OFTO Availability Incentive

August 2013

Transaction Advice

ARUP

Contents

1. Executive Summary – Background

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. An Offshore Transmission Owner's (OFTO) annual revenue is adjusted through an availability incentive mechanism that considers OFTO performance.
- Ofgem is exploring the opportunity to implement an enhancement to the existing availability mechanism for future licensees. It has undertaken an option appraisal to identify an appropriate enhancement and the proposed alternative solution is known as the Capacity Weighting mechanism.

Status Quo mechanism

- The availability incentive mechanism used in the second round of tenders (TR2) produces adjustments to the base revenue based on performance against an availability target. Meeting the target over an annual period leads to the OFTO receiving 100% of its base revenue. 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 base revenue 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.

Capacity Weighting mechanism

- The Capacity Weighting mechanism is based on the Status Quo mechanism, but incorporates a weighting that impacts the size of penalties based on the proportion of transmission capacity which is lost.
- The aim of the Capacity Weighting is to incentivise OFTOs to maximise availability at any time. This would be achieved by undertaking multiple small capacity planned maintenance activities instead of fewer, large capacity outages.
- The Capacity Weighting utilises a power function to define how the penalties vary with outage capacity. It takes the form ax^{b} with the variables ***a*** and ***b*** defining this relationship. To replicate the current mechanism, the values of both ***a*** and ***b*** need to be 1.

Approach

- Arup have been engaged by Ofgem to assess the financial and behavioural impact of varying ***a*** and ***b***. This report provides a summary of the key results, trends and findings; it does not present the full analysis.
- To assess the impacts of varying the Capacity Weighting variables, a financial model was created for three OFTO configurations during a 20 year project period. Each model includes assumptions on the operational cost, capital cost, financing, planned and unplanned outages and OFTO redundancy.
- OFTO annual revenue for each configuration, given the outage and availability assumptions, is a function of ***a*** and ***b.*** Different combinations of ***a*** and ***b*** have been applied to the models, which calculate financial performance measures such as equity Internal Rate of Return (IRR) and Debt Service Cover Ratio (DSCR). The results using the Capacity Weighting profiles are compared to those using the Status Quo mechanism for each configuration. This provides an indication of how behaviour, bidding strategy and perceived risk profile is impacted by implementation of the enhancement.
- The capacity weighting has been assessed against the following configurations;
  - **Configuration 1 – Simple HVAC** – Two offshore platforms, each with two transformers and export cables. Outages in any of the transformers or cables results in the loss of 25% of transmission capacity.
  - **Configuration 2 – Simple HVDC** – Two offshore AC platforms, each with two transformers and two export cables. The AC export cables connect into one offshore converter platform, which has one converter and one DC export cable. Outages in HVAC transformers and cables lead 25% lost capacity. Outages in the HVDC system result in 100% lost capacity.
  - **Configuration 3 – Three cable HVAC** – Two platforms, each with two transformers. However, one platform has two export cables and other has one. There is also an interconnection between the two platforms. Outages in the offshore transformers lead to 25% lost capacity. Outages in the offshore cables and onshore transformers lead to 33% outages.
- Due to commercial sensitivity the specific results and assumptions used in the analysis are not presented.

1. Executive Summary – Results

- The comments below discuss the impact of changing the variables ***a*** and ***b***, which define the capacity weighting of the incentive. The adjacent graph graphically illustrates how the relationship between penalties and outages capacity changes as ***a*** or ***b*** is increased from the Status Quo values.

Varying *a*

- Increasing ***a*** in isolation has the effect of increasing penalties at all capacities, but without providing any additional capacity weighting effect, therefore providing no greater incentivisation to undertake small capacity outages. It may also lead to higher Tender Revenue Stream (TRS) bids (and consequently higher base revenue), a higher cost of capital and the lost revenue caps being reached more rapidly for all configurations, as the penalties from each outage become larger.
- These impacts are relatively minor for configurations 1 and 3, but are significant for configuration 2. When ***a*** and ***b*** are both equal to 1.5 for configuration 2, it leads to the lost revenue cap being reached in every normal year. As a result, ***a*** should not be increased too significantly.

Varying *b*

- Increasing ***b*** in isolation from 1 increases the capacity weighting effect and reduces penalties at all capacities except at 100%. The further ***b*** is increased the greater the capacity weighting effect, leading to a greater incentive to undertake small capacity outages. Increasing ***b*** could also lead to lower TRS bids (and consequently lower base revenue), a lower cost of capital and the lost revenue cap being reached less rapidly, as penalties from outages become smaller.
- Increasing ***b*** has no impact on the penalties that result from Configuration 2's DC circuit; it is a single point of failure, so leads to 100% outages.
- The main drawback for increasing ***b*** is that it could reduce the penalties to an extent where it does not provide a sufficient deterrent to undertaking unnecessary or inefficient outages. When ***a*** is 1 and ***b*** is 2, the penalised capacity for a 25% outage is 6.3%, meaning the penalty for a 25% outages would be 74.8% lower than the Status Quo mechanism. As a result, ***b*** should not be increased too significantly to a point where it does not incentivise efficient management of the transmission assets.

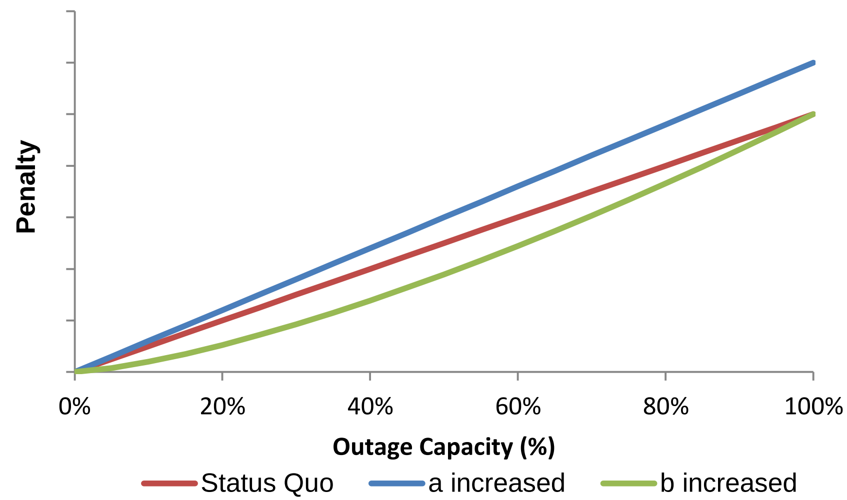
Varying *a* and *b*

- The configurations react differently to increasing ***a*** and ***b*** together. For Configurations 1 and 3, increasing ***b*** has the greatest impact. Therefore, when ***a*** and ***b*** are increased together, the results follow a similar pattern to increasing ***b*** in isolation, but with slightly lower returns, due to increasing ***a***.
- For Configuration 2, where increasing ***a*** has the greatest impact, varying ***a*** and ***b*** together leads to similar results to increasing a in isolation, but with slightly higher returns due to increasing ***b***.

Behavioural impact

- OFTOs are structured as special purpose vehicles containing only the project assets and, as a result, are relatively cash constrained. They also operate at a small profit margin due to the competitive bidding environment. Consequently, it is considered that OFTOs would change their behaviour for a relatively small increase in revenue, assuming the gains are greater than the costs. Consequently, applying the capacity weighting could lead to a behavioural change.

Impact of increasing *a* and *b*



1. Executive Summary – Report

Report structure

- This report has been split into the following sections;
  - **Section 2. Approach** – This section provides a description of the approach that has been followed in undertaking the financial analysis.
  - **Section 3. Results** – This provides a description of the results from undertaking the analysis. It is split into three parts. In the first, ***a*** is varied while ***b*** remains constant at 1.5 (the mid-point of the specified range). In the second, ***b*** is varied while ***a*** remains constant at 1, which is the value used in the Status Quo mechanism. In the final part both ***a*** and ***b*** are increased simultaneously. In each section, the trend of equity returns are presented for the three different OFTO configurations.
  - For each configuration there is a normal year scenario, which contains all planned maintenance required by the OFTO, and a downside scenario, which includes one minor transformer failure and one cable failure in years five and nine respectively.
  - The impact different weighting profiles have on an OFTO's returns is compared to the values achieved using the status quo mechanism. Understanding how the variation in these numbers with different weighting profiles impact the OFTOs provides an insight into how bidding strategy, investment risk profile and behavioural incentivisation could change.
  - **Section 4. Conclusions** – Given the findings summarised in Section 3, comments are provided on how varying ***a*** and ***b*** impact the OFTOs behaviour, bidding strategies and risk profiles.
  - **Appendix 1** – Provides background information to OFTOs and the availability incentive.
  - **Appendix 2** – Details are provided for the OFTO configurations and outages that were used as part of the revenue analysis in Section 2.
  - **Appendix 3** – Provides the assumptions that have been used in the financial analysis.
  - **Appendix 4** – Provides a glossary of terms.

