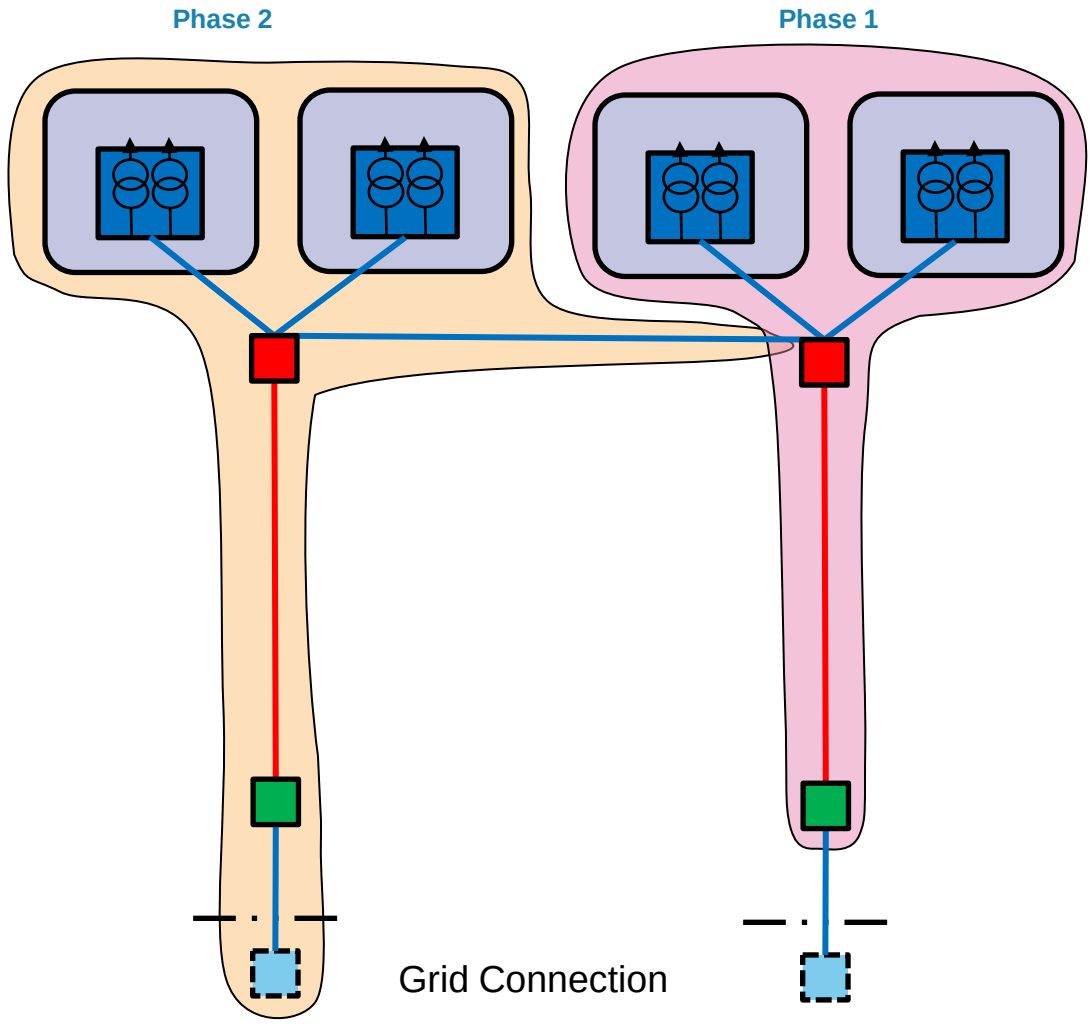
- A developer may choose to construct a windfarm using AC transmission assets in multiple phases, as illustrated in the adjacent diagram. Due to practical (consenting and land constraints), operational (NETS SQSS) and economic (minimum cost) reasons, a single onshore substation may be built and operated by the first OFTO with sufficient capacity to connect future phases.
- This situation would require anticipatory build at the onshore sub-station into which the second and third OFTOs would connect.
- As they are separate phases, it is assumed that each would be tendered as a separate OFTO. Consequently, OFTO 1 would be responsible for one offshore platform, which transmits one third of the installed capacity, and the entire onshore platform, which transmits the entire installed capacity.
- Phase 1 would be the configuration we would assess under this asset configuration.



