Reactive Power Offshore and the Commercial Arrangements – Consultation

PURPOSE

This consultation is being issued by the Balancing Service Standing Group (BSSG)[1]. The purpose is to outline the offshore regime, specific to reactive power and how National Grid plans to manage the Obligatory Reactive Power Service (ORPS).

This consultation briefly discusses the technical requirements around the provision of reactive power in the offshore regime, the commercial arrangements under the existing regulatory framework that are scheduled to be applied to offshore, and gives a comparison of the offshore regime and the onshore. This paper concludes with a set of questions designed to seek the industry's views.

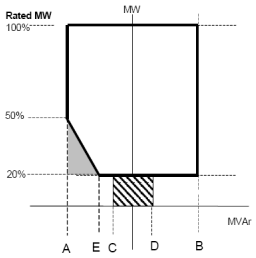
BACKGROUND

At offshore 'Go-Active' on 24 June 2009 the industry codes (Grid Code, Balancing and Settlement Code, System Operator – Transmission Owner Code and the Connection and Use of System Code) were modified under the direction of the Secretary of State for the purposes of introducing an offshore regime.

In summary, the changes to the codes were designed to facilitate the introduction of competitively tendered Transmission Networks offshore, and also cater for the consequential treatment of any Power Station wishing to connect to the offshore transmission networks.

At offshore 'Go-Live' through the direction of the Secretary of State, any asset operating at a voltage of 132kV will be required to be owned by a Transmission Licensee. Subsequently, all Power Stations connected offshore via sub-sea cables of 132kV or above will see their connection to the Transmission System move from an onshore connection point to the offshore point where the Power Station connects to the 132kV system. Offshore 'Go-Live' for the existing connected offshore Power Stations is expected to happen in 2011.

REACTIVE POWER



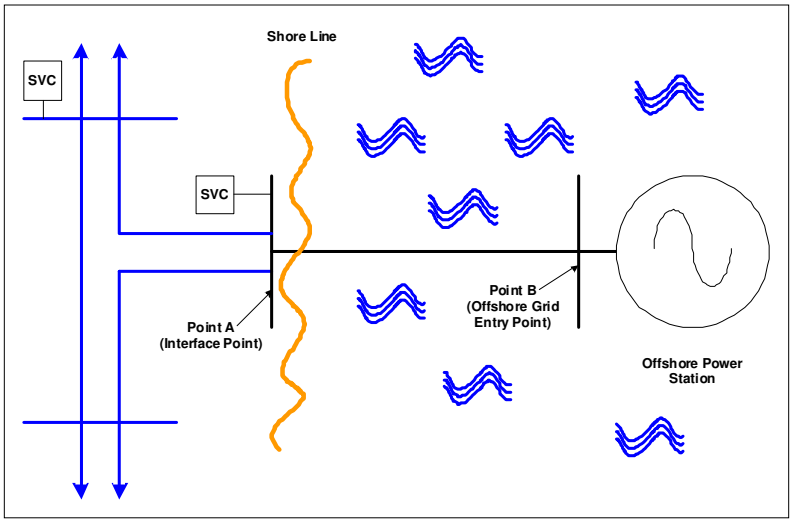
Point A is equivalent (in MVAr) to: 0.95 leading **Power Factor** at **Rated MW** output
Point B is equivalent (in MVAr) to: 0.95 lagging **Power Factor** at **Rated MW** output
Point C is equivalent (in MVAr) to: -5% of **Rated MW** output
Point D is equivalent (in MVAr) to: +5% of **Rated MW** output
Point E is equivalent (in MVAr) to: -12% of **Rated MW** output

Figure 1

[1] The BSSG is a Standing Group established by the CUSC Amendments Panel to consider the development of Balancing Services under the CUSC. Further information is available at National Grid: Balancing Services Standing Group (BSSG) Meeting Documents

Large Power Stations[2] are required to install, control and maintain a voltage control system. The voltage control system must also meet a capability envelope of at least the range illustrated in CC.6.3.2 Figure 1, shown, at the connection point with transmission system.