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2. Financial Analysis – Approach

Project Scope

- Arup have been engaged by Ofgem to assess the financial and behavioural impact of varying ***a*** and ***b***. This has included the following requirements requested by Ofgem;
  - The availability incentive is to use the formula $\boldsymbol{a}x^{\boldsymbol{b}}$ to define the relationship between outage capacity and penalties.
  - The variable ***a*** is to be varied between 1 to 1.5 inclusive. Ofgem proposed this range as reducing ***a*** below 1 would reduce penalties compared to the current mechanism and it was considered that increasing ***a*** above 1.5 could lead to excessive penalties.
  - The variable ***b*** is to be varied between 1 to 2 inclusive. This range was selected by Ofgem as reducing ***b*** below 1 would lead to an inverse capacity weighting and it was considered that increasing ***b*** above 2 would result in very small penalties for low capacity outages.
  - The analysis will be undertaken assuming one capacity weighting profile will be applied consistently to all OFTO configurations on implementation.
  - It will consider three OFTO configurations, on which details are provided in Appendix 2.

Approach

- To understand the impact of the capacity weighting variables, analysis has been undertaken which investigates how they affect financial performance. The results have provided an indication of how different weighting profiles will impact risk profile, bidding strategies and behaviour.
- A financial model has been developed for each of the three configurations, to assess the performance of each OFTO through its 20 year lifespan. During our work, financial performance has been measured by assessing equity internal rate of return (IRR) and debt service cover ratios (DSCR) under two availability scenarios.
- The models incorporate representative capital costs, operational costs, financing structure, outage requirement and redundancy assumptions for each OFTO.
- Due to commercial sensitivity the specific results and assumptions used in the analysis are not presented.

Process

- Analysis of the Capacity Weighting variables involved the following steps;
  - For each configuration a financial model using representative assumptions has been developed.
  - The model has been solved using the Status Quo mechanism to calculate a base revenue that produces a representative IRR considered broadly appropriate for an Enduring Regime generator build investment. This sets the base case using the Status Quo mechanism, from which variations are measured.
  - With a base revenue calculated for each configuration, the Capacity Weighting with a combination of ***a*** and ***b*** has been applied to the outage assumptions, so defining the penalties in each year and so the revenue stream.
  - The revenue stream using the Capacity Weighting has been used in the financial model to assess the financial performance. As a result, for each weighting profile (combination of ***a*** and ***b***), the equity returns and DSCR have been calculated.
  - This process was repeated for a number of different weighting profiles to assess the impact of varying a in isolation, b in isolation and both variables together.
- For each of the enhancements two scenarios have been produced;
  - Normal Year – planned maintenance only, so including all transformer and circuit breaker maintenance. Additionally, unplanned failures are included at their probable rate of failure (as would be undertaken during an OFTO bidder assessment).
  - Downside Sensitivity – Normal Year assumptions plus significant unplanned outages. This includes a minor transformer failure in year 5 and a cable failure in year 9. For each configuration, the worst case component outage is assumed (ie. the component which leads to the greatest lost capacity).
- The assumptions used to undertake the financial modelling are detailed in Appendix 3.

2. Financial Analysis – Approach

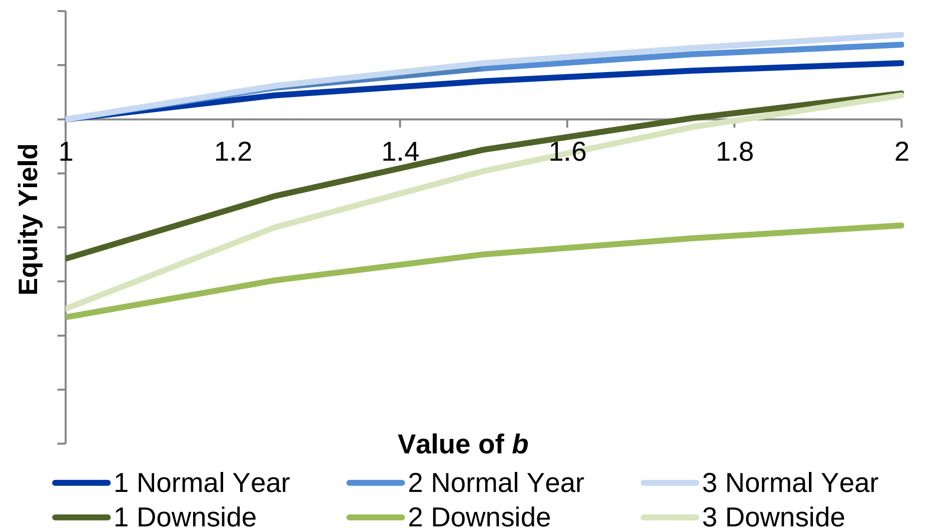
Results

- The adjacent table and graph provides an example of the output produced from the financial analysis. In this example a has remained constant while ***b*** has been varied between 1 and 2.
- A table such as this is created for each of the three configurations. The table illustrates the shape of the weighting profile for each combination of ***a*** and ***b***. It indicates the size of the penalised capacity at 25%, 50% and 100% capacity outage. This can be compared to the Status Quo mechanism, where the outage capacity is equal to the penalised capacity. As ***b*** increases the curve in the weighting profile becomes more exaggerated, so reducing the penalties at 25% and 50% outage capacity.
- The graph shows the equity yield trend for the Normal Year and Downside Scenarios for all three configurations as ***b*** increases from 1 to 2 and ***a*** remains constant at 1. The x-axis represents the value of ***b*** and the y-axis shows the resulting equity yield. The x-axis crosses the y-axis at the equity yield produced using the status quo mechanism, where ***a*** and ***b*** equal 1, for a normal outages year. The blue lines show the normal year scenarios and the green lines show the downside scenarios.

Weighting profiles – *b* varies; *a* = 1

Profile variables		Penalised capacity at		
a	b	25%	50%	100%
Status Quo				
1	1	25.0%	50.0%	100.0%
Capacity Weighting				
1	1	25.0%	50.0%	100.0%
1	1.25	17.7%	42.0%	100.0%
1	1.5	12.5%	35.4%	100.0%
1	1.75	8.8%	29.7%	100.0%
1	2	6.3%	25.0%	100.0%

Equity yield – *b* varies; *a* = 1



1, 2 and 3 relate to the asset configurations covered in Appendix 2

Contents

3. Results – *a* varies; *b* = 1.5

Results

- The adjacent graph shows how the equity return trend varies as ***a*** increases and ***b*** remains constant at 1.5 for the three configurations. The weighting profiles used are illustrated in the adjacent table, the scale of penalties at the different outage capacity illustrates how the weighting profile varies from the Status Quo.
- Increasing ***b*** from 1 in the status quo to 1.5 leads to a reduction in the size of penalties at 25% and 50% outage capacity, so increasing equity returns and cover ratios are observed. As a result, when ***a*** is equal to 1, equity IRRs would be greater than that used to set the base revenue using the Status Quo mechanism.
- As ***a*** increases it leads to greater penalties at all capacities, so reducing revenues, which results in reducing equity IRR across the range, as illustrated in the graph. The same trend would also be experienced for DSCRs.
- The OFTOs respond differently to varying ***a*** and configuration 2 is most significantly affected. This is a result of the 100% outages it experiences due to it's DC circuit, which is a single point of failure, and the fact it has a lower normal year availability, due to the DC conversion equipment.
- Where ***a*** equals 1.5, configuration 2 would reach the 10% lost revenue cap in all years for the both the normal year and downside scenario. This configuration reaches the lost revenue cap very rapidly as it has a normal year availability less than the 98% availability target.
- Additionally, when ***a*** is 1.5, minimum cover ratios in default are observed for configuration 2, assuming the same capital structure without increasing the base revenue.

