# Offshore Transmission Expert Group
## Great Britain Security and Quality of Supply sub-group

## Recommendation of the default scope of an offshore transmission system
### Discussion Paper

**Summary**

This paper considers proposed connection arrangements for offshore transmission networks to the onshore electricity grid system, along with the connection of offshore generators to the offshore transmission system. This work has been carried out by the OTEG GBSQSS sub-group and puts forward a recommendation for the default scope of an offshore transmission system. This information is needed to develop a common understanding of the required scope of the offshore security and quality of supply standard.

**Objective and scope**

The specific objectives of the sub group are to:

a) Develop a framework of security rules that can be applied to offshore transmission networks that is compatible and consistent with the current onshore transmission network and market structure
b) To achieve (a) it will be necessary to assess the relevance of the existing GB SQSS for offshore transmission networks in the first instance and, if required, to outline any amendments that are needed to extend the GB SQSS offshore; and
c) Identify and develop a range of feasible alternative options for security standards relating to offshore transmission networks.

These objectives have been reflected in the assessment and drafting approach taken by the sub group in developing a recommendation to OTEG. The broad structure of the paper is as follows:

(i) consideration of the regulatory precedents which are in place onshore
(ii) establishment of an offshore model and possible offshore options
(iii) assessment of the onshore precedents to determine their relevance for each of the offshore options; and
(iv) recommendation on the default scope of an offshore transmission system.

The original terms of reference for the GB SQSS sub group included the need:

- to facilitate competition
- to minimise the overall level of transmission costs
- to ensure the safe operation of all transmission circuits
- for existing transmission licensees to meet existing SQSS compliance requirements in respect of the onshore transmission network
- for no undue discrimination on a geographic basis
- to ensure consistency and compatibility with onshore structure and application, and
- to promote equality of treatment in respect of system access for existing and future transmission users across GB.

**Onshore arrangements**

Different codes determine the appropriate default ownership and electrical boundaries to apply to any electrical project connecting to the onshore GB transmission system. These boundaries determine the default scope of the onshore security standard. Consistency with these default principles of ownership is therefore crucial to this assessment work.

It should be noted, for the avoidance of doubt, that the CUSC, STC and GB Charging methodology are applicable to the transmission system in England, Wales and Scotland.

Sections 2.12.1 (a) and (e) of the CUSC state:

*(a)in relation to **Plant** and **Apparatus** located between the **GB Transmission System** and a **Power Station**, the electrical boundary is at the busbar clamp on the busbar side of the busbar isolators on **Generators** and **Power Station** transformer circuits;*

*(e)in the case of a metal clad switchgear bay the electrical boundary will be the equivalent of those specified in this Paragraph 2.12.1 save that:*

*(i) for rack out switchgear, the electrical boundary will be at the busbar shutters;*

*(ii) for SF6 switchgear, the electrical boundary will be at the gas zone separators on the busbar side of the busbar selection devices.*

These principles of ownership exactly mirror those in STC Sections 3.1.1 and 3.1.5.

It should be noted that the CUSC assumes that the transmission system has been constructed to be compliant with the GB SQSS.

The existing arrangements in GB are such that any generation requesting connection to the transmission system would be made a connection offer with a point of connection that is consistent with the CUSC. It should be noted that a connection to a voltage which is lower than the transmission voltage (400kV or 275kV in England and Wales and 132kV in Scotland) could be requested as a design variation. Under these circumstances, the relevant TO could agree to own the busbars at the lower voltage substation, however the assets at that substation would be classed as connection assets.

Under existing arrangements, a generator requesting connection to the transmission system in Great Britain would be offered a connection consistent with existing GB SQSS standards, therefore a double busbar. As described above, the customer can request a design variation, for example, a single busbar connection. Under these circumstances, the customer would not be compensated for loss of system access if this loss of access were directly due to the single busbar connection. Any connections of this nature would be defined in the Bilateral Connection Agreement held between the generator and the SO, and defined as design variations based on customer requests.

