CIGRE Study Committee B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG B4.87	**Name of Convenor:** Carl BARKER (UK)
Strategic Directions #[2]: 1-2	**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: Voltage Source Converter (VSC) HVDC responses to disturbances and faults in AC systems which have low synchronous generation	

Scope, deliverables and proposed time schedule of the WG:

Background:

Cigre Task Force B4-77 was created in October 2017 in response to growing concerns in the market with respect of the operation and fault response of the AC grid with a reduction in the amount of synchronous generation and a corresponding increase in Power Electronic (PE) generation. There was an observed trend to discuss VSC HVDC converter performance in the same context as PE connected generation, neglecting that VSC HVDC is a *transmission* system as opposed to PE connected *generation*. Of course, VSC HVDC converters are inherently flexible in their operating characteristics and can be made to respond to AC events in different ways dependent on the system needs. However, some responses may impact on the plant rating and hence the cost of the converter. This could lead to the economic cases for HVDC transmission connections being negatively impacted by an imposed transient response intended to make this transmission infrastructure component respond in a similar way to a synchronous generator.

The TF published its findings in the CSE journal, Volume No. 15, October 2019. In this paper the TF recommended the following further work:

- The development of a concise set of requirements appropriate to HVDC converters
- The finalisation of a test bench simulation circuit to permit the comparison of synchronous generation dominated AC grids to PE dominated AC grids
- Based on the test bench identify, through simulation, the inherent capability of HVDC converters considering different control modes.

Scope:

1. The WG will review the definitions of the different types of converter control given in the TF-77 paper as:

    - Grid Following
    - Grid Forming
    - Synchronous Grid Forming
    - Virtual Synchronous Machine (VSM)

    Furthermore, the WG will seek to expand this list of definitions to incorporate newer concepts such as *Grid Firming*.

2. Based on the defined controller concepts the WG will attempt to create a requirements specification for each type of control along with a testing methodology.

3. Considering the testing methodology addressed in 2, the WG will propose Electro-Magnetic Transient (EMT) simulation models that can be used for testing purposes.

4. The WG will quantitively review the potential impact of the control types on the equipment rating and on the interconnected AC system at the other end of the HVDC transmission circuit.

Cigre WG B4.85, "Feasibility study and application of electric energy storage systems embedded in HVDC systems", clearly relates to the definition of a VSM as defined in the TF-77 paper, namely:

> A **Virtual Synchronous Machine (VSM)** is a (Synchronous) Grid-Forming converter with energy storage capable of delivering additional energy for a short period of time, from the converter rather than the DC link and rated to provide a current greater than the steady-state rated current during a fault.

The proposed WG will, therefore, co-ordinate with B4.85 in order to ensure that there is no overlap or conflict in the activities of the two WG's.

Deliverables:

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

Time Schedule: Start May 1, 2020 **Final Report**: April 2022

Approval by Technical Council Chairman:

Date: April 26th, 2020

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.