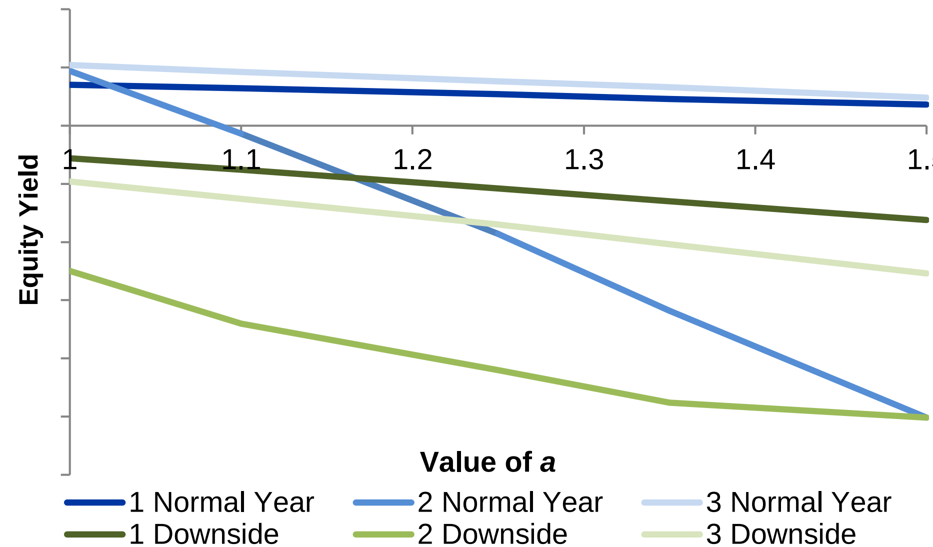
Conclusions

- The key rationale for increasing ***a*** above 1 would be to provide an upward pressure on penalties which have been reduced by increasing ***b*** above 1 and applying a capacity weighting.

Weighting profiles – *a* varies; *b* = 1.5

Profile variables		Penalty at outage		
a	b	25%	50%	100%
Status Quo				
1	1	25.0%	50.0%	100.0%
Capacity Weighting				
1	1.5	12.5%	35.4%	100.0%
1.1	1.5	13.8%	38.9%	110.0%
1.25	1.5	15.6%	44.2%	125.0%
1.35	1.5	16.9%	47.7%	135.0%
1.5	1.5	18.8%	53.0%	150.0%

Equity yield – *a* varies; *b* = 1.5



1, 2 and 3 relate to the asset configurations covered in Appendix2

3. Results – ***a*** varies; ***b*** = 1.5

- In this example ***b*** was equal to 1.5, leading to a capacity weighting and incentivisation to undertake small capacity outages. However, increasing ***a*** in isolation leads to the penalties at all capacities increasing at the same rate, so does not lead to a relative change in the scale of penalties at each capacity. Therefore, it is not anticipated that increasing ***a*** would lead to a change in capacity weighting effect. It may, however, lead to an increase in base revenue to achieve the same equity IRR and the revenue cap being reached more quickly.
- Increasing ***a*** is likely to result in a greater base revenue for all OFTOs to achieve the same equity IRR. It also increases perceived risk of owning the assets and would be likely to increase the cost of capital. This is due to returns decreasing despite the risk of outages remaining the same, for a given base revenue. However, for configurations 1 and 3, the change in the range shown is not significant.
- Increasing ***a*** will reduce the scale of outages required to meet the lost revenue cap for all OFTOs. This is of greatest concern for configuration 2 as it has a normal year availability of less than 98%.
- The difference in results between the HVAC configurations (1 and 3) and the HVDC configuration (2) are defined by the redundancy in the configurations and their normal year availability, which is not exclusively linked to technology. The DC circuit in configuration 2, as it is a single point of failure, leads to 100% outages, meaning it has low redundancy, but this would also be true for a single cable AC system, so is not technology dependent. Additionally, the configuration 2 has converter equipment which requires long duration, 100% outages. Consequently, it has a lower normal year availability than the other configurations.

Extrapolation

- Increasing ***a*** would lead to a reduction in equity returns and cover ratios. If ***a*** were increased above 1.5, this trend would be expected to continue for configurations 1 and 3 for both the normal year and downside scenarios.
- It would continue until the penalties created by 25% and 33% capacity outages reached a point where the 10% lost revenue cap is met in every year by the normal year scenario.
- This is achieved for configuration 2 where ***a*** =1.5. It is indicated by the two scenarios converging, as the unplanned outages do not increase the penalties above the normal year outages. Increasing ***a*** above 1.5 should not have a further impact on configuration 2.

3. Results – *b* varies; *a* = 1

Results

- The adjacent graph shows how the equity return trends varies as ***b*** increases and ***a*** remains constant at 1 for the three configurations. The weighting profiles used are illustrated in the adjacent table, the penalties at the different capacity outage illustrates how the profile varies from the Status Quo.
- Increasing ***b*** reduces the penalties at all capacities except 0% and 100%, so increasing OFTO financial results for all three configurations. This trend is experienced for both scenarios of all three configurations.

Conclusions

- As ***b*** increases, the capacity weighting effect become more exaggerated, so providing greater incentivisation to undertaken smaller capacity outages.
- Increasing ***b*** reduces the penalties at all capacities except 0% and 100%, so leading to a greater equity IRRs. This indicates that OFTOs could potentially reduce their TRS bids (and consequently base revenue) through the range. It may also lead to a reduction in the cost of capital and the risk associated with the incentive reduces. However, increasing ***b*** will have no impact on the penalties that result from Configuration 2's 100% outages in its DC circuit.
- When ***b*** reaches 2, for 25% outages the penalty reduces to 6.3%. There could be a risk that reducing penalties to this level could result in an OFTO taking outages unnecessarily or inefficiently because there is not a sufficient deterrent.

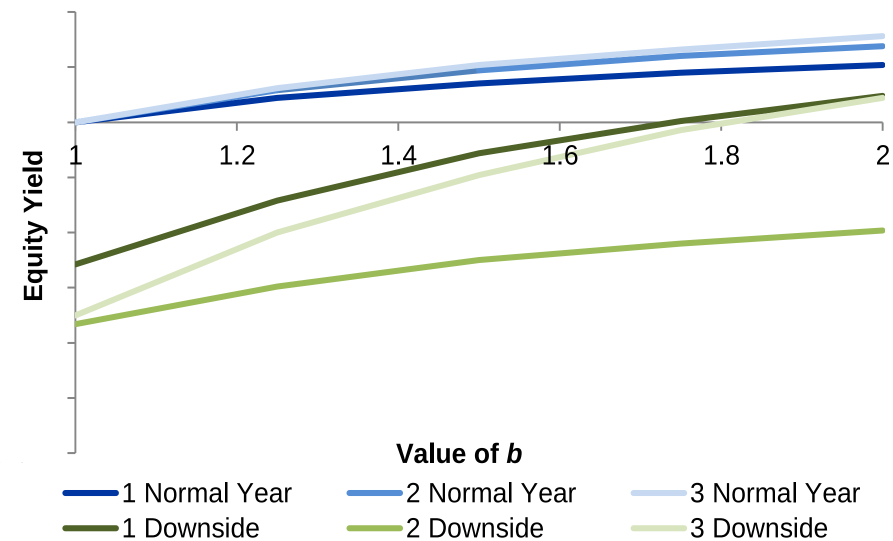
Extrapolation

- Increasing ***b*** leads to an increase in equity IRR. If ***b*** were increased above 2, this trend would be expected to continue for all of the configurations in both the normal year and downside scenarios.
- As ***b*** increases the rate at which the equity IRR grows will slow, but not stop. This is because there will never be a point where outages do not lead to penalties.

Weighting profiles – *b* varies; *a* = 1

Profile variables		Penalised capacity at		
a	b	25%	50%	100%
Status Quo				
1	1	25.0%	50.0%	100.0%
Capacity Weighting				
1	1	25.0%	50.0%	100.0%
1	1.25	17.7%	42.0%	100.0%
1	1.5	12.5%	35.4%	100.0%
1	1.75	8.8%	29.7%	100.0%
1	2	6.3%	25.0%	100.0%

Equity yield – *b* varies; *a* = 1



1, 2 and 3 relate to the asset configurations covered in Appendix 2

3. Results – *a* and *b* vary

Weighting profiles

- When varying ***a*** and ***b*** it is less clear what the profiles represents. The adjacent table lists five profiles which show the combinations used in the subsequent analysis.
- Both ***a*** and ***b*** are increased across the range through the 5 profiles. This results in the penalties at 25% and 50% decreasing through the profiles while the penalties at 100% increase.
- Increasing ***a*** leads to the gradient of the weighting profile increasing at all outage capacities, which is illustrated by the increasing penalties at 100% capacity. However, increasing ***b*** results in the curve becoming more exaggerated, so reducing the penalties at 25% and 50% capacity.