Under the terms of the GB SQSS, customer choice can be applied to generator connections on the provision that:

*2.15 Variations, arising from a generation customer's request, to the generation connection design necessary to meet the requirements of paragraphs 2.5 to 2.13 shall also satisfy the requirements of this Standard provided that the varied design satisfies the conditions set out in paragraphs 2.16.1 to 2.16.3. For example, such a generation connection design variation may be used to take account of the particular characteristics of a power station.*

*2.16 Any generation connection design variation must not, other than in respect of the generation customer requesting the variation, either immediately or in the foreseeable future:*

*2.16.1 reduce the security of the MITS to below the minimum planning criteria specified in Section 4; or*

*2.16.2 result in additional investment or operational costs to any particular customer or overall, or a reduction in the security and quality of supply of the affected customers' connections to below the planning criteria in this section or Section 3, unless specific agreements are reached with affected customers; or*

*2.16.3 compromise any GB transmission licensee's ability to meet other statutory obligations or licence obligations.*

*2.17 Should system conditions subsequently change, for example due to the proposed connection of a new customer, such that either immediately or in the foreseeable future, the conditions set out in paragraphs 2.16.1 to 2.16.3 are no longer satisfied, then alternative arrangements and/or agreements must be put in place such that this Standard continues to be satisfied.*

*2.18 The additional operational costs referred to in paragraph 2.16.2 and/or any potential reliability implications shall be calculated by simulating the expected operation of the GB transmission system in accordance with the operational criteria set out in Section 5. Guidance on economic justification is given in Appendix E .*

National Grid's Connection Charging Methodology specifies the boundary that should apply between connection assets and use of system assets. Under the existing arrangements, most offshore network assets are likely to be defined as infrastructure assets. The connection boundary would be dependant upon the boundary between TO and user assets with any single user assets being treated as connection assets.

National Grids Connection Charging methodology states;

*1.5 In general, connection assets are defined as those assets solely required to connect an individual User to the GB transmission system, which are not and would not normally be used by any other connected party (i.e. "single user assets"). For the purposes of this Statement, all connection assets at a given location shall together form a connection site.*

*1.6 Connection assets are defined as all those single user assets which:*

*a) for Double Busbar type connections, are those single user assets connecting the User's assets and the first transmission licensee owned substation, up to and including the Double Busbar Bay;*

*b) for teed or mesh connections, are those single user assets from the User's assets up to, but not including, the HV disconnector or the equivalent point of isolation;*

*c) for cable and overhead lines at a transmission voltage, are those single user connection circuits connected at a transmission voltage equal to or less than 2km in length that are not potentially shareable.*

**Offshore model**

A typical offshore windfarm would consist of a number of wind turbines connected to a single point, generally an offshore platform. From that connection point the power is to be transmitted via the proposed offshore transmission network to the onshore electricity grid system. It should be noted that part of this offshore transmission network will pass over land up to the first on shore substation. An example of an expected offshore transmission system is shown in Figure 1

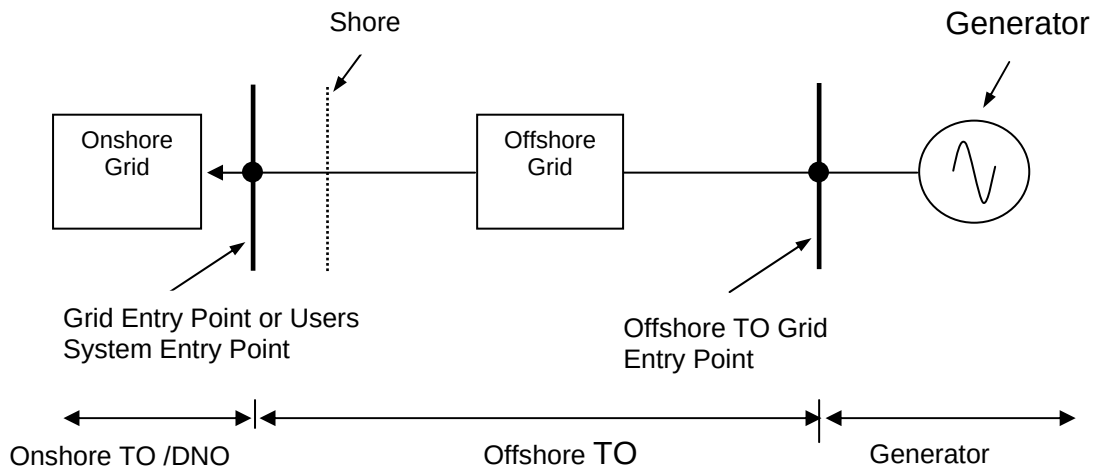


***Figure 1**: Designation of offshore transmission system*

Ownership of the assets on the offshore platform require careful consideration, a generic model has been developed based on the advice of offshore developers and can be seen in figure 2. This model consists of:

- A high voltage busbar;
- High voltage/low voltage transformer;
- Switchgear on the low voltage side of the transformer, and
- Low voltage busbars and outgoing feeder switchgear

**Options**

Four options for the Offshore Grid Entry Point were considered. These options took account of both existing arrangements in Great Britain and current design proposals for offshore generation projects that are being developed. The options considered were that the Offshore Grid Entry Point would be at the:-

1. Busbar clamp on the high voltage busbar situated on the offshore platform.
2. Disconnector on the busbar side of the low voltage transformer circuit breaker on the offshore platform.
3. Disconnector on the busbar side of the circuit breaker on the low voltage busbar on the offshore platform.
4. Individual wind turbine generator transformer(s) within the windfarm.