Appendix 1 – Asset Configuration 4

Complex DC connection

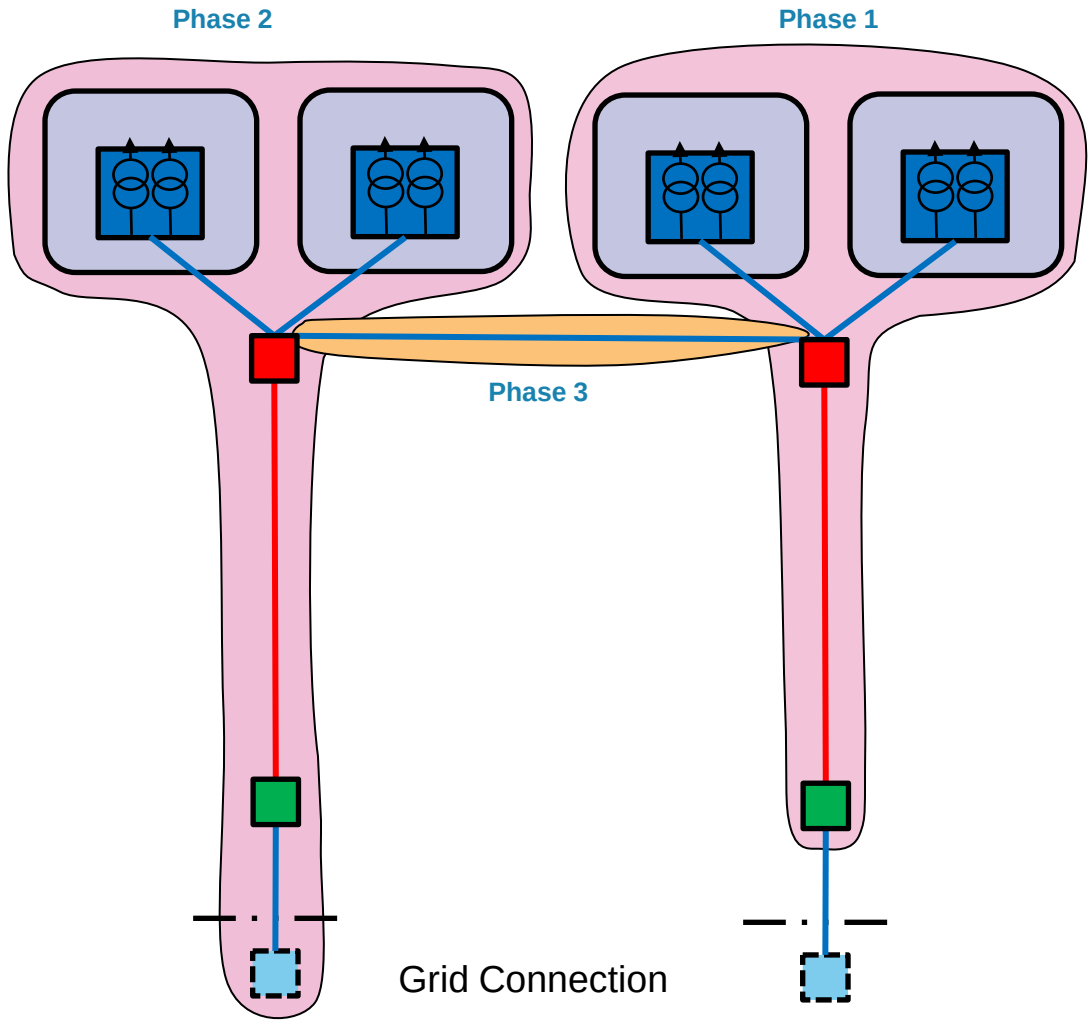
- It is expected that the majority of Round 3 projects, due to their locations offshore, will utilise HVDC transmission as their means of connection. Current HVDC technology limits each HVDC link to approximately 1000MW, meaning windfarms will be developed in units of this size. Where multiple units constitute a larger windfarm, it may prove beneficial to connect each block together to provide alternative paths for power flow, which may reduce the impact of component failure.
- The adjacent diagram shows two units of a windfarm with an interconnection. It is assumed that the first phase was installed as a simple DC connection. The second phase is installed with similar DC link, but includes an AC connection between the two DC platforms.
- In this scenario, Phase 2 would be the assessed asset configuration.