Results

- The graphs show how the equity IRR trend varies as ***a*** and ***b*** increase.
- Increasing ***a*** and ***b*** leads to divergence in how the OFTOs are impacted by implementing the capacity weighting. For configurations 1 and 3, increasing ***b*** has the greater impact as they are dominated by 25% and 33% outages. Consequently, returns increase from profile 1 to 5. Due to the increase in ***a***, the increase in returns has not been as great compared to solely increasing ***b*** as shown in the earlier analysis.
- For configuration 2, increasing ***a*** has a greater impact due to the impact on outages in the DC circuit and its limited redundancy. Consequently, returns reduce significantly from profile 1 to 5. Due to the increase in ***b***, the reduction in returns has not been as great compared to increasing ***a*** in isolation as shown in the previous analysis.

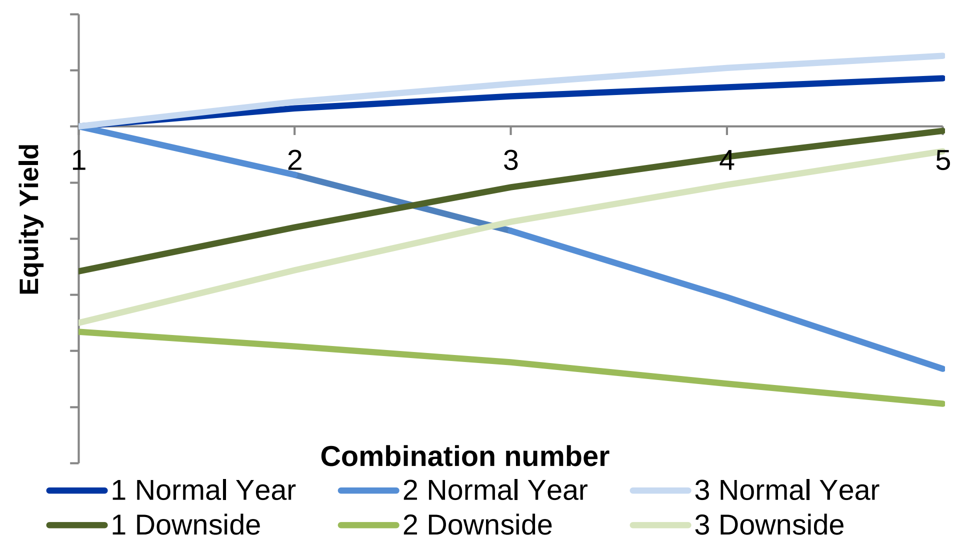
Conclusions

- Compared to the status quo, increasing ***a*** and ***b*** should lead to increasing incentivisation to undertake lower capacity outages for all configurations where these types of outage are possible, as the capacity weighting becomes more exaggerated as ***b*** increases.

Weighting profiles – *a* and *b* varies

Combination No.	Profile variables		Penalty at outage		
	a	b	25%	50%	100%
Status Quo					
	1	1	25.0%	50.0%	100.0%
Capacity Weighting					
1	1	1	25.0%	50.0%	100.0%
2	1.125	1.25	19.9%	47.3%	112.5%
3	1.25	1.5	15.6%	44.2%	125.0%
4	1.375	1.75	12.2%	40.9%	137.5%
5	1.5	2	9.4%	37.5%	150.0%

Equity yield – *a* and *b* varies



1, 2 and 3 relate to the asset configurations covered in Appendix 2

3. Results – ***a*** and ***b*** vary

- As the returns and cover ratios increase for both configurations 1 and 3, increasing ***a*** and ***b*** should lead to a reduction in the base revenue through the profiles. However, as configuration 2 is negatively affected by increasing ***a*** and ***b***, it would lead to an increase in base revenue through the profiles.
- The difference in results between the HVAC configurations (1 and 3) and the HVDC configuration (2) are defined by the redundancy in the configurations and their normal year availability, which is not exclusively linked to technology. The DC circuit in configuration 2, as it is a single point of failure, leads to 100% outages, meaning it has low redundancy, but this would also be true for a single cable AC system, so is not technology dependent. Additionally, the configuration 2 has converter equipment which requires long duration, 100% outages. Consequently, it has a lower normal year availability than the other configurations.

Extrapolation

- Continuing to increase both ***a*** and ***b*** is expected to continue the current trends. For configurations 1 and 3, the returns will continue to increase, although the rate of increase slows as the revenue gets closer to the maximum.
- For configuration 2, further increasing the variables will lead to a point where the lost revenue cap is met in each year and the normal year and downside scenarios will converge, at which point the further increases in ***a*** and ***b*** will not impact returns.

3. Results – Behavioural Impact

- Analysis has been undertaken to calculate the difference in revenue that an OFTO would receive through different maintenance strategies.
- The normal year revenue for configurations 1 and 2 has been calculated in two different maintenance scenarios when ***a*** equals 1 and ***b*** varies. In the first scenario, 'Small Outages', the OFTO does all maintenance to ensure the smallest possible capacity outages. In the second scenario, 'Large Outages', it is assumed to maintain multiple components at the same time, so resulting in fewer, greater capacity outages.
- For example, for configuration 1 which is a four circuit system, in 'Small Outages' it is assumed that all four transformers are maintained sequentially, leading to four, 25% outages. However, in 'Large Outages', it would undertake two, 50% outages. Under the Status Quo, this would lead to identical penalties. However, using the capacity weighting and undertaking greater capacity outages will lead to greater penalties.
- The adjacent graph shows the increase in revenue an OFTO would receive in a normal year from undertaking the 'Small Outages' for configurations 1 and 2 as ***b*** varies and ***a*** equals 1, compared to 'Large Outages'. It shows that as ***b*** increases and the capacity weighting becomes stronger, the difference in revenue increases. However, the scale of this effect reduces, which is illustrated by the gradients of the lines decreasing.
- This analysis assumes only the required annual maintenance and does not include any unplanned failures. This should be representative of the position most OFTOs will face in the majority of years as unplanned maintenance should not be common, particularly in the early years.

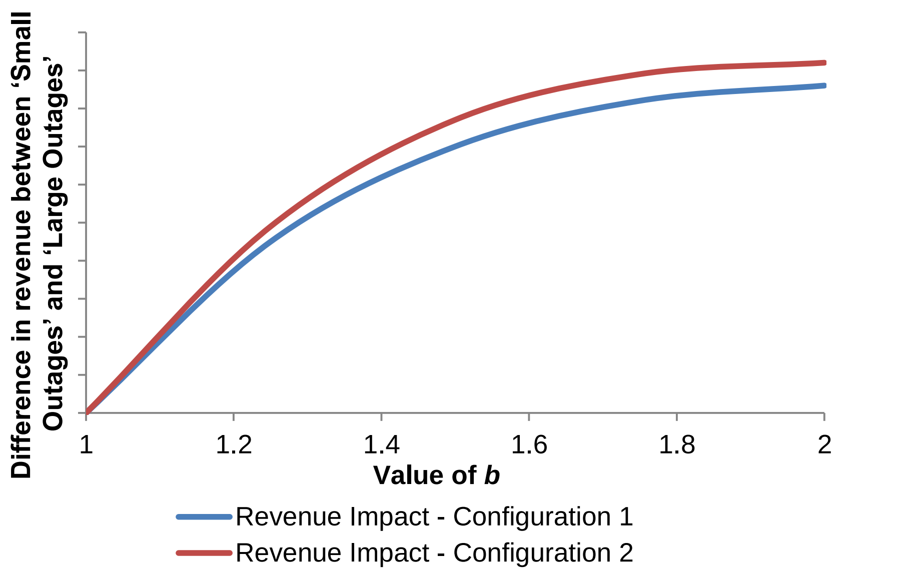
Behavioural Impact

- OFTOs are structured as special purpose vehicles containing only the project assets and, as a result, are relatively cash constrained. They also operate at a small profit margin due to the competitive bidding environment. This would mean even a comparatively small increase compared to the total revenue could drive behavioural change, where the cost of altering behaviour does not exceed the increase in revenue. OFTOs would include the increased revenue in their bids, so would be forced to follow that behaviour during operation.

