Quick Update of JWG B4/C4.103

AC Network Equivalents for HVDC and FACTS Project Studies

CIGRE UK B4 Technical Liaison Meeting

Friday 16th May 2025

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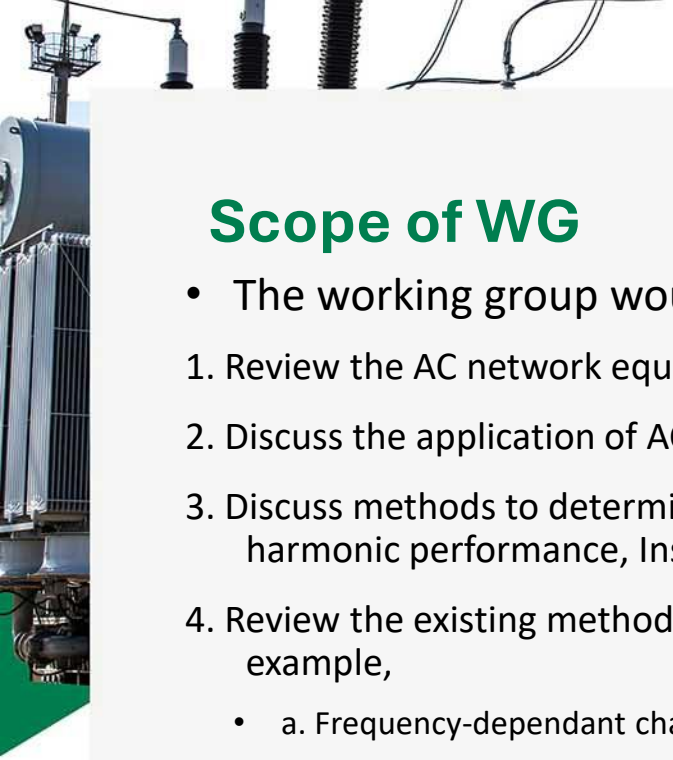
Background

- Electromagnetic Transient (EMT) domain simulations based on reduced AC system network representation (AC system equivalents) have been widely used by HVDC/FACTS OEMs for HVDC and FACTS projects to design and verify their system performance such as control and protection (C&P) to meet the specified performance and control functionality in terms of
- Although AC system equivalents are being used for performing studies for HVDC systems and FACTS devices, **the modelling techniques and processes used to develop AC network equivalents are not well documented**. Also, the adequacy and applicability of traditional equivalencing methods to the present-day AC networks need to be re-evaluated. Furthermore, the adequacy and applicability of new modelling techniques such as co-simulation need to be assessed. At present a guideline on developing AC network equivalents for modern power systems is not available.

Objective of WG

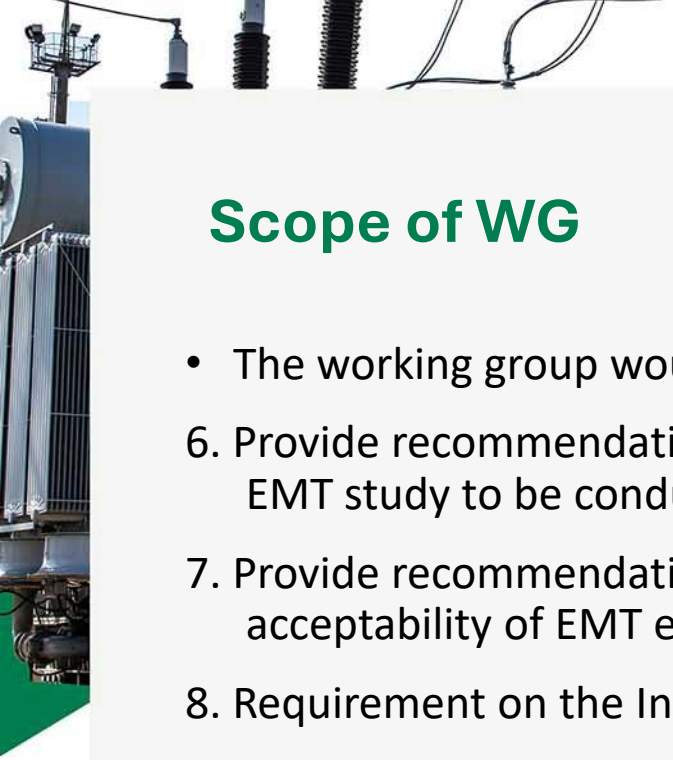
- The objective of this working group is to provide guidelines for developing AC system equivalents in EMT tools for studying HVDC systems or FACTS devices. Both static and dynamic equivalents as well as other modelling techniques such as co-simulation will be considered and recommendations on how to determine the size of the equivalent AC network and benchmarking against the original model will also be presented.
- Although the main focus of the this WG is HVDC and FACTS studies, the outcome of this WG may be possible to directly apply to development of network equivalents for some large scale IBR projects (e.g. Offshore wind farms). This working group will highlight when the developed guidelines can be applied to IBR study context and limitations.