Appendix 1 – Asset Configuration 5

Interconnection only

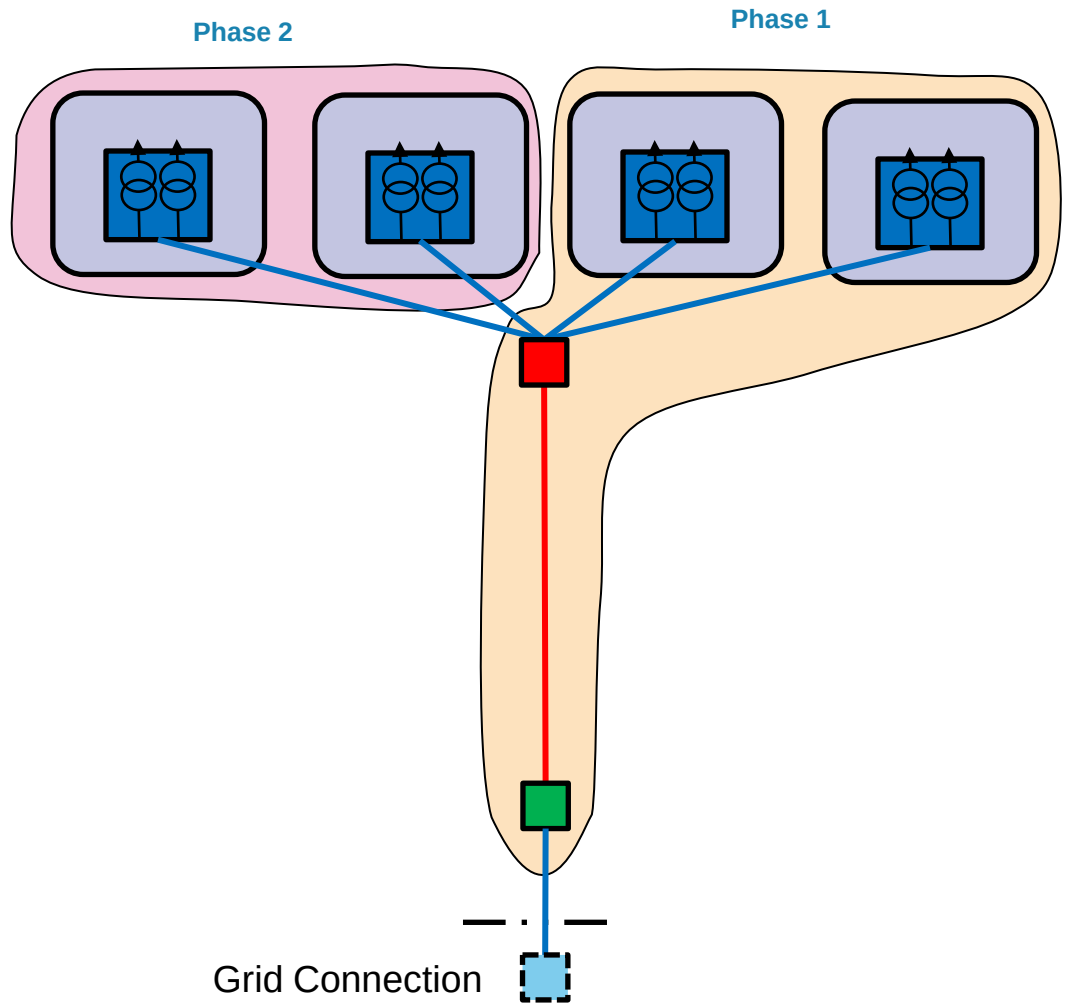
- As with Asset Configuration 4, larger windfarms may wish to include an interconnector. However, for windfarms connecting to multiple onshore locations, the interconnector may be beneficial to the Onshore Transmission Operator as a means of boundary reinforcement. This may be specified after the construction of Phase 2, so requiring a third OFTO.
- Phase 3 would be assessed under this scenario.



Appendix 1 – Asset Configuration 6

Simple DC connection with anticipatory build

- As convertor technology develops, it is expected that later windfarm phases may utilise 2000MW HVDC links. As phases are still expected to be developed in 1000MW, future phases may be connected to an already installed HVDC link.
- Phase 1 would be considered under this scenario.



Appendix 1 – Asset Configuration Summary

- This table provides a summary of the relevant details for each of the eight configurations.

