CIGRE Study Committee SC C1

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG N° C1-B4.49	**Name of Convenor:** Cornelis Plet (CANADA) **E-mail address**: cornelis.plet@dnv.com	
Strategic Directions #[3]: 1, 3		**Sustainable Development Goal #[3]: 7, 9, 13**
The WG applies to distribution networks[4]: No		
Potential Benefit of WG work #[5]: 1, 2, 3 & 4		
Title of the Group: Offshore transmission planning		

Scope, deliverables and proposed time schedule of the WG:

Background:

The use of offshore transmission infrastructure has grown significantly over the last decade and is set to undergo exponential growth in the near future, spurred on by four factors:

- the realisation of offshore renewable energy sources such as offshore wind farms
- the interconnection of different countries and market zones
- the electrification of offshore oil & gas platforms and islands
- the need for reinforcements to the onshore grid, effectively implemented by means of offshore circuits.

Compared to onshore transmission developments, offshore transmission infrastructure is often unique because typically:

- it is a greenfield development and does not take incumbent Transmission & Distribution (T&D) systems into account (except for the onshore grid connection point)
- it does not supply or connect consumers or distribution grids directly
- it is remote, makes use of cables and of platforms with which the electricity sector has relatively little experience; also, it is located in a hostile environment, requiring specific techniques, practices and equipment for installation and maintenance.
- it often crosses multiple offshore jurisdictions such as national borders, offshore regulatory zones, exclusive economic zones and/or control area borders, requiring special/innovative regulation and inter-country agreements.

In the early phases of development, offshore transmission links were typically realized as dedicated point-point transmission links, optimized for their specific purpose, and without considerations for future expansion or connection with other offshore transmission infrastructure. However, as the need for offshore transmission capacity increases, multi-purpose and more complex grid topologies are being considered. More complex grid topologies have a number of benefits over point-to-point links:

- Link and onshore substation outage mitigation (higher availability)
- Reduced curtailments due to onshore grid constraints or congestion
- Relief of congestion in onshore grids
- Improved reliability and resiliency to onshore grid
- Ancillary services to onshore grid
- Inter-zone and inter-regional capacity value
- Fewer, larger circuits: reduced impact on environment and local communities.

At the same time, due to the long distances and high capacities of offshore energy resources, High Voltage Direct Current (HVDC) technology is becoming widely used in offshore transmission systems. HVDC technology is developing rapidly, enabling new application areas such as multi-terminal and multi-purpose offshore grids, but also raising new challenges.

Previous CIGRE working groups have addressed technical challenges regarding the design and operation of offshore transmission infrastructure, most notably for multi-terminal HVDC systems:

- TB483 - Guidelines for the Design and Construction of AC Offshore Substations for Wind Power Plants
- TB536 - Influence of Embedded HVDC Transmission on System Security and AC Network Performance
- TB610 - Offshore generation cable connections
- TB657 - Guidelines for the preparation of Grid Codes for multi-terminal schemes and DC Grids
- TB684 - Recommended Voltages for HVDC Grids
- TB699 - Control methodologies for direct voltage and power flow in a meshed HVDC grid
- TB713 - Designing HVDC Grids for Optimal Reliability and Availability Performance
- TB883 - Installation of Submarine Power Cables

Purpose/Objective/Benefit of this work:

Several European research & demonstration projects such as E-Highways, Twenties, BestPaths and PROMOTioN have addressed offshore and HVDC grids. Multiple industry initiatives in the North Sea basin such as Dutch, Belgian, German and UK national offshore grid plans and projects such as NSWPH and EUROBAR are strongly driving uptake of offshore grids. Similar initiatives are currently underway in other areas in the world with significant offshore wind targets such as China, Japan and the US.

This working group aims to build on the findings of previous and ongoing working groups and projects, drawing together key issues and international experience, to provide insight into and guidelines for how offshore transmission grids can be planned, developed, deployed and operated, taking into account the purpose to be fulfilled, the limits of onshore AC grids, limited planning horizons, and technology characteristics.