Scope of WG

- The working group would investigate and report on:

1. Review the AC network equivalencing and identify the gaps in the existing methodologies and approaches.
2. Discuss the application of AC network equivalents for various HVDC and FACTS studies and their limitations.
3. Discuss methods to determine the size of the network equivalent considering the type of the study (e.g. dynamic performance, harmonic performance, Insulation coordination), and the AC network characteristics.
4. Review the existing methods and propose modelling methods of the network elements based on the type of studies performed. For example,
    - a. Frequency-dependant characteristics of transmission lines and cables
    - b. Inverter-based resources
    - c. Dynamic loads
    - d. FACTS devices
    - e. DERs
5. Propose benchmarking methods to evaluate the adequacy of the AC network equivalents. The indicators highlighting the following system characteristics will be considered.
    - a. Steady-state performance
    - b. System impedance
    - c. Short-circuit level
    - d. System inertia
    - e. Dynamic performance following disturbances



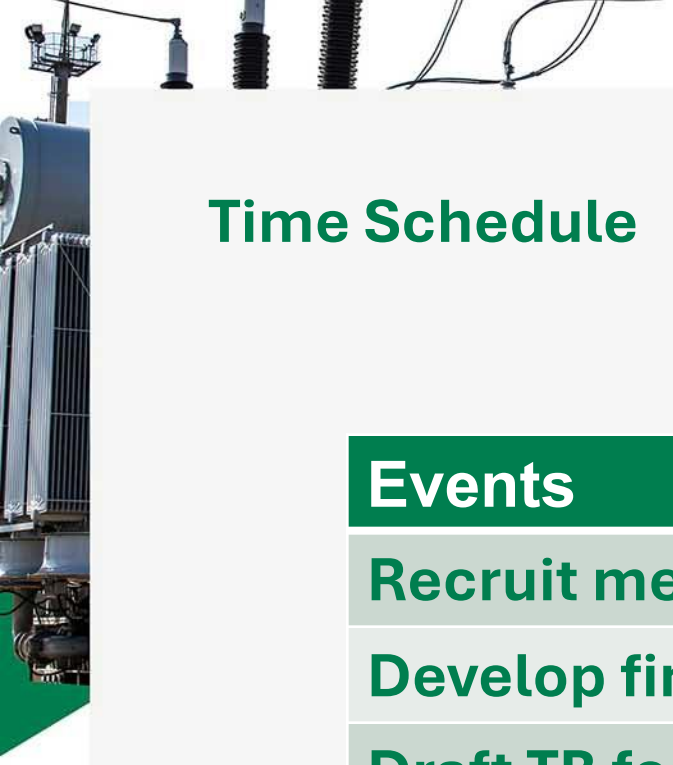
Scope of WG

- The working group would investigate and report on:

6. Provide recommendations on the significance/relevance of the proposed benchmarking methods for the type of EMT study to be conducted with the AC network equivalent in EMT.
7. Provide recommendations on the required level of accuracy which can be considered adequate for the acceptability of EMT equivalent.
8. Requirement on the Input data. For example,
    - a. Quality of the Phasor-Domain Transients (PDT) models
    - b. Level of details of (e.g., bus bar configurations, medium and low voltage network details)
    - c. EMT modelling details
9. Discuss recommendations with regards to practical implementation: Challenges for different stakeholders (Manufacturers, Network Owners, Developers, and consultants) with respect to aspects such as timelines, data availability and possible solutions.
10. Discuss the applicability of the recommendations/guidelines to IBR projects and identify any gaps.

Proposed Technical Brochure Table of Contents

- 1. Introduction
- 2. AC network equivalents for HVDC and FACTS
- 3. Network Reduction
- 4. Modelling the detailed network
- 5. Benchmarking
- 6. Recommendations/Guidelines
- 7. Conclusions and Recommendations for Future Work



Time Schedule

Events	Date
Recruit members (National Committees)	Q2 2024
Develop final work plan	Q3 2024
Draft TB for Study Committee Review	Q3 2026
Final TB	Q1 2027
Webinar	Q2 2027
Tutorial	Q3 2027

Thank you!

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