Under the offshore regime these arrangements still hold true for onshore Power Stations. However offshore, the requirement is anchored at the onshore connection point, otherwise known as the Interface Point (IP), and further to this will be an obligation directly on the Transmission Licensee for the relevant part of the network, otherwise known as the Offshore Transmission Network Owner (OFTO). The obligation on the OFTO is specified within the System Operator Transmission Owner Code (STC)[3]. The diagram below illustrates this situation. This outcome is a direct result of the work carried out by the Offshore Transmission Expert Group (OTEG), a subgroup formed by the Grid Code Review Panel. The group determined that it would be uneconomic to require the capability at the Offshore Grid Entry Point due to the additional cable capacity that would be required. This is examined later on in this document.



However, while the reactive capability obligation under the offshore regime is on the OFTO rather than generator, the Grid Code allows offshore Power Stations to contribute to the OFTO obligation where agreement is reached between the generator, OFTO and National Grid. This is specified within Connection Condition 6.3.2 of the Grid Code[4]. Where any agreement is reached for the Power Station to contribute to the OFTO obligation, the agreed contribution from the Power Station will be contained within the Bilateral Agreement between National Grid and the generator who owns/operates the relevant Power Station.

---

[2] Those with a Registered Capacity of 100MW connecting to National Grid Electricity Transmission, 30MW connecting to Scottish Power Transmission and 10MW connecting to Scottish Hydro-Electric Transmission Limited any any Offshore Transmission System

[3] Specifically contained within Section K, 2 Reactive Capability and Voltage Control of the STC, link; http://www.nationalgrid.com/NR/rdonlyres/DE34BA62-ACE8-4E88-A038-0CC138181843/35311/STC_SectK_GoActive.pdf

[4] Link to the Connection Conditions of the Grid Code; http://www.nationalgrid.com/NR/rdonlyres/83F+D31D3-0F0E-4B20-8345-9636E0093453/42972/GC_CC_I4R3.pdf

As a consequence of this, it can be considered that there are three possible outcomes as to how the reactive capability obligation will be met;

1. No Power Station contribution
No agreement is reached with the generator for the Offshore Power Station to contribute to the OFTO obligation. As a consequence the OFTO will need to procure its own apparatus in order to meet the requirements. In such circumstance the offshore Power Station will be required to maintain unity power factor (0MVAr), allowing for a tolerance, at the Offshore Grid Entry Point.

2. No OFTO involvement
Agreement is reached between the parties for the Power Station to contribute and furthermore the Power Station has the capability to overcome the reactive gains and losses along the OFTO network to meet the reactive capability envelope at the onshore IP.

3. The Power Station and the OFTO both contribute
Agreement is reached between the parties for the Power Station to contribute to the requirement. However the Power Station is unable to meet the full OFTO obligation and hence the OFTO will need to procure its own apparatus in order to meet the remaining requirement.

THE COMMERCIAL ARRANGEMENTS

Further to the technical reactive power capability obligations upon Power Stations contained within the Grid Code, Large, and Medium transmission connected generators are also required to provide a reactive power system ancillary service[5].

The CUSC Section 4 Balancing Services and Schedule 3 outlines how the reactive power system ancillary service is commercially managed and paid for by National Grid in the role of the System Operator. In summary National Grid enters into a Mandatory Service Agreement with each generator and pays each generator a formula derived price for each MVArh of reactive power produced by the generator's Power Station at the point at which it connects to the transmission system or as defined within schedule 3 of the CUSC. This is known as the Default Payment Mechanism (DPM) and the service is known as the Obligatory Reactive Power Service (ORPS).

Onshore generators meeting the Grid Code defined reactive capability requirements can consequentially provide and get paid for the ORPS. Generators owning Offshore Power Stations however, may or may not be providing a reactive service from those Offshore Power Stations in accordance with the Grid Code. The question becomes how should they be treated?

At offshore 'Go-Active' the commercial arrangements around reactive ancillary services remained unchanged. Consequentially the existing principles around which the regulatory regime is based will be applied to Generators owning Offshore Power Stations. The results of applying these principles to the 3 scenarios previously discussed in this document are outlined below;

1. No generator involvement

[5] Specified with the Grid Code CC.8.1, see link above

As the generator is not providing reactive capability or the subsequent ancillary service, there is no payment due to the generator.

