CIGRE Study Committee B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

JWG N° B4/C4.93	**Name of Convenor: Dechao KONG** (UK)
Strategic Directions #[2]: 1	**Sustainable Development Goal #[3]: 7 & 9**
The WG applies to distribution networks: ☒ Yes / ☐ No	
Potential Benefit of WG work #[4] : 1, 2 , 3, 4	
Title of the Group: Development of Grid Forming Converters for Secure and Reliable Operation of Future Electricity Systems.	

Scope, deliverables and proposed time schedule of the WG:

Background:

Climate change is gradually becoming a global challenge for the sustainable development of humanity. A number of countries have or will set their own Net Zero targets to co-addressing this challenge. There will potentially be two key features, for future electricity systems, in support of the Net Zero transition:

1) High penetration or even dominance of Power Electronic (PE) applications for clean energy e.g. onshore/offshore wind, solar PV, cross-border HVDC interconnectors.
2) Steady reduction of fossil-fuelled thermal power plants with synchronous generators.

However, these two features could bring a series of potential impacts on the electrical power system operability, particularly relevant to declining inertia and fault levels.

As a starting point, CIGRE B4 have initialised certain works on Grid Forming (GF)/Virtual Synchronous Machine (VSM) capabilities/functions for HVDC systems to deal with potential impacts. One example is WG B4.87 “Voltage Source Converters (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation”. In addition, TF-77 and B4.84 also address Grid Forming/VSM capabilities of HVDC systems. Other PE-based technologies across global power and energy markets, including onshore/offshore wind, battery storage, Solar PV as well as FACTS devices, etc., can also demonstrate forms of Grid Forming capabilities for system services but these require appropriate definition, design, verification & validation.

In this way, all the PE applications with Grid Forming capabilities can be generally defined as Grid Forming Converters (GFCs) and they can potentially be applied in the support of maintaining and/or improving system parameters of future electricity systems as mentioned above. As a result, great efforts are needed:

- To explore potential Grid Forming functions of GFCs for secure and reliable operation of future electricity systems in support of the Net Zero transition.
- To achieve dominant design[1] (e.g. recognised best practice across multiple vendors) for a wider range of PE-based technologies[2], facilitating potential opportunities in certain regional nascent markets for these GF-based services.

Note1: The Term “Dominant Design” as referred to Anderson, P., M. Tushman, and C. O'Reilly. "Technology Cycles, Innovation Streams and Ambidextrous Organizations." In Managing Strategic Innovation and Change, edited by P. Anderson and M. Tushman. New York: Oxford University Press, 1997.
Note2: Those technologies can include but not limited to onshore/offshore wind, battery storage, Solar PV, HVDC and FACTS.

Scope:

This new WG will aim:

- To review definitions of Grid Forming Capability in TF-77, B4.84 and B4.87 if relevant and check any need for refinement of those definitions when applied to a wider range of PE-based technologies as mentioned above.
- To survey existing Grid Forming functions and investigate potential new ones resulting from different PE-based technologies to maintain or further improving system operability for future electricity systems.
- To investigate effective analysis methodologies, tools, models to support performance validation of GFCs based on different technologies taking into consideration of the source of energy available to provide the Grid Forming functionality.
- To define high level technical requirements for network services from Grid Forming technologies.
- To develop models/benchmark simulation & testing systems as well as relevant test specifications for compliance testing of GFCs based on different technologies against identified technical requirements.
- To provide high level evaluation of feasibility to achieve identified requirements between grid-forming technologies as defined in this ToR and alternative technologies/services.
- To share global good practices of development and deployment of GFCs for secure and reliable operation of regional electricity systems.

Deliverables:

☒ Technical Brochure and Executive Summary in Electra
☒ Electra Report
☒ Future Connections
☒ Tutorial
☒ Webinar

Time Schedule: start: September 1, 2022 **Final Report**: August 31, 2025

Approval by Technical Council Chairman:

Date: April 29th, 2022

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

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.