	Option 1a	Option 1b	Option 2a	Option 2b	Option 3	Option 4	Option 5	Option 6
General								
No. AC Platforms	2	2	2	2	1	2		2
No. DC Platforms			1	1		1		1
No. Onshore Platforms	1	1	1	1	1	1		1
AC System								
Transformers per platform	2	2	2	2	2	2		2
Transformer rating	50%	50%	50%	50%	50%	50%		50%
AC Cables per platform	1	2	1	2	2	2		2
Cable Rating	100%	50%	100%	50%	50%	50%		50%
DC System								
Converters per platform			1	1		1		1
DC Cables per platform			1	1		1		1
Cable Rating			100%	100%		100%		100%
Interconnector								
No. Cables						1	1	
Cable Rating						50%	50%	
Onshore Substation								
No. Transformers	2	2			2			
Transformer Rating	50%	50%			50%			
No. Converters			1	1		1		1

Appendix 1 – Outages

Outage events

- The adjacent table presents the planned and unplanned outage events that will be considered in the quantitative analysis as set out for the current availability mechanism in Section 2.
- Planned activities relate to annual maintenance and are based on the maintenance access to primary power equipment that is likely to result in a temporary reduction in available export capacity. Maintenance hours are dependent on the type of equipment.
- Unplanned maintenance is caused by equipment failures and accidental damage resulting in a reduction in export capacity. The former are generally where the equipment is not being operated correctly (overloaded) or maintenance has not been carried out in accordance with the manufacturer's instructions causing premature failure.
- The repair times for offshore transmission systems are heavily dependent on weather conditions and vessel availability, in addition to the availability of spare parts and repair crews. The outage lengths provided are indicative and would be subject to significant variation in reality.
- The outage duration for a cable failure of 720 hours (6 months) is considered to represent the upper bound for a repair of this kind.
- The mean time to failure of cables from internal faults has typically been in the order of >25 years for the OFTO regime to date. With respect to third party damage, this is specific for each asset's location and burial condition.

Failure Type	Lost Capacity for Component (%)	Outage Length (Hours)	Probability of Failure
Planned			
Transformer Maintenance - Minor	100%	12	Annual
Tap-changer Replacement	100%	48	7 years max
Circuit Breaker Maintenance	100%	1	Annual
Converter Maintenance	100%	72	Annual
Unplanned			
Transformer Failure - Minor	100%	720	0.011 per year
Circuit Breaker Failure	100%	720	0.025 per year
Cable Failure	100%	4320	Varies upon number of joints
Converter Failure	100%	720	0.12 per year

Equipment

- **Cables** – effectively maintenance free and thus all outages are unplanned.
- **Transformers** – maintenance is largely non-intrusive involving visual inspection and oil sampling. However, some activities such as testing control and protection systems or the replacement of tap changers requires the isolation of the transformer for safety reasons.
- **Convertor stations** – for simplicity, despite its complex nature consisting of multiple components, a single value has been taken to represent the convertor stations. Maintenance largely consists of replacement of faulty convertor modules and larger outages are a event of combined failures.
- **Circuit breakers** – maintenance is also largely non-intrusive involving visual inspection. However, exercising switches and the testing/operation of control and protection systems require the isolation of the circuit breaker for safety reasons.

Contents

Appendix 3 – Glossary

Glossary of terms	
Abbreviation	**Definition**
AC	Alternative Current
DC	Direct Current
DECC	Department of Energy and Climate Change
HV	High Voltage
ITT	Invitation to Tender
MW	Mega Watt
MWh	Mega Watt Hour
NETSQSS	National Electricity Transmission System Security and Quality of Supply Standard
NGET	National Grid Electricity Transmission
Ofgem	The Office of Gas and Electricity Markets
OFTO	Offshore Transmission Owner
RIGS	Regulatory Instructions and Guidance
TR1	Transitional Regime Round 1
TR2	Transitional Regime Round 2
TRS	Tender Revenue Stream

Craig Forrest
Arup
13 Fitzroy Street
London
W1T 4BQ
t: +44 (0)20 7636 1531
craig.forrest@arup.com

Graeme Bathurst
TNEI Services
2nd Floor Bainbridge House
86-90 London Road
Manchester
M1 2PW
t: +44 (0)16 1233 4800
graeme.bathurst@tnei.co.uk

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