Expert Group Interaction Studies and Simulation Models (EG ISSM) for PGMs/HVDC

- Consolidated amendment proposal of the EG members

Presentation to GC ESC on behalf of the EG ISSM

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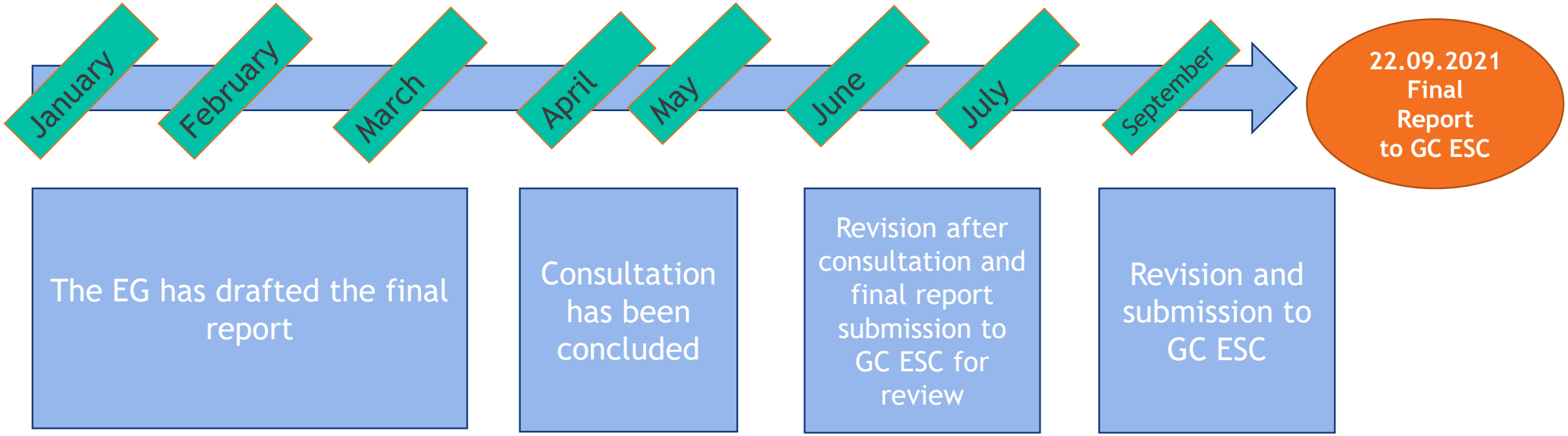
Project time line



The EG ISSM has proposed the following CNC amendments

- NC RfG
  Art.15.6.c / General requirements for type C power-generating modules
- NC RfG
  Art.52 / Compliance simulations for type C synchronous power-generating modules
- NC HVDC
  Art.54 / Simulation models
- NC DC
  Art.21.3 / Simulation models

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(i) at the request of the relevant system operator or the relevant TSO, the power-generating facility owner shall provide simulation models which properly reflect the behaviour of the power-generating module for the relevant study purpose in both steady- state, and dynamic simulations (root mean square), or in electromagnetic transient simulations. The simulation model requirements and data provided shall not violate manufactures intellectual property;

The power-generating facility owner shall ensure that the models provided have been verified against the results of compliance tests referred to in Chapters 2, 3 and 4 of Title IV, and shall notify the results of the verification to the relevant system operator or relevant TSO. Member States may require that such verification be carried out by an authorised certifier;

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(ii) the Synchronous PGM simulation models provided by the power-generating facility owner shall contain the following sub-models, depending on the existence of the individual components:

- alternator and prime mover
- speed and power control
- voltage control, including, if applicable, power system stabiliser ('PSS') function and excitation control system,
- power-generating module protection models, as agreed between the relevant system operator and the power- generating facility owner,
- ~~and converter models for power park modules;~~

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(iii) For the purpose of electromechanical dynamic simulations (RMS simulation studies) of power park modules the relevant system operator or the relevant TSO shall have the right to specify the power park modules simulation model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the simulation models of the power park modules provided by the power generation facility owner shall:

a) be valid for the specified operating range and all control modes of the power-generating facility;
b) include a proper representation of the converter modules and its control systems (including the synchronization module) that influence the dynamic behaviour of the power-generating module in the specified time frame;
c) be open source generic model for cross border network stability studies;
d) in the case that encrypted detailed RMS models are accepted by the relevant TSO, the relevant TSO shall specify the requirements of the model encryption according to national regulations (for example use of source code, the model structure and the signal interfaces to be observable in the network studies);
e) include the relevant protection function models;