2. No OFTO involvement
The generator will be paid for the reactive power provided by the generating apparatus in the same manner as any onshore generator would be i.e. the DPM will be applied to the reactive power provided at the entry to the Transmission Network, in this case the Offshore Grid Entry Point.

3. The generator and the OFTO both contribute
The generator will be paid for the reactive power provided by the generating apparatus in the same manner as any onshore generator would be i.e. the DPM will be applied to the reactive power provided at the entry to the Transmission Network, in this case the Offshore Grid Entry Point.

In terms of the remuneration of the OFTO for any reactive power provided be it from a capability base that meets wholly or partly the STC obligation, the OFTO will receive an agreed rate of return on the asset and associated costs, much the same as other Transmission Owners. The agreed return is levied from Users of the network through the Transmission Network Use of System charge (TNUoS). Specifically the costs associated with reactive assets are recovered through the local circuit elements of TNUoS, as outlined in paragraph 2.50 of the Use of System Charging Methodology[6]. As a result, the offshore generator's tariff will recover the majority of these costs over the OFTO's twenty year regulatory revenue stream. The remaining costs will be spread across the industry through the residual element. For completeness it should be noted that instances where an onshore TO procures reactive assets, for the purposes of system security, the whole cost would be socialised across the industry.

Further to this it should be noted that under the current framework National Grid is not permitted to procure Balancing Services from Transmission Licensees, of which the ORPS is one[7].

ONSHORE VS. OFFSHORE COMPARSION

Given the backdrop of the technical reactive power requirements and the applied commercial framework around those obligations, the Balancing Services Standing Group (BSSG) has considered whether or not the commercial arrangements are appropriate. This has been done by comparison of the potential offshore scenarios previously discussed, against the arrangements for onshore generators. The following section discusses the comparison by component parts, starting with the Capital Costs.

Capital Costs

The capital costs refer to the build costs of installing and commissions the reactive apparatus needed to meet the reactive capability requirements. The equipment required to meet the reactive capability will vary significantly by the generation technology chosen by the user and also potentially by manufacturer of the

[6] Use of System Charging Methodology
http://www.nationalgrid.com/NR/rdonlyres/C20ACF42-4D18-45C1-ACBF-CB52D3D7C481/43444/UoSCMI6R3v10Final.pdf

[7] This is specified within the definition of Balancing Services contained with the Electricity Transmission Licence

technology class. In essence this could vary from generators inherently having the full capability all the way to generators that have very little capability. Typically, the latter category is made up from wind turbines generators (WTG), and in acknowledgement of this the Grid Code allows WTG to install stand alone kit otherwise known as static compensation. Clearly the range of generation technologies available will therefore result in varying capital costs for reactive capability. However, it is incumbent on Large and Medium Power Stations to have the capability regardless of the cost to install it. Furthermore it is also the Generators' cost to bear, in that there is no current mechanism to remunerate the installed capacity.

Considering this in the context of a Generator owning an onshore Power Station compared to an Offshore Power Station, it is the view of this paper that there is no substantive difference between the two classes. Where a generator chooses to provide reactive capability at its Offshore Power Station on behalf of the OFTO they will be exposed to the capital costs in much the same way as the equivalent onshore generator, accepting that the offshore environment might alter the costs of installation and transport.

However, what happens in the case where the Offshore Power Station does not contribute to the OFTO requirement? The reactive asset the OFTO procures to meet the obligation will be included within the local tariff of the TNUoS charge, as highlighted previously. As a consequence the generator with the Offshore Power Station will directly bear the costs of the asset including the allowed rate of return. Accepting that in circumstances where the generator is not meeting the obligation the charging mechanism does not allow for user choice – TNUoS charges need to be paid over the 20 year recovery period. That aside, it is arguable that the capital costs offshore generators would be exposed to from OFTO reactive assets should not be principally different to those of generators installing the capability themselves.

Conclusion – regardless of the option offshore generators choose, the capital costs are not fundamentally different

Operating Cost – Fixed

The fixed operating costs are those required to ensure the reactive apparatus remains capable and operational should the service ever need to be called. Note this does not include the incremental costs of maintenance resulting from any actual operation of the assets, this is covered separately. Fundamentally the same principal points described above under the capital costs heading apply to the fixed operating costs. In short these costs are currently borne by the generators, be it through managing their own assets or through the local TNUoS tariff charge.