The diagram seen in figure 2 illustrates the ownership boundary options considered, all assets within the dotted line are assumed to be sited on a single offshore platform.

**Options analysis**

In order to provide a recommendation of the default scope of offshore transmission systems, a review of both existing and potential arrangements were considered to ensure the scope specified was suitable for offshore systems given the known difference in technologies and equipment to be installed.

A full consideration of the pros and cons of each option (shown in figure 2) has been carried out, and is seen attached in Appendix 1. An outline of the key points for each option is seen below.

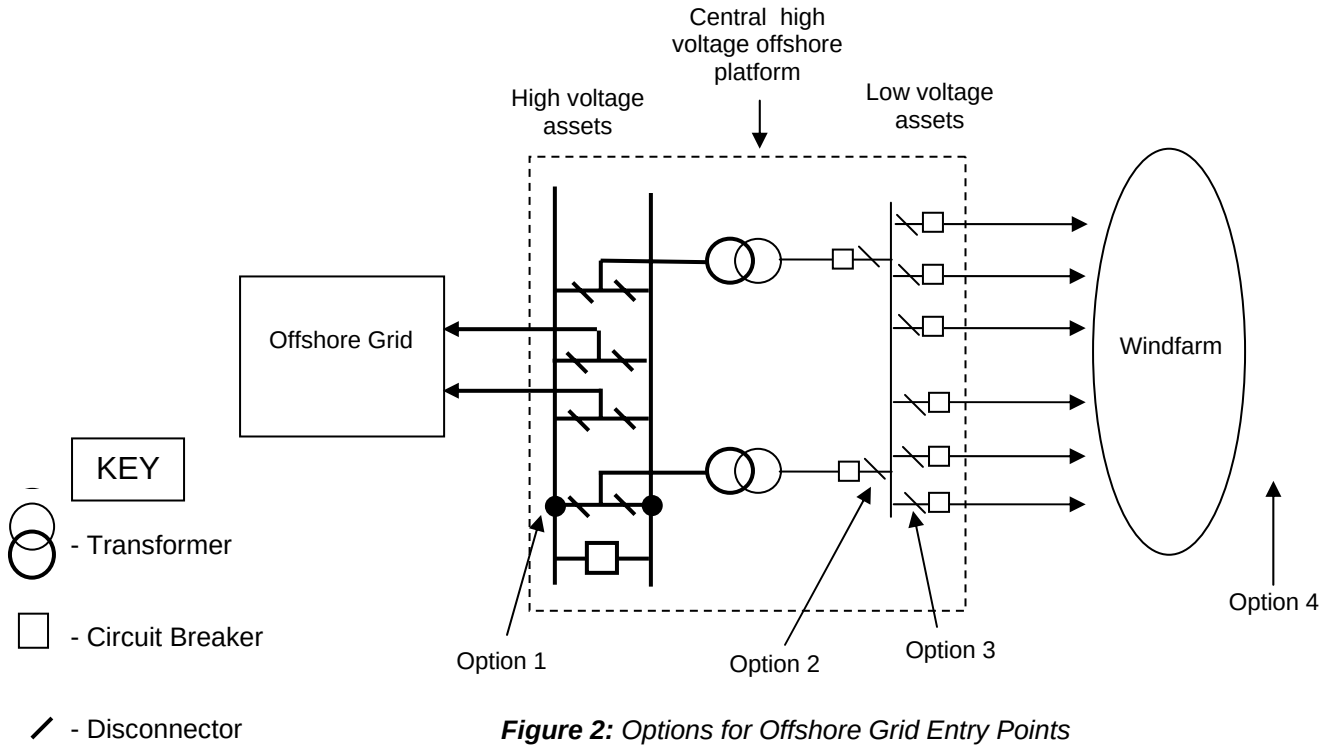


***Figure 2:*** *Options for Offshore Grid Entry Points*

**Option 1: Transmission voltage busbar clamps on the platform transformer circuits. i.e. TO own up to the transmission voltage busbar clamps on the platform transformer circuit.**

With only one party connected to the offshore platform, this option is consistent with the CUSC section 2.12.1 (e)(ii) and is also consistent with existing Great Britain arrangements.