Weighting profiles – *b* varies; *a* = 1

Profile variables		Penalised capacity at		
a	b	25%	50%	100%
Status Quo				
1	1	25.0%	50.0%	100.0%
Capacity Weighting				
1	1	25.0%	50.0%	100.0%
1	1.25	17.7%	42.0%	100.0%
1	1.5	12.5%	35.4%	100.0%
1	1.75	8.8%	29.7%	100.0%
1	2	6.3%	25.0%	100.0%

Revenue Impact – difference in OFTO revenue between following 'Small Outages' and 'Large Outages' maintenance scenarios



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4. Conclusions

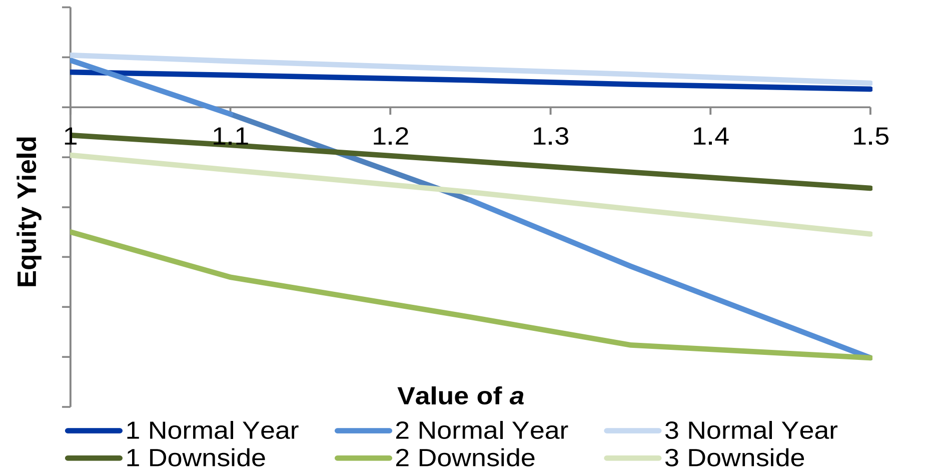
Varying *a*

- Increasing ***a*** from 1 has the effect of increasing penalties, but without providing any additional incentivisation to undertake small capacity outages. It could also lead to higher TRS bids (and consequently higher base revenue), a higher cost of capital and the lost revenue caps being reached more rapidly for all configurations.
- These impacts are relatively minor for configurations 1 and 3, but are significant for configuration 2. When ***a*** and ***b*** are both equal to 1.5 for configuration 2, it leads to the lost revenue cap being reached in every normal year. As a result, ***a*** should not be increased too significantly, to a point where the penalty limit is reached too quickly and the availability incentive no longer provides a financial incentive to minimise outages.

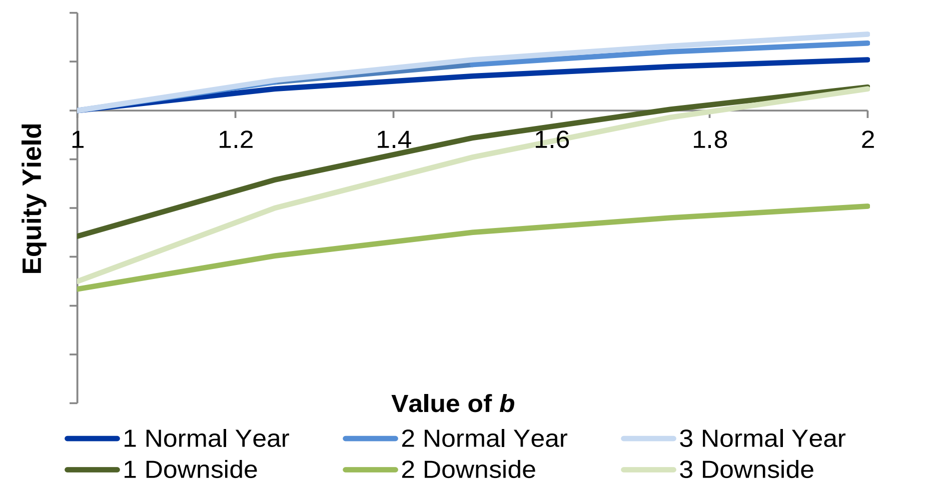
Varying *b*

- Increasing ***b*** from 1 has the effect of reducing penalties at all capacities except at 100%. The further ***b*** is increased, the greater the capacity weighting effect, leading to a greater incentive to undertake small capacity outages. Increasing ***b*** could also lead to a lower TRS bids (and consequently lower base revenue), a lower cost of capital and the lost revenue cap being reached less rapidly. Therefore, this could provide benefits to the incentivisation of the OFTOs and value to the consumer.
- Increasing ***b*** has no impact on the penalties that result from Configuration 2's DC circuit; it is a single point of failure, so leads to 100% outages.
- The main drawback for increasing ***b*** is that it could reduce the penalties to an extent where it does not provide sufficient deterrent to undertaking unnecessary or inefficient outages. When ***a*** is 1 and ***b*** is 2, the penalised capacity for a 25% outage is 6.3%, meaning the penalty for a 25% outages would be 74.8% lower than the Status Quo mechanism. As a result, ***b*** should not be increased too significantly to a point where it does not incentivise efficient management of transmission assets.

Equity yield – *a* varies; *b* = 1.5



Equity yield – *b* varies; *a* = 1



1, 2 and 3 relate to the asset configurations covered in Appendix 2

4. Conclusions

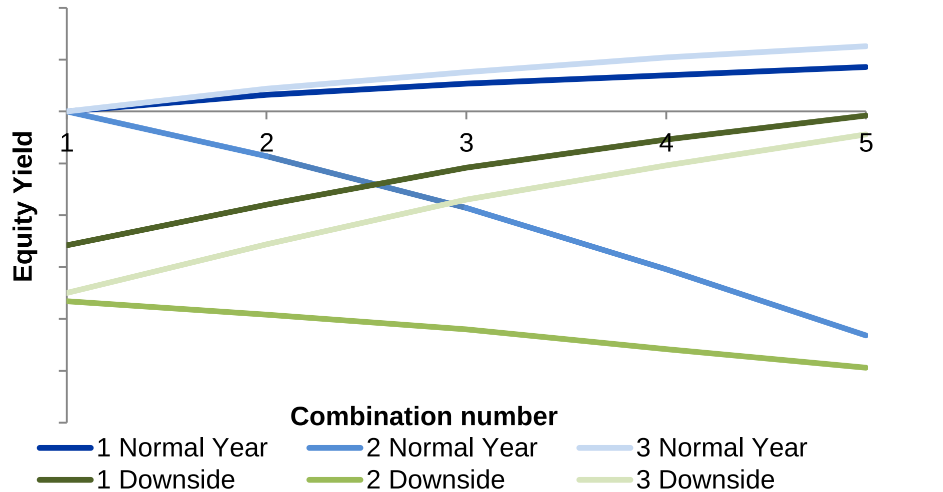
Varying *a* and *b*

- The configurations react differently to increasing ***a*** and ***b*** together. For Configurations 1 and 3, increasing ***b*** has the greatest impact. Therefore, when ***a*** and ***b*** are increased together, the returns follow a similar pattern to increasing ***b*** in isolation, but with slightly lower returns, due to increasing ***a***.
- For Configuration 2, where increasing ***a*** has the greatest impact, varying ***a*** and ***b*** together leads to similar results to increasing ***a*** in isolation, but with slightly higher returns due to increasing ***b***.

Behavioural impact

- OFTOs are structured as special purpose vehicles containing only the project assets and, as a result, are relatively cash constrained. They also operate at a small profit margin due to the competitive bidding environment. Consequently, it is considered that OFTOs would change their behaviour for a relatively small increase in revenue, assuming the gains are greater than the costs. Consequently, applying the capacity weighting could lead to a behavioural change.

Equity yield – *a* and *b* varies



1, 2 and 3 relate to the asset configurations covered in Appendix 2

Contents

Appendix 1 – Background Information

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 several tender rounds.
- Ofgem started the first tender round (TR1) 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, a further two preferred bidders were selected in October 2010 and May 2011. To date seven Round 1 projects have reached Financial Close.
- Ofgem is currently running the tenders for the Offshore Transmission Owner (OFTO) second tender round (TR2) projects. The four projects in this tender are worth c. £1bn.
- For future tenders, the scale and complexity of projects is expected to develop significantly from those involved in TR1 and TR2 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).
- Tenders for the third tender round (TR3) are expected to start in 2013.
- 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 the TRS they tender. This is adjusted through an availability incentive mechanism that considers OFTO performance. Through TR1 and TR2 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.
- Ofgem have undertaken an option appraisal exercise to identify a potential appropriate enhancement. The proposed alternative solution is referred to as the Capacity Weighting. Arup have been engaged to assess the financial and behavioural impact of key characteristics of this enhancement. This report provides a summary explanation of the trends and conclusions.

