



EMT Model Requirements for Existing Generators

Background

- As Great Britain's (GB) power system moves towards net zero carbon operation, the number of Inverter-Based Resources (IBR) is expected to increase and the amount of synchronous generation in the grid to decline which will significantly change the characteristics of the GB network.
- These changes giving rise to the potential control interactions between the devices across the network leading to risks of oscillations and inverter stability.
- Electromagnetic Transient (EMT) analysis is important for investigating the dynamics of converters, control interactions between the devices in the network, detecting system oscillations, commutation failure analysis, inverter stability analysis and identifying transient phenomena such as Transient Over Voltage (ToV).
- Root Mean Squared (RMS) simulations might not be able to capture or be capable of highlighting these issues adequately and they have limitations on modelling fast controls within the converters and non-fundamental frequency phenomenon.

What is the Ask?

- With the Grid Code GC0141 implementation, Users with completion date on or after September 2022 need to submit EMT models to the ESO.
- To carry out analysis such as system oscillation, inverter stability, ToV analysis, EMT models for generators with a completion date prior to September 2022 would be required.
- **Without these additional models, it could lead to unnecessary investment by the users or the TO, significant increase in constraint cost, single event leading to tripping of number of generators and could ultimately lead to loss of supply.**
- The generic EMT models may not be the correct representation of Inverter Based Resources (IBR) control elements such as Phase Locked Loop (PLL) control behaviour.
- **ESO is suggesting a Grid Code change that mandates all Users to provide EMT models for their plants.**
- ESO fully appreciate the importance of IP of manufacturers, however, it should not sit above the integrity of national infrastructure
- **ESO believe that the most efficient way to do this is, whilst remaining considerate of IP, is through a code modification.**

Enablers

- PC.A.6.1.3 suggest that at The Company's reasonable request, EU Code users expected to submit EMT simulations. Hence it is expected that these Users should have developed EMT models already.

of identifying the best way in which **The Company's** requirements can be met. In respect of **EU Code User(s)** only, **The Company** may request the need for electromagnetic transient simulations at **The Company's** reasonable request. **Users** with **EU Grid Supply Points** may be required to provide electromagnetic transient simulations in relation to those **EU Grid Supply Points** at **The Company's** reasonable request.

- EU Code Users, in general it covers for generators connected from late 2018
- For all HVDCs, already BCA requests for EMT models
- With the existing GC requirements, synchronous generators to provide shaft data when requested by The Company for SSTI studies

Need Case Examples

- **Scotland Region**

- In the recent years system oscillation of 1Hz to 8 Hz have been reported in the Scotland region, with the declining conventional synchronous generations and increasing IBR sources.
- To evaluate the source of oscillations and to plan the mitigating actions to eliminate the oscillation issues, EMT models are required.
- In addition to the oscillation analysis, inverter stability, commutation failure of LCC HVDC, TOV analysis to be carried out, for region with high penetration of IBR.

- **South East Coast Region**

- Region with high penetration of power electronic devices; LCC HVDC, VSC HVDC, Type 4 wind farms, hybrid STATCOMs so on
- To gain confident in planning ESO need to carry out analysis on system oscillation, inverter stability, commutation failure of LCC HVDC and TOV analysis, for a region with such a high penetration of IBR.

- **The UK government has set out ambition to deliver 50GW of offshore wind by 2030**

- Future IBR, such as offshore HVDC sources, are going to be connected to locations closer to already existing IBR resources and/or synchronous generator, then possible Sub-synchronous Torsional Interaction (SSTI) and Sub-Synchronous Control Interactions (SSCI) need to be evaluated.



Possible Approaches

| Option | Comments |
|---|--|
| <p>Option 1: GC modification can mandate all the existing generators (connected before 1st September 2022) to provide EMT models</p> | <ul style="list-style-type: none"> • Number of generators connected long time ago, mainly conventional synchronous generators, may not have EMT model or expertise within company to provide EMT model. This was discussed during the GC0141 modification with Users concerns that models could be difficult to produce for older plant • Small number of WF plants may have the issue. • Users may concerned about the cost for developing EMT model to represent their plants, if it is not already available |
| <p>Option 2: GC modification can mandate User Plant Specific EMT model submission from Users of IBR technology connected before 1st September 2022</p> | <ul style="list-style-type: none"> • This approach can reduce the risk of very old plants, mainly synchronous generators, to develop EMT models |
| <p>Option 3: GC modification can mandate EMT model submission for all EU Code Users connected before 1st September 2022 and The Company can request other Users connected before 1st September 2022 to provide EMT model within X months</p> | <ul style="list-style-type: none"> • Based on the existing PC.A.6.1.3, EMT simulations should be submitted by EU Code Users by the request from The Company • Many generators (generators connected late 2018) may fall into this category |
| <p>Option 4: GC modification to reflect that The Company can request EMT models from all Users connected before 1st September 2022 and Users are expected to submit their models within X months</p> | <ul style="list-style-type: none"> • ESO can target and prioritise • Not yet sure about the months (may be 6 months) |



Feedback to comments
from the GCDF 29/08/23

| Comment | Feedback |
|--|--|
| It is essential that there is manufacture representation on any Workgroups. | We will ensure that is considered when selecting the Workgroup (WG) members (manufacturers were present in the GC0141 Workgroup as well) |
| We need to be mindful that there may be circumstances where the User simply cannot obtain these models due to circumstances beyond their control as changes to the Grid Code could leave them non-compliant. | The WG will ensure that is explicitly captured in the legal text and what are the options the Company and Users can take when it is the case |
| Could there be an alternative where the information is passed direct from the manufacturer to the ESO (rather than the User providing the model to the ESO)? | After GC0141 we currently do work with the users and manufacturers during the connection process to ensure the models are compliant and provide support. However, it needs to be clear that the models remain the User responsibility and any future requests regarding the model should be facilitated by the users |
| It is vital that the potential commercial implications for Users are considered as there is no cost recovery model for this | We will take these comments on board and will be part of the discussions in the WG which would be held as part of the Grid Code modification |
| Would a generic model be used for example? | This will be left to the WG to investigate as part of the options from comment 2 above |

| Comment | Feedback |
|--|--|
| <p>It was asked if any potential Grid Code changes will apply to commercial providers of STATCOMs (as opposed to those owned by the TOs which will be bound by the STC Code)?</p> | <p>This will be investigated by the WG, however currently it is a requirement for pathfinder solutions. As mentioned, the TO assets will be covered by the STC procedures</p> |
| <p>Could there be an option where the ESO, User, and the Manufacturer have joint discussions in relation to the provision of the EMT Model similar to the 'Joint Investigations' section of the Grid Code currently as part of section OC10?</p> | <p>We agree if any investigation triggered by significant incident, we can include the request to the EMT model in the investigation. However, for the purpose of this modification we will be looking from the planning stages and if the models are required even if there is no incidents triggered</p> |
| <p>It was asked if any consideration had been given in terms of the minimum power level for the provision of these models?</p> | <p>This will be left to the WG to decide, we do envisage size and location will be taken into account when considering who will be covered by this modification</p> |
| <p>GC0117, that is looking to harmonise Power Station thresholds across GB</p> | <p>Thanks for raising this point, it will be raised to the WG to ensure alignment with GC0117 final outcomes</p> |