With more than one party connected to the platform LV substation, this option would not be consistent with industry best practice and existing arrangements in Great Britain. In GB, shared assets are owned by the relevant TO and charged as infrastructure assets.

This option is comparable to option 3 and could be developed further. This option however offers fewer benefits than option 3, since it is not best placed to facilitate competition. If the transformers were owned by the generator, then this could provide a barrier for future generators seeking connection to the same platform.

**Option 2: Low Voltage (LV) disconnector of the platform SGT's / Converters, i.e. TO own up to the transformer LV disconnectors.**

This option is not consistent with the CUSC, nor is it consistent with existing arrangements in England and Wales.

This option would complicate the ownership of assets on the platform as the other options mean that a single party will own the platform along with the majority of the assets housed upon it. This option is also not best placed facilitate competition, and with more than one party connected is not consistent with existing arrangements in Great Britain. This option is therefore is not recommended.

**Option 3: All assets contained on platform owned by TO, i.e. TO own up to the disconnector on the busbar side (customer side) of the circuit breaker on the outgoing 33kV circuit.**

3.1 Connecting into a single busbar substation

With any number of parties connected to the 33kV substation, this option is not consistent with the CUSC and is also not consistent with existing Great Britain arrangements as a result of the connection layout of the substation. This is a result of the substation being non compliant with the GB SQSS.

With the 33kV substation as a single busbar substation, the GBSQSS would have to be amended for offshore connections to reflect this substation configuration.

3.2 Connecting into a double busbar substation

This option is consistent with existing CUSC arrangements for onshore generation connections.

This option is best placed to facilitate competition in generation, maintains simplicity of ownership of offshore assets with one party owning the platform and the majority of assets housed upon it, and also is most consistent with existing arrangements in GB.

**Option 4: 33kV windfarm electrical system (incl cable array), i.e. TO own everything up to the individual wind turbine generation transformer.**

This option is not consistent with the CUSC, STC or Great Britain arrangements.

This arrangement would mean the TO / SO would become involved in the day to day operation and maintenance of the windfarm electrical system and hence not preferred.

This option is not consistent with any onshore windfarm model in England, Wales and Scotland.

**Recommendations**

The OTEG SQSS Sub-Group considers it necessary to define the expected scope of an offshore transmission system to understand the required scope of the offshore Security and Quality of Supply Standard. The GBSQSS sub-group considers that Option 3 is the most appropriate default Offshore Grid Entry Point because this option;

- Best facilitates competition in generation
- Simplifies ownership of offshore platform assets
- Allows the offshore TO to provide Users with a consistent level of security
- Consistent (if more than one party is connected) with the default boundary arrangements defined in the CUSC and STC.

Option 1 could be considered however offers less benefits than Option 3, namely;

- Is not best placed to facilitate competition in Generation
- With more than one party connected is not consistent with existing arrangements in England Scotland and Wales

Option 2 is not recommended as it has a number of disadvantages that would make it un-suitable as a default ownership boundary, the main issues are that option 2;

- Is not best placed to facilitate competition
- Complicates Ownership of offshore transmission assets

Option 4 is not recommended because it is not consistent with;

- Existing generator connection arrangements.
- Existing licensing arrangements.
- Any existing on-shore windfarm generator model.

All recommendations made have been made in conjunction with all parties represented at the GB SQSS subgroup.

**Impact on future work**

- The GBSQSS sub-group has assumed that the default Offshore Grid Entry point will be as per option 3 in figure 2 for the cost benefit analysis work.
- Main impacts of this assumption:
  - transformer circuits will be included within the security standards for offshore transmission
  - will require the review of Grid Code, access rights and charging methodology to reflect default ownership boundary

## APPENDIX 1

**Option 1: Transmission voltage busbar clamps on SGT circuits.**

| Pro's | Con's |
|---|---|
| 1) Avoids complex arrangements to avoid constraint costs<br>2) Transformers owned by generator (more cost reflective)<br>3) Security level up to customer | 1) Multi Ownership on off-shore platform<br>2) Asset standardisation is difficult e.g. Transformer spares strategy more complex – could lead to longer down times post fault<br>3) Transformers owned by generator (could be seen as a barrier)<br>4) Extendibility could be problematic<br>5) Would not best facilitate competition in generation |

With one party connected to the platform;

- This option is consistent with that set out in section 2.12.1 of the CUSC, and section D 3.1.1 of the STC.
- No assets on the platform will be classed as connection assets in accordance with the current charging methodology.
- This option is consistent with the England, Wales and Scotland model.
- There would be no consequential impact on the onshore GB transmission system.