Scope:

The working group aims to carry out the following tasks:

- To review existing and planned offshore transmission systems/concepts and drivers
- To discuss offshore transmission purposes & multi-purpose infrastructure and associated requirements (capacity, availability, reliability, cost efficiency, environmental impact, power quality, etc.)
    - Export offshore renewable energy (wind, wave, floating solar) to shore
    - Enable energy trade (between countries, control zones, markets,…)
    - Supply energy to offshore loads (e.g. islands / Oil&Gas platforms / electrolysers)
    - Provide auxiliary power to offshore transmission infrastructure
    - Reinforce onshore transmission system (within control zone, embedded)
    - Provide ancillary services to offshore islanded HVAC systems
    - Provide ancillary services to onshore grids
- To provide an overview of offshore transmission technologies & their range of application
    - HVAC
    - HVDC (including DC enabling components such as HVDC breakers)
    - Combination of HVAC and HVDC
    - Support structures (e.g. monopiles, jackets, gravity based structures, caissons, islands)
    - Synergies with Power-to-Gas (P2G) projects
    - Prospects for low frequency AC or high capacity superconducting DC
- To discuss basic offshore grid topologies, functions & associated performance
    - Network topologies
    - Ratings & redundancy
    - Operating strategies
    - Fault clearing strategies
- To analyse the interface with onshore grids & associated impact on offshore grid design
    - Selection criteria for onshore substation and onshore grid connection point
    - Injection & deliverability analysis

- o Maximum loss of infeed & associated stability issues
  - o Ancillary services delivered by offshore grids
  - o Avoided onshore reinforcements

- To research and discuss offshore grid growth models
  - o Expansions of existing links
  - o Connection of separate links

- To provide an overview of applicable governance & ownership frameworks and their potential impact on offshore grid design and operation

- To research and discuss offshore grid planning considerations
  - o Bundling – Guidelines for connecting different offshore energy resources onto the same shared transmission infrastructure
  - o Expandability – How to ensure future expandability of offshore transmission assets?
    - ▪ Standardization – How to achieve compatible systems?
    - ▪ Anticipatory investment requirements – How to manage risk of stranded assets?
  - o Modularization – How to achieve compatibly and cost savings by fixing design parameters?

- To explore necessity and models for coordination of offshore grid planning
  - o Identification of stakeholders in offshore grid planning coordination
  - o Demonstration of benefits and costs of coordinated planning
  - o Discussion of parameters to be coordinated
    - ▪ Technical
    - ▪ Non-technical
  - o Trade-offs in capacity allocation for different purposes (e.g. interconnection and evacuation of wind power)
  - o How to determine benefits of ancillary services from different market zones?
  - o How to coordinate offshore wind farms and HVDC interconnectors for ancillary service provision?
  - o Alignment in planning offshore wind farm areas and offshore transmission infrastructure
  - o Non-technical barriers for multi-purpose offshore assets and offshore HVDC networks
  - o Benefit and revenue sharing schemes for investments in different time frames, e.g. overcapacity of backbone network
  - o Environmental impacts, consideration of concurrent offshore space utilization and impact on coastal areas in landing zones

Remarks:

The working group foresees liaisons with the following other working groups that are active at the time of this proposal:

- JWG C1-C4.46 Optimising power system resilience in future grid design
- WG C1.45 Harmonised metrics and consistent methodology for benefits assessment in CBA of electric interconnection projects
- WG C1.44 Global interconnected and sustainable electricity system - Effects of storage, demand response and trading rules
- JWG C2-B4.43_The impact of offshore wind power hybrid ACDC connections on system operations and system design.

Moreover, the interdisciplinary character of the topic, and its concrete application stage, call for tight collaboration not only with SC B4 for HVDC technologies, but also with B1 (on submarine cables), B3 (on offshore stations) and C5 (on regulation of off-shore grids).

The outcomes of the analysis will be summarized in a technical brochure, which could be the nucleus for a future Green Book by the mentioned SCs.