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(iv) For the purpose of time domain electromagnetic transient (EMT) simulations of power park modules the relevant system operator or the relevant TSO shall have the right to specify the power park module model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the models shall contain the following:

a) be valid in the frequency range 0.2 Hz – 2500 Hz for relevant interaction studies. The validity of the PPM model shall be ensured for the given frequency range at the connection point;
b) be valid for specified operating range and control modes of the PPM in both the positive and in the negative phase sequence;
c) reproduce the detailed response of the power-generating module and its control blocks during balanced and unbalanced AC network faults in the valid frequency range;
d) include the power plant level control and the power plant relevant functionalities if applicable;
e) include the frequency dependence of the lines and/or cables in the power-generating facility;

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(iv)

…

f) represent the Power Plant Module transformers model including saturation, resistors, filter, breaker and AC arrester in the valid frequency;
g) include all the relevant protection function models for the relevant interaction studies;
h) be capable to be used for the numerical calculation of the frequency dependent impedance of PPM at the connection point (impedance amplitude and impedance phase angle) in the frequency range that the model is valid);
i) In the case that encrypted detailed EMT models are accepted by the relevant system operator or the relevant TSO, the relevant system operator or the relevant TSO shall have the right to specify the model encryption based on national regulations (for example the model structure and the signal interfaces to be observable in the network studies);

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(v) For the purpose of frequency domain simulations for the risk assessment of the resonance stability of the power park module, the relevant system operator or the relevant TSO shall have the right to request from the power-generating facility owner the frequency dependent impedance model of the power-generating facility at the point of interconnection to the grid. Without prejudice to the Member State's rights to introduce additional requirements, the following requirements shall apply:

a) The impedance model of the power-generating facility shall be requested at least in the range 5.0 Hz - 2500Hz; As an additional requirement, the relevant system operator or the relevant TSO can extend the required applicability of the model to up to 9 000 Hz.
b) The relevant system operator or the relevant TSO shall have the right to request the calculation of the impedance model of the power-generating facility either numerically (using the EMT model) or analytically (using transfer function);

NC RfG / Article 15.6.c

General requirements for type C power-generating modules

c. with regard to the simulation models:

(v)

..

c) The relevant system operator or the relevant TSO shall have the right to request the impedance profile of the power-generating facility at the connection point through the whole operating range and control modes of operation;
d) The impedance model of the power-generating facility shall be provided for both the positive and for the negative phase sequence;
e) The power-generating facility owner shall take into account the influence of the power-generating module control and measurement system as other parts of the power-generating module which influences the output impedance in the specified frequency range;
f) The power-generating facility owner shall specify and justify simplifications made in the calculation of the impedance model.

NC RfG / Article 52

Compliance simulations for type C synchronous power-generating modules

2. With regard to the LFSM-U response simulation the following requirements shall apply:
(a) the power-generating module's capability to modulate active power at low frequencies in accordance with point (c) of Article 15(2) shall be demonstrated by RMS simulation;

3. With regard to the FSM response simulation the following requirements shall apply:
(a) the power-generating module's capability to modulate active power over the full frequency range in accordance with point (d) of Article 15(2) shall be demonstrated by RMS simulation;

4.With regard to the island operation simulation the following requirements shall apply:
(a) the power-generating module's performance during island operation referred to in the conditions set out in point (b) of Article 15(5) shall be demonstrated by RMS simulation;

5.With regard to the reactive power capability simulation the following requirements shall apply:
(a) the power-generating module's capability to provide leading and lagging reactive power capability in accordance with the conditions set out in points (b) and (c) of Article 18(2) shall be demonstrated by simulation in the outer corners of the U-Q/Pmax diagram. In addition to simulations of the executed tests shall be performed with the real grid voltage and load points during the tests;

NC HVDC / Article 54

Simulation models:

