CIGRE Study committe B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG B4/C4.100

NAME OF THE CONVENOR
Rault Pierre (FRANCE)

TITLE
Guide for Electromagnetic Transient Studies of VSC-HVDC connected offshore or onshore islanded wind farms

THE WG APPLIES TO DISTRIBUTION NETWORKS: **NO**

ENERGY TRANSITION
4 / Sustainability and Climate Change
5 / Grids and Flexibility
6 / Solar PV and Wind

POTENTIAL BENEFIT OF WG WORK
2 / potential interest from a wide range of stakeholders
4 / state-of-the-art or innovative solutions or directions
5 / Guide or survey on techniques, or updates on past work or brochures

STRATEGIC DIRECTION
1 / The electrical power system of the future reinforcing the End-to-End nature of CIGRE: respond to speed of changes in the industry by preparing and disseminating state-ofthe-art technological advances

SUSTAINABLE DEVELOPMENT GOAL
7 / Affordable and clean energy

BACKGROUND :

1)
An increasing number of offshore Wind Farms (WFs) connected through VSC-HVDC links are already in operation, with many more expected in coming years. In addition, onshore islanded WF connected via VSC-HVDC are also attracting growing interest. There is presently a lack of technical documentation that presents typical transient and dynamic behaviour and control interactions which might occurs with the surrounding offshore network. Such transients can be triggered by AC/DC faults onshore or offshore, energization of offshore transformers or other events. During these transients, the system behaviour is primarily driven by the HVDC control and protection systems, but also significantly by the wind turbines (WT) and wind farm (WF) control and protection, which are partially documented in literature.

2) EMT studies that include both the offshore WF (OWF) and the HVDC station are mandatory for the offshore station design and performance assessment. However, such studies face several challenges:

a. At the early stages of the HVDC design, detailed information of OWFs and especially the wind turbines, is often unavailable. The industry has developed several approaches to mitigate these uncertainties without delaying project execution.
b. Large Modern OWFs of gigawatt scale can include more than 50 WTs. Modelling each WT individually in EMT studies is cumbersome and unnecessary. Aggregation methods are therefore used, but these are not standardized and must be justified on a project-by-project basis.
c. The large number of WTs and feeders creates an exponential increase in possible topologies; a selection of most relevant cases must be made.
d. A list of required EMT studies and associated input data, agreed between stakeholders, is needed to improve project execution efficiency.

3) Control, high-frequency, and nonlinear interactions are well known in power-electronic-dominated grids, and OWFs connected through HVDC systems are a prime example. Despite the relatively small number of HVDC-connected OWFs currently in service, several onsite issues have already been experienced. It is therefore critical to anticipate such problems in future OWF–HVDC projects through appropriate studies and mitigation measures.

4) Bipolar HVDC schemes for OWF connection are increasingly attractive. However, they introduce new challenges for offshore operation, particularly in achieving proper pole balancing and ensuring reliable parallel operation of offshore HVDC converter. Their typical dynamic and transient behaviours must be better illustrated and documented.

5) To enable larger OWF connections, improve power supply reliability and dispatch flexibility, and allow the integration of offshore loads, OWFs will be interconnected and connected to shore through several parallel HVDC links, as in energy island projects. The coordination of grid-forming HVDC converters with OWFs is a key area requiring further attention.

6) Interconnecting HVDC links and OWFs at the offshore side, including bipole, presents several challenges such as risk of cascading trip due to overload, offshore substation short circuit current withstand capability, harmonics …

7) As grid-forming support is increasingly requested from power-electronic-based devices, HVDC–OWF systems are potential candidates in the near future, which may affect their dynamic behaviour.

PURPOSE / OBJECTIVE / BENEFIT OF THIS WORK :

This WG will provide guideline and insight on the typical dynamic and transient behaviour of OWF-HVDC system.

1) The brochure will consider the typical arrangements of HVDC connected OWFs (reference to TB619) and will discuss the corresponding WF and HVDC control philosophy.

2) Follow the same approach as TB 832 “Guide for electromagnetic transient studies involving VSC converters” while focusing on VSC-HVDC connected OWFs.

3) This brochure will intend to provide recommendations on EMT studies to be performed and required input data during the project life of an OWF connected through HVDCs.

4) The brochure will illustrate typical dynamic and transient behaviours of an VSC-HVDC connected to OWF. The focus will be mainly on the offshore side. Illustrative examples shall either comes from field records, real projects, or eventually from generic results validated by the working group members.

5) The brochure intends to highlight possible issues which need to be carefully investigated and then discuss the different mitigation measures which exist to obtain a proper behaviour.

6) If, during the development of the brochure, real projects using grid-forming control of VSC-HVDC connected to OWFs (onshore or offshore) enter the project execution phase, some typical dynamic behaviours may be included.

7) If relevant, the differences between OWFs and onshore islanded wind farms will be highlighted.

8) Harmonic stability of offshore network can be discussed in a standalone chapter

SCOPE :

1. Principle of operation of WFs connected through VSC-HVDC and use cases considered in this brochure:

1.1. One HVDC point-to-point link connecting one or more offshore WFs

1.2. Bipolar HVDC point-to-point link connecting one or more offshore WFs

1.3. Two HVDC point-to-point links connected to two or more coupled offshore WFs connected on the AC offshore side

2. Depending on each configuration the following typical transient and dynamic behaviour shall be analysed:

2.1. Onshore fault ride through

2.2. Offshore fault ride through

2.3. Trip of one pole for Bipolar HVDC configuration

2.4. Sympathetic interaction of transformer

2.5. Feeder incomer CB TRV

2.6. DC fault ride through

2.7. Control interaction

2.8. High frequency interaction

2.9. Onshore frequency control performance

2.10. Offshore frequency control and load sharing for two parallel HVDC links

2.11. Power flow dispatch control for two parallel HVDC links

2.12. Trip of one HVDC link for two parallel HVDC links

3. Offshore grid harmonic emission and stability (Optional, Standalone part)

3.1. Discussing the methods for analysing offshore harmonic stability and emission

3.2. Impact of different offshore grid configurations

Remarks:

The objective is to gather stakeholders involved in EMT studies of HVDC–OWF systems. This should include the perspectives of TSOs, HVDC and wind turbine manufacturers, as well as HVDC and wind farm developers. The brochure is intended to provide guidance for conducting EMT studies based on current industry best practices.

Industry experiences:

Industry experience and feedback will be highly appreciated, particularly records from existing projects. If you are not a working group member but have material to share, please send it to the group; it will be considered and will add significant value to the brochure.

DELIVERABLES AND EVENTS

Deliverables Types

Annual progress and activity report to Study Committee
Technical Brochure and Executive Summary in Electra
Tutorial
Webinar

Time schedule

Q4	2025	Recruit members
Q1	2026	Kick off meeting
Q2	2026	Develop final work plan
Q1	2029	Tutorial
Q4	2029	Draft TB for SC review
Q4	2029	Final TB
Q1	2030	Webinar

APPROVAL BY TECHNICAL COUNCIL CHAIRMAN:

Rannveig S. J. Loken
January 28th, 2026