Conclusion – regardless of the option offshore generators choose the capital costs are not fundamentally different

Operating Cost – Variable

The variable operating costs are those incremental costs incurred as a result of providing a reactive power service to National Grid. This can be further broken down into two parts, maintenance and heat losses. Unlike the previous categories discussed above, the variable operating costs are not borne by providers but rather catered for by the DPM within the ORPS[8].

Maintenance

[8] Section 1 of Appendix 7 Charging Principles within Schedule 3 of the CUSC

As the DPM specifically caters for the maintenance costs directly incurred as a result of service provision, a difference appears between those parties receiving the DPM and those that do not. Put another way, the generator owning an Offshore Power Station not meeting the full OFTO obligation will be exposed to the incremental maintenance cost of the OFTO assets whereas generators owning an Onshore Power Station will be paid the DPM to cover their maintenance cost.

For a 200MW offshore Power Station, a reactive power range of ±66MVAr will be required to meet the STC obligation. If the Power Station does not contribute to the requirement and the OFTO employs Static Compensation, then for example the compensation could require a capability of approximately ±80MVAr to overcome the capacitive gain of the offshore cable. Based on costs incurred on the England and Wales transmission system National Grid estimates that the annual cost of maintenance of such apparatus could be of the order of £10K. It should be noted that this cost cannot be accurately apportioned between the fixed and the variable maintenance costs.

Conclusion – A potential difference exists between generators owning offshore and onshore power stations

Heat Losses
Heat losses consist of losses through the reactive equipment and through the generator owned transformers. The DPM also specifically caters for the heat loss costs directly incurred as a result of service provision. Therefore on initial consideration, in exactly the same manner as discussed above, it looks like generators owning offshore Power Stations not fully meeting the Interface Point obligation are at a disadvantage as compared to their onshore counterparts. However, under the current regulatory framework it can be shown that offshore generators will be held neutral to such heat losses.

OFTO owned assets providing reactive power are by definition transmission assets. Under the Balancing Settlement Code (BSC) any energy losses over the transmission network are socialised across the users of the network through the Balancing Service Use of System (BSUoS) charge[9], rather than being charged to the OFTO. Therefore as the OFTO does not incur the charge in the first instance for the losses over the reactive assets, they will not pass on such charges to the offshore generator.

Conclusion – Offshore generators are held neutral

Cable cost
To fully compare offshore with onshore generators, there is a further cost to consider. Offshore generators must connect to the onshore transmission network via sub-sea cables, which are substantially more expensive than overhead lines. Through obligating the reactive power capability at the IP rather than the Offshore Grid Entry Point, the offshore generator could potentially save on cable rating requirements and in turn on TNUoS costs.

For example were the reactive requirements at the Offshore Grid Entry Point, then for every MW of active power, the cable rating would need to be 1.05MVA. This is opposed to only the need for a one-to-one relationship between MW and MVA under the existing rules. Again taking the example of the 200MW offshore generator, the

[9] BSC Section T Settlement and Trading Charges, paragraph 2 contains the treatment of Transmission Losses.

cable would need to be rated for 211MVA rather than 200MVA. Accepting that cable is procured at set ratings and is not particularly granular, National Grid estimates that on said generator 50Km offshore, the difference in cable costs could be an additional £2.5m were the obligation at the Offshore Grid Entry Point. This illustrates the potential benefit to offshore generators resulting from the alternate technical requirements are compared to onshore generators.

Conclusion – Offshore generators potential benefit from the reactive obligation point being at the interface point

Summary

It is the view of this paper that there are differences between onshore generators and offshore generators that don't meet the entire IP obligation point.

Exposure to the incremental maintenance of OFTO reactive equipment is estimated to cost approximately £10k[10] per year, which onshore generators recover from the DPM. However, potentially offshore generators benefit from the offshore regime in the form of a reduced cable capacity requirement which this paper estimates could be in the order £2.5m.