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.

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

Appendix 1 – Background Information

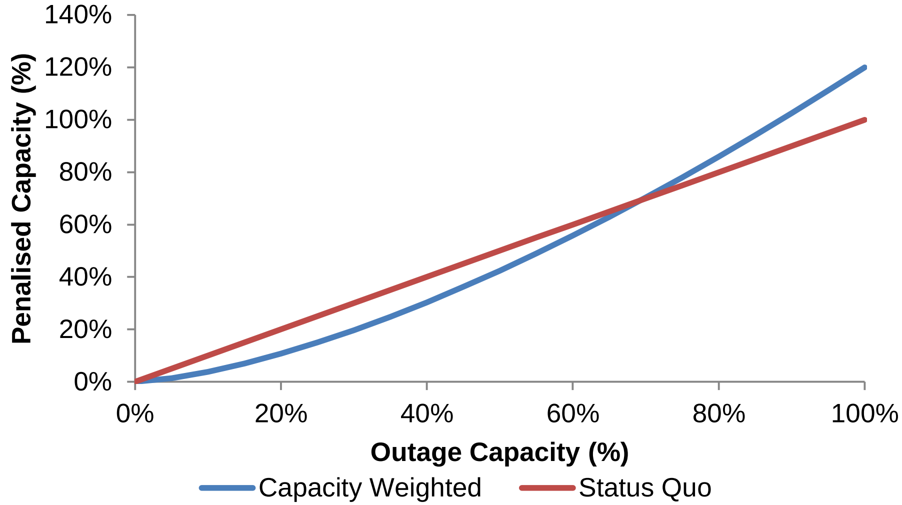
Status Quo mechanism

- The availability incentive mechanism used in the second round projects (TR2) produces adjustments to the base revenue based on performance against an availability target.
- The annual target availability is 98%. Meeting the target over an annual period leads to the OFTO receiving 100% of its base revenue. 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 base revenue 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 base revenue each year.
- The availability mechanism calculates the lost availability of transmission capacity in mega watt hours (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.

Capacity Weighting mechanism

- Having appraised a number of enhancement options, Ofgem have chosen to further investigate implementing an enhancement to the availability incentive that is referred to as the Capacity Weighting mechanism.
- The Capacity Weighting mechanism is based on the Status Quo mechanism, but incorporates a weighting that impacts the size of penalties based on the proportion of transmission capacity which is lost.
- The weighting will lead to an OFTO being penalised proportionately more for each lost unit of unavailability (MWh) the larger the capacity of the outage.

Capacity Weighting



- The aim of the Capacity Weighting is to incentivise OFTOs to maximise availability at any time. This would be achieved, for example, by undertaking multiple small capacity planned maintenance activities instead of fewer larger capacity outages.
- The above graph illustrates a Capacity Weighting profile compared to the Status Quo. It shows how lost capacity from an outage (outage capacity) is converted into a penalty. The Status Quo mechanism has an equal and proportional relationship between outage capacity and penalties. However, for the Capacity Weighting, as the relationship is not proportional, the penalties per unit of lost availability (MWh) increase with the lost capacity of the outage.
- The Capacity Weighting utilises a power function to define how the penalties vary with outage capacity. It takes the form $\boldsymbol{a}x^{\boldsymbol{b}}$ with the variables ***a*** and ***b*** defining this relationship. To replicate the current mechanism, the values of both ***a*** and ***b*** need to be 1.
- All the key aspects of the Status Quo mechanism are retained, including the availability target and lost revenue caps.

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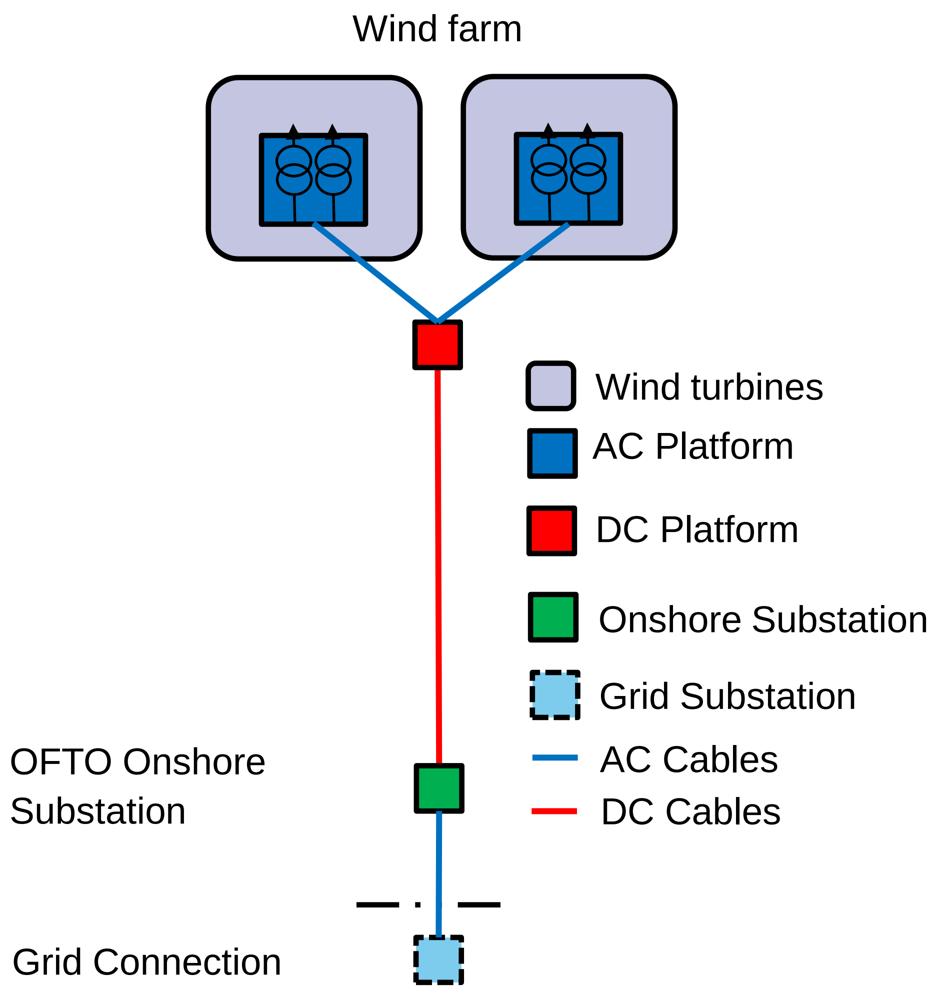
Appendix 2 – Introduction

Introduction

- The capacity weighting will impact OFTOs differently 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 for our analysis.