Deliverables:

☒ Annual Progress and Activity Report to Study Committee

☒ Technical Brochure and Executive Summary in Electra
☐ Electra Report
☐ Future Connections
☒ CIGRE Science & Engineering (CSE) Journal
☒ Tutorial
☒ Webinar

Time Schedule:

• Recruit members (National Committees)	Q4 2023
• Develop final work plan	Q4 2023
• Draft TB for Study Committee Review	Q4 2024
• Final TB	Q2 2025
• Tutorial	2025
• Webinar	2025
• Green Book	2026

Approval by Technical Council Chairman:

Date: August 21st, 2023

Notes:
[1] Working Group (WG) or Joint WG (JWG),
[2] See attached Table 1,
[3] See attached Table 2 and CIGRE reference Paper: Sustainability – at the heart of CIGRE's work.
[4] See attached Table 3

WG Membership: refer Comments at end of document

Table 1: Strategic directions of the Technical Council

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-of-the-art technological advances
2	Making the best use of the existing systems
3	Focus on the environment and sustainability (in case the WG shows a direct contribution to at least one SDG)
4	Preparation of material readable for non-technical audience

Table 2: Environmental requirements and sustainable development goals

	CIGRE selected the 7 SDGs that are the most relevant to CIGRE. In case the WG work refers to other SDGs or do not address any specific SDG, it will be quoted 0.
0	Other SDGs or not applied
7	**SDG 7: Affordable and clean energy** Increase share of renewable energy; e.g. expand infrastructure for supplying sustainable energy services; ensure universal access to affordable, reliable, and modern energy services; energy efficiency; facilitate access to clean energy research and technology
9	**SDG 9: Industry, innovation and infrastructure** Facilitate sustainable infrastructure development; facilitate technological and technical support
11	**SDG 11: Sustainable cities and communities** Increase attention on sustainable and resilient buildings utilizing local (raw) materials, power for electric vehicles, strengthening long-line transmission and distribution systems to import necessary power to cities, developing micro-grids to reinforce the sustainable nature of cities; protect and safeguard the world's cultural and natural heritage; reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and waste management
12	**SDG 12: Responsible consumption and production** E.g. Promote public procurement practices that are sustainable; address reducing use of SF6 and promote alternatives, encourage companies to adopt sustainable practices and to integrate sustainability information into their reporting cycle, address inefficient fossil-fuel subsidies that encourage wasteful consumption
13	**SDG 13: Climate action** E.g. Increase share of renewable or other CO_2-free energy; energy efficiency; expand infrastructure for supplying sustainable energy; strengthen resilience and adaptive capacity to climate-related hazards and natural disasters; integrate climate change measures into national policies, strategies and planning; improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning
14	**SDG 14: Life below water** E.g. Effects of offshore windfarms; effects of submarine cables on sea-life
15	**SDG 15: Life on land** E.g. Attention for vegetation management; bird collisions; integration of substations and lines into the landscape

Table 3: Potential benefit of work

1	Commercial, business, social and economic benefits for industry or the community can be identified as a direct result of this work
2	Existing or future high interest in the work from a wide range of stakeholders
3	Work is likely to contribute to new or revised industry standards or with other long term interest for the Electric Power Industry
4	State-of-the-art or innovative solutions or new technical directions
5	Guide or survey related to existing techniques; or an update on past work or previous Technical Brochures
6	Work likely to contribute to improved safety.

Comments:

1) CIGRE Official Study Committee Rules: WG Membership

https://www.cigre.org/GB/about/official-documents

a. Only one member per country (by exception of SC Chair)

b. WG nominees must first be supported by their National Committee (or local SC Member) as an appropriate representative of their country.

c. Acceptance of the nomination is granted by the SC Chair and advised to the WG Convener

2) Collaboration Space

https://www.cigre.org/article/GB/collaborative-tools-2

CIGRE will provision the WG with a dedicated Knowledge Management System Space.

The WG will use the KMS for drafting collaboration, capture and retention of discussion and meeting records.

Official country WG Members will be sent registration instructions by the Convener.

Official country WG Members may request the WG Convener to allow additional access for an extra national subject matter specialist to aid in the work at the national level, including NGN members.