OPERATION OF THE TRANSMISSION SYSTEM

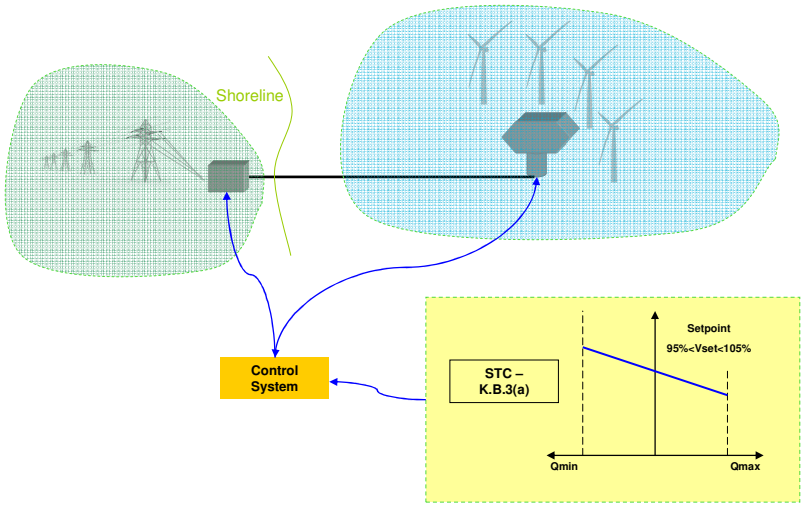
The BSSG have considered how National Grid will manage the voltage of the transmission system under the commercial arrangements outlined above. Simply put, this centres around the fact that, National Grid will be provided with a 'free reactive service' from any OFTO assets while incurring costs through generator service provision.

This issue was explored by the group through two separate scenarios.

Scenario 1:Joint Power Station – OFTO Contribution

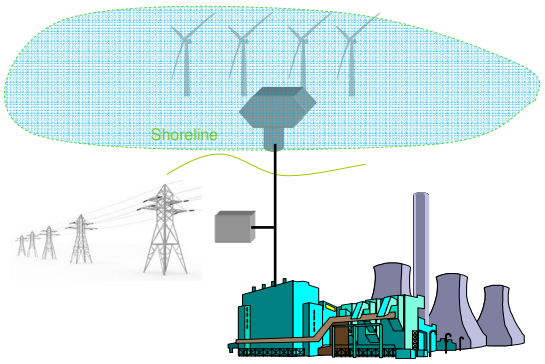
First the group considered the scenario where both the Offshore Power Station and OFTO contribute towards the requirement. While the Grid Code and STC are not prescriptive as to how the Power Station and OFTO assets should work together to meet the requirement, it is the view of this paper that to a certain extent they will need to work together. Whether this is achieved through a single voltage control system or plural is unclear. It is expected that in most cases the system operator will be despatching the control system through the OFTO and not the individual components, hence the control system will define whether the OFTO asset, generator asset or both are utilised. The diagram below illustrates this view. It is accepted that there is potentially a circumstance (although considered unlikely) where the two providers are independently controlled. In such cases National Grid would likely despatch the OFTO asset first.

[10] Fixed and variable maintenance costs can not be apportioned



Scenario 2: OFTO Provision and Power Station Provision

Second the group considered the scenario where there are two Power Stations next to each other one Onshore and one Offshore that are both equally effective on the local transmission voltage. Using the illustration below, the onshore Power Station as per code obligations directly provides the reactive service whereas under the offshore scenario, the OFTO rather that the Power Station provides the service. National Grid in this scenario would despatch the OFTO assets that are effectively free to use for the system operator. It should be noted that National Grid's actions in this scenario are consistent with the operation of onshore TO reactive assets, i.e. where a TO reactive asset is available that meets the requirements for managing the voltage on the network, National Grid will utilise the asset. The rationale for this is driven from National Grid's obligation to operate the system in an efficient and economic manner[11] ensuring that end consumer costs are minimised where possible.



CONSULTATION QUESTION

This paper seeks industry views on the offshore reactive commercial arrangements. As such please find a number of consultation questions below;

[11] The Electricity Transmission Licence obligates National Grid to operate the system efficiently and economically

1. Do you agree with the findings of the comparison between the offshore and onshore generators? Please provide your rationale.
2. Do you believe the commercial arrangements as described in the consultation are appropriate for the offshore regime? Please provide your rationale.
3. Do you believe alternative commercial arrangement should be considered? If yes please describe those alternative arrangements

Please respond using the attached proforma by close of play on Thursday 3rd March 2011.