Asset configurations

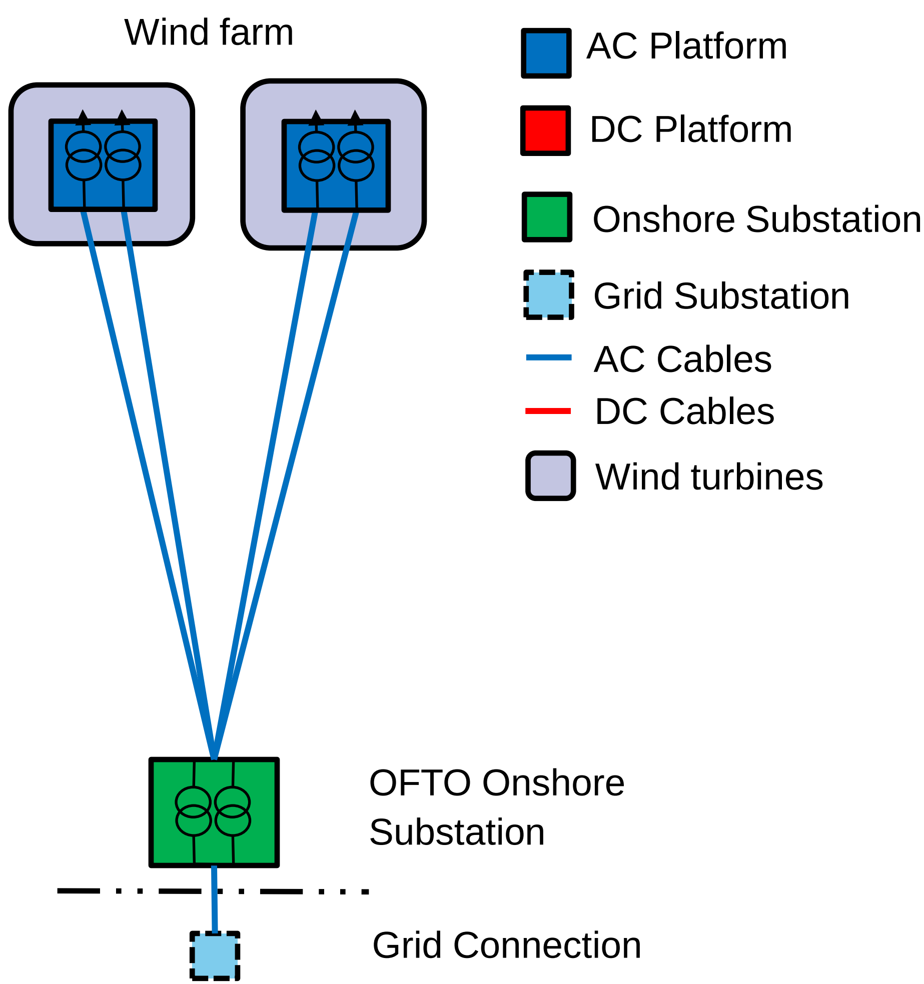
- The following pages provide high-level details of the asset configurations that have been assessed. They are illustrated using diagrams, as shown on the right, and in a summary table.
- These asset configurations have been chosen to represent the OFTO configurations that may be deployed in the early stages of the Enduring Regime.



Appendix 2 – Asset Configuration 1

Simple AC connection

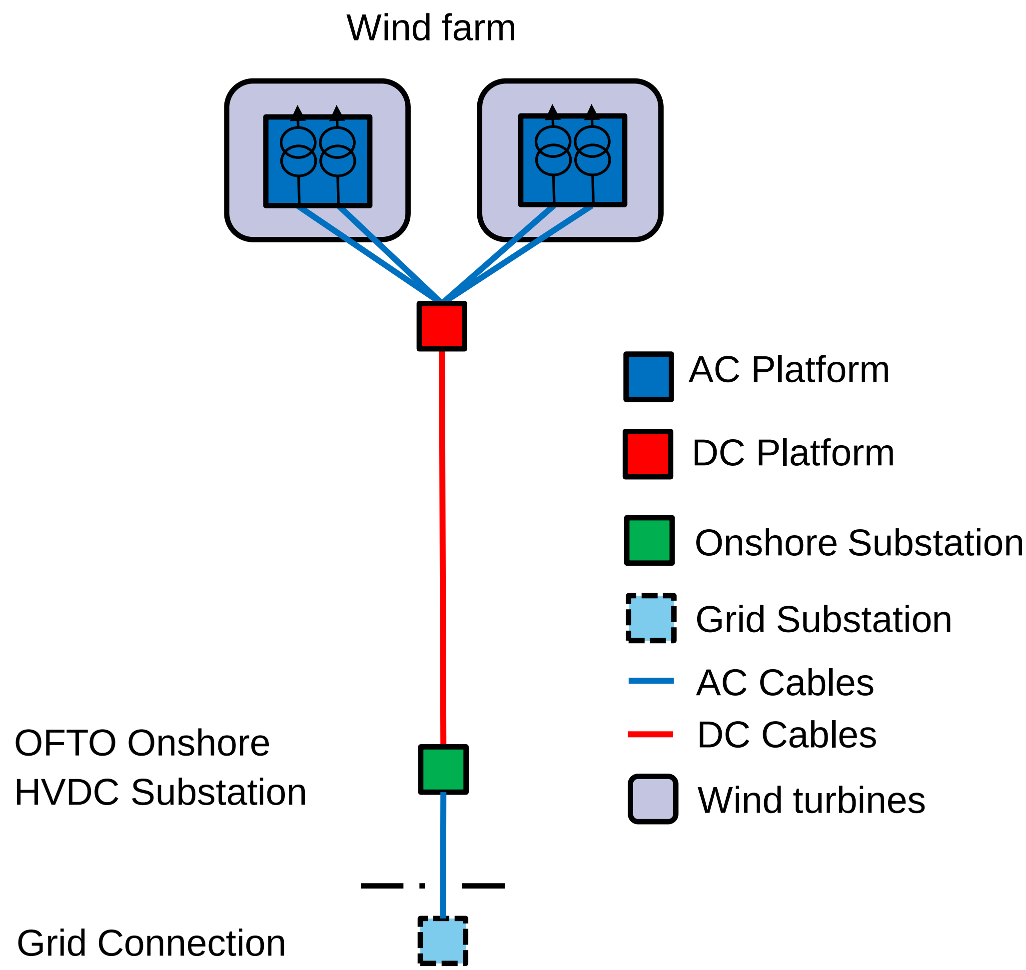
- This configuration represents the simplest alternating current (AC) asset configuration that is expected to be deployed as a single phase during the Enduring Regime.
- It is assumed to have two offshore platforms, with export cables and two transformers per platform. This gives the cable four circuits. As a result, an outage in any of the four circuits leads to a 25% capacity outage.
- 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.
- For transmission lengths of less than 100km AC options may prove to be more cost effective than a HVDC solution.



Appendix 2 – Asset Configuration 2

Simple DC connection

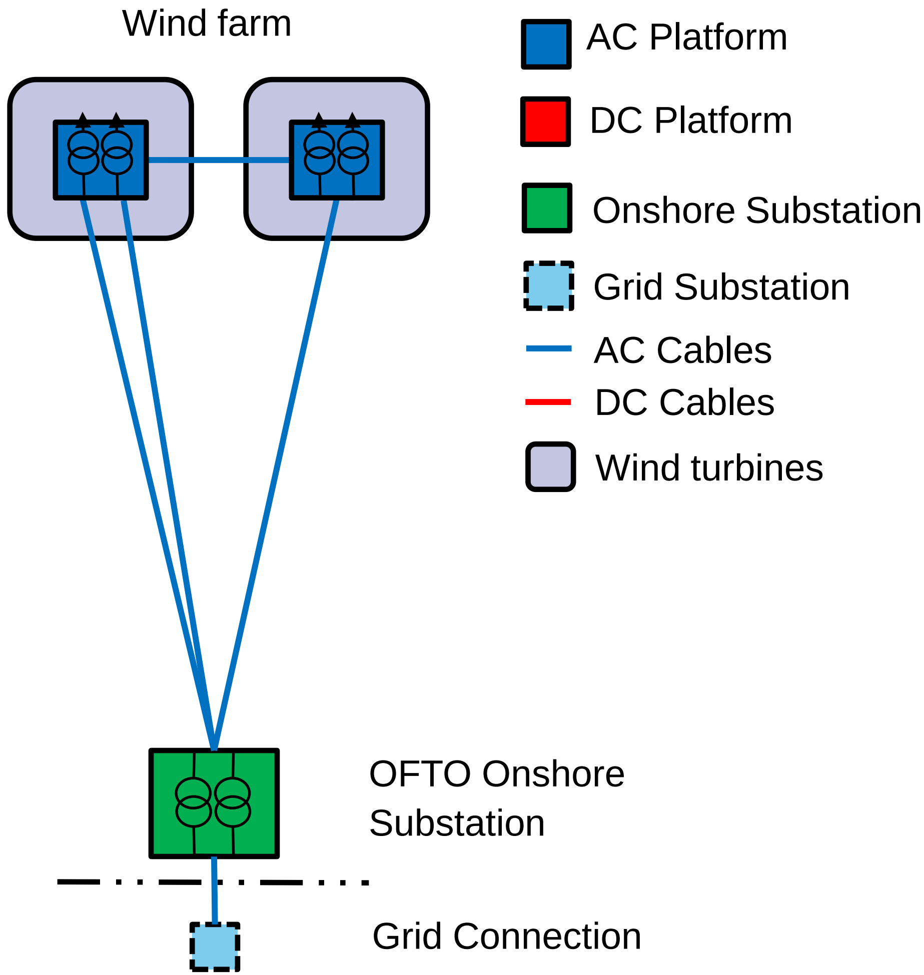
- This configuration represents the simplest direct current (DC) asset configuration that would be expected to be deployed as a single phase during the Enduring Regime.
- It is assumed that the AC system within this OFTO consists of two platforms, each with two transformers and two export cables. As a result, there are four AC circuits. An outage in any of these circuits results in a 25% capacity outage.
- The AC export cables connect to one converter platform. This converts the electricity from AC to DC. There is one DC export cable which is connected to one onshore converter station. Therefore, there is only one HVDC circuit, so any outage in this circuit results in 100% lost capacity.
- 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 2 – Asset Configuration 3