1. The relevant system operator in coordination with the relevant TSO may specify that an HVDC system owner deliver simulation models which properly reflect the behaviour of the HVDC system in ~~both~~ steady-state, in time domain dynamic simulations (root mean square, RMS) and in electromagnetic transient simulations (EMT).
2. The format in which models shall be provided and the provision of documentation of models structure and block diagrams shall be specified by the relevant system operator in coordination with the relevant TSO. In the case that encrypted detailed RMS or EMT models are accepted by the relevant TSO, the relevant TSO together with the HVDC system owner shall specify the requirements of the model encryption (for example use of source code, the model structure and the signal interfaces to be observable in the network studies). The agreement should be made on project specific basis according to national regulations;

NC HVDC / Article 54

Simulation models:

3. For the purpose of electromechanical (RMS) simulations used in network studies, the relevant TSO shall have the right to specify the model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the HVDC system models shall contain at least the following:

   a) be valid for the specified operating range and all control modes of the HVDC system;
   b) include representation of HVDC converter unit, HVDC lines/cables and control systems that influence the dynamic behaviour of the HVDC transmission system in the specified time frame;
   c) include the relevant protection function models as agreed between the relevant TSO and the HVDC system owner;
   d) be open source generic model for RMS simulations delivered for cross-border network stability studies;
   e) The above listed simulation model requirements and information must not violate manufactures intellectual property;

NC HVDC / Article 54

Simulation models:

4. For the purpose of electromagnetic transient simulations (EMT), the relevant TSO shall have the right to specify the model requirements. Without prejudice to the Member State's rights to introduce additional requirements, the models shall contain the following:

    (a) be valid at least in the frequency range 0.2Hz to 2500 Hz for relevant studies;
    (b) be valid for the specified operating range and all operation modes of the HVDC system in both the positive and in the negative phase sequence;
    (c) be able to reproduce the detailed transient response of the HVDC system and its control blocks (including synchronisation) during balanced and unbalanced AC network faults in the valid frequency range;
    (d) include an accurate representation of the semiconductor valves, the frequency dependency of the HVDC system lines and sufficient representation of communication systems instruments where deemed necessary for the respective HVDC system model and study purpose;
    (e) …

NC HVDC / Article 54

Simulation models:

4. …

(e) represent transformers models (including saturation), resistors, filter, breaker, AC and DC arrester in the valid frequency range;
(f) include all the control and protection models as agreed between the relevant TSO and the HVDC system owner (under/overvoltage, overcurrent, chopper and frequency sensitive control functions);
(g) be capable to be used for the numerical calculation of the frequency dependent impedance of the HVDC converter station (magnitude and phase angle of the Z(f)) in the frequency range that the model is valid;
(h) The above listed simulation model requirements and information must not violate manufactures intellectual property;

NC HVDC / Article 54

Simulation models

5. For the purpose of the risk assessment of the resonance stability of the HVDC convert station, the TSO shall have the right to request from the HVDC system owner the frequency dependent impedance model of the HVDC converter station at the AC side. Without prejudice to the Member State's rights to introduce additional requirements, the following requirements shall apply:

   (a) The impedance model of the HVDC converter station shall be requested in the frequency range 5Hz till 2500 Hz; The TSO has the right to extend the required applicability of the model up to 9 000 Hz.
   (b) The relevant TSO together with the HVDC owner shall agree if the calculation of the impedance model of the HVDC converter station will be either numerically (using the EMT model) or analytically (using transfer function) or both; In the case of numerical calculation, the TSO shall specify the frequency steps where the impedance is provided. The number of different frequency steps shall be reasonably limited to provide acceptable results and at the same time limit the simulation effort and data storage to an acceptable amount.

NC HVDC / Article 54

Simulation models

5.

…

(c) The relevant TSO shall have the right to request the impedance model of the HVDC station through the specified operating range and all control modes of operation;
(d) The impedance model of the HVDC converter station shall be provided for both the positive and for the negative phase sequence;
(e) The HVDC system owner shall take into account the influence of the whole HVDC unit control and measurement system as well as other parts of the HVDC unit which influences the output impedance in the specified frequency range; If coupling between different frequencies exists in a given frequency range, this should be sufficiently represented.
(f) The HVDC system owner shall specify and justify simplifications made in the calculation of the impedance model;

NC DC/ Article 21

3. Each TSO shall specify the content and format of those simulation models or equivalent information. The content and format shall include: (a) steady and dynamic states, including 50 Hz component; (b) electromagnetic transient simulations in time domain at the connection point, (c) frequency domain simulations including the frequency dependent grid impedance at the connection point; (d) structure and block diagrams.