With more than one party connected to the platform;

- This option is not consistent with that set out in section 2.12.1 of the CUSC, and section D 3.1.1 of the STC.
- No assets on the platform will be classed as connection assets in accordance with the current charging methodology.
- This option is not consistent with the England, Wales and Scotland model.
- There would be no consequential impact on the onshore GB transmission system however there would be a requirement to review the licence arrangements for the owner of the platform transformers – if not a transmission licence holder there may be a requirement for one.

**Option 2: LV disconnector of the platform SGT's / Converters**

| Pro's | Con's |
|---|---|
| 1) Clean connection boundary<br>2) Likely that less 132kV circuit breakers will be used<br>3) Simplifies metering<br>4) May allow TO to hold spares to minimise SGT down time. | 1) Multi Ownership on off-shore platform<br>2) All connections will be via single busbar<br>3) Would not best facilitate competition in generation<br>4) Outages for TO busbar maintenance may cause constraint costs depending on offshore transmission access arrangements – at present not determined |

This option as the ownership boundary is **not** consistent with that set out in section 2.12.1 of the CUSC, and section D 3.1.1 of the STC.

**Existing arrangements**

**E&W –** This option is not consistent with the England and Wales model

**Scotland** – This option is not consistent with generation connections in Scotland.

**Option 3: All assets contained on platform owned by TO, i.e. ownership boundary is the disconnector on the busbar side of the circuit breaker on the outgoing 33kV circuit.**

| Pro's | Con's |
|---|---|
| 1) Clear demarcation of ownership of assets on platform<br>2) TO could provide consistent level of security – in accordance with SQSS<br>3) Facilitates future user requirements and competition<br>4) Better facilitate the strategic development of the transmission system<br>5) Transformers could not be defined as Single User Assets – therefore infrastructure costs socialised (reduced barrier to entry)<br>6) Likely to promote use of standard plant sizes which may justify TO to hold strategic spares | 1) Requires offshore standards to consider 33kV network.<br>2) Outages for TO busbar maintenance may cause constraint costs depending on offshore transmission access arrangements – at present not determined<br>3) Transformers could not be defined as Single User Assets –(less cost reflective)<br>4) Complex metering due to requirement for metering individual feeders. |

For 33kV metal enclosed switchgear, the outgoing switch is likely to be a circuit breaker, with a disconnector and earth switch between the busbar and the circuit breaker. In the case of this type of switchgear, all assets are enclosed in a single unit therefore point of ownership is defined by the technology utilized. It is thought to be more appropriate for the circuit breaker to be owned by the developer as they can control and protect their own cable, and can isolate and earth their own cable (this will mean a joint ownership switch room).

With one party connected to the platform;

- This option is not consistent with that set out in section 2.12.1 of the CUSC, and section D 3.1.1 of the STC.
- The 33kV board and the transformers on the platform would be classed as connection assets in accordance with the current charging methodology.
- This option is not consistent with the England and Wales arrangements, however is consistent with a number of agreements in Scotland due to interpretation of CUSC guidelines.
- There would be no consequential impact on the onshore GB transmission system.

*Note: Connection assets are as defined in the onshore arrangements chapter.*

With more than one party connected to the platform;

- This option is consistent with that set out in section 2.12.1 of the CUSC, and section D 3.1.1 of the STC.
- No assets on the platform will be classed as connection assets in accordance with the current charging methodology.
- This option is consistent with the England, Wales and Scotland model.
- There would be no consequential impact on the onshore GB transmission system.
- No assets on the platform will be classed as connection assets in accordance with the current charging methodology.

The onshore charging methodology does not include a clear definition of connection to a single busbar substation. The impact of assuming this scope of the offshore transmission system would need to be considered as part of the development of the offshore transmission charging arrangements.

**Option 4: 33kV windfarm electrical system (incl cable array)**

| Pro's | Con's |
|---|---|
| 1) Offshore generators do not have to develop 33kV networks | 1) Voltage level of circuits would lead to this option not being consistent with Offshore licence<br>2) TO will be involved with day to day operation of wind farm<br>3) Not consistent with E&W model<br>4) Not consistent with any existing wind farm connection model<br>5) Complicated interfaces; multiple interfaces at many locations i.e. each wind turbine, up to 100.<br>6) Complicated metering |

This option as the ownership boundary is **not** consistent with that set out in section 2.12.1 of the CUSC, and section D 3.1.1 of the STC.

This option is not consistent with the England, Wales and Scotland model.

Should this be chosen as the preferred option, the consideration of ownership of onshore windfarm electrical circuits would have to be considered.