Simple AC connection – 3 export cables

- This is an adaptation of configuration 1, a four cable simple AC link. It has three cables linking two offshore platforms to the onshore substation.
- The three cables each have an identical capacity. On each platform, one cable transmits the electricity created by two thirds of the turbines to which it connects. The third cable transmits one third of the electricity from each platform. Given that the third cable can only be connected to one platform, a link is required between the two platforms.
- There are four offshore transformers, so an outage leads to 25% lost capacity. However, there are three export cables and three onshore platforms, so outages in these components will lead to 33% lost capacity. The interconnection between the two cables carries a third of one platforms electricity, therefore an outages would lead to a 17% outage.
- The advantage of this configuration is that it reduces the cost of subsea cabling compared to a four cable solutions, if the offshore platforms are in close proximity. It does, however, reduce the redundancy in the system.
- This is considered to be a realistic three cable configuration which could be deployed in the early stages of the Enduring Regime.



Appendix 2 – Asset Configuration Summary

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

	Configuration. 1 Simple HVAC	**Configuration. 2** Simple HVDC	**Configuration. 3** Three cable HVAC
General			
No. AC Platforms	2	2	2
No. DC Platforms		1	
No. Onshore Substations	1	1	1
AC System			
Transformers per platform	2	2	2
Transformer rating	25%	25%	25%
AC Cables per platform	2	2	1/ 2
Cable capacity (% of total)	25%	25%	33.3%
DC System			
Converters per platform		1	
DC Cables per platform		1	
Cable capacity (% of total)		100%	
Onshore Substation			
No. Transformers	4		2
Transformer Rating	100%		50%
No. Converters		1	

Appendix 2 – Outages

Outage events

- The adjacent table presents the planned and unplanned outage events that have been used to build up the normal year and downside scenario outage assumptions.
- 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 are 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 of damage, this is specific for each assets location and burial condition.

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 system or the replacement of tap changers requires the isolation of the transformer for safety reasons.

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

- **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 system require the isolation of the circuit breaker for safety reasons.

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Appendix 3 – Financial Modelling Assumptions

- In the financial model the following general assumptions have been made. These are considered appropriate for Enduring Regime generator build investments.

Operational costs

- Normal year operation and maintenance (O&M) cost are assumed to include the price of an O&M contract covering planned maintenance, lifecycle costs for the replacement of components (such as battery systems and generators) and seabed surveys required by environmental consents.
- Other opex costs include insurance and special purpose vehicle (SPV) costs, which covers the accounting and legal costs of the OFTO.

Unplanned events

- It is assumed that insurance claims will cover the cost of rectifying unplanned events.
- It is possible in the years following an insurance claim insurance premiums could increase. However, as the impact would be consistent across all the considered weighting profiles (therefore the cost would not alter the assessment of the impact of each weighting profile), and due to complex nature of predicting insurance premiums, this additional cost has not been included.

Capital costs

- The capital costs associated with the asset transfer are assumed to occur in the first month of the project.
- Other capex such as transaction costs, special purpose vehicle (SPV) running costs during asset transfer, Debt Service Reserve Account (DSRA) pre-fund and financing costs have been included using representative values.

Inflation

- All cost items and revenues have been assumed to inflate at 2.5%.

Financing assumptions

- Financing assumptions have been developed that represent an OFTO transaction in the current market conditions, but obviously these are subject to change as they are driven by the market.
- The following financial structure of each OFTO has been assumed;
  - Senior debt facility
  - European Investment Bank (EIB) facility
  - Shareholder loans
  - Equity
- Both debt repayment profiles are assumed to be sculpted to match cash flows available to debt and rank pari passu.
- It is assumed that a Debt Service Reserve Account (DSRA) will be required.

Availability profile

- For each configuration, an availability assessment has been undertaken that replicates the approach that would be taken by OFTO bidders. This provides a 'normal year' availability, in which no major failures occur. This consists of two parts;
  - An assessment of the necessary planned maintenance; and
  - A statistical representation of unavailability that would result from minor failures.
- It is assumed that risk of unplanned failures is low. However, it would not be appropriate to assume in an assessment of a normal year, that reflects availability over the life of the project, that only planned maintenance would occur. Consequently, a statistical representation of unavailability from minor failures is included.

Appendix 3 – Financial Modelling Assumptions

Availability profile (cont.)

- The availability assessment is based on the following information for each key primary power component;
  - Planned maintenance that requires equipment outage;
  - Frequency and time to repair minor failures;
  - Export capacity reduction resulting from a single outage; and
  - Access restrictions due to operating environment including weather conditions.
- In a normal year it is assumed that no major failure events occur. Lost availability is due to planned maintenance and minor failures. These events are listed below;
  - Onshore and offshore transformer maintenance and minor failure;
  - Transformer circuit breaker maintenance and failure;
  - Cable circuit breaker maintenance and failure;
  - Reactive compensation system minor failure;
  - Low voltage system minor failure; and
  - SCADA minor failure.

Revenue

- A base revenue has been calculated for each configuration of the OFTO using the Status Quo mechanism and normal year scenario. The base revenue has been set to achieve a nominal equity yield given the other assumptions.
- This base revenue has been assumed for the modelling of all enhancements and scenarios for the given configuration, so allowing the impact of each enhancement to be compared to the Status Quo mechanism.
- 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.
- It is assumed that none of the components are operated above their stated capacity.

Downside sensitivity

- For configuration 1, the downside sensitivity includes all the normal year unavailability in addition to a minor transformer failure in year 5 and an AC cable failure in year 9.
- For configuration 2, the downside sensitivity includes all the normal year unavailability in addition to a minor convertor failure in year 5 and an DC cable failure in year 9.
- For configuration 3, the downside sensitivity includes all the normal year unavailability in addition to a minor transformer failure in year 5 and an AC cable failure in year 9.

Contents

Appendix 4 – Glossary

Terminology

- The report has been written using the following terminology;
  - **Asset configuration** – This refers to three different OFTO asset configurations that have been identified as representative of future projects. These are detailed in Appendix 2.
  - **Debt Service Cover Ratio (DSCR)** – The ratio between the cash flow available to service debt within a given period and the required interest and principal payments.
  - **Debt Service Reserve Account (DSRA)** – A cash reserve that is sized for a future period of debt service. The DSRA gives additional funds in the event that the project has inadequate cash flow to meet the debt service requirements in a given period. Implementation of a DSRA is a common requirement of lenders in project finance transactions.
  - **Enhancement option** – This refers to any of the options assessed for altering the availability incentive for future projects.
  - **Internal Rate of Return (IRR)** – The IRR measures project returns incorporating the time value of money. It is the discount rate required to make the net present value of cash flows from a project equal to zero. It can be thought of as the rate of growth that a project is expected to generate on the invested capital.
  - **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 2.
  - **Outage type** – Refers to the difference between planned and unplanned maintenance.
  - **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.
  - **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.
  - **Status Quo mechanism** – This refers to the availability incentive used in the second round tenders (TR2).
  - **Tender Revenue Stream (TRS)** – The TRS is the revenue bid by participants in the tender process. It forms the basis of the base revenue an OFTO will receive. The base revenue also takes into account (where applicable) adjustments in market rates and changes to the final transfer value.
  - **Weighting profiles** – The Capacity Weighting changes the relationship between unavailability and penalties compared to the Status Quo mechanism. This relationship is termed a weighting profile.

Appendix 4 – Glossary

Glossary of terms	
Abbreviation	**Definition**
AC	Alternating Current
DC	Direct Current
DECC	Department of Energy and Climate Change
DSRA	Debt Service Reserve Account
DSCR	Debt Service Cover Ratio
EIB	European Investment Bank
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IRR	Internal Rate of Return
MW	Mega Watt
MWh	Mega Watt Hour
O&M	Operation and Maintenance
Ofgem	The Office of Gas and Electricity Markets
OFTO	Offshore Transmission Owner
SPV	Special Purpose Vehicle
TR1	Transitional Tender Round 1
TR2	Transitional Tender Round 2
TRS	Tender Revenue Stream