CIGRE Study Committee B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP[1]

WG N° B4.79	**Name of Convenor:** Hong Rao (CHINA)
Strategic Directions #[2]: 1	**Technical Issues #[3]: 1**
The WG applies to distribution networks[4]: No	
Potential Benefit of WG work #[6]: 3	
Title of the Group: Hybrid LCC/VSC HVDC Systems	

Scope, deliverables and proposed time schedule of the Group:

Background:

Line commutated converter (LCC) and voltage sourced converter (VSC) are the two technologies utilized in High Voltage Direct Current transmission systems (HVDC). Over the past 60 years more than 100 LCC-HVDC systems have been put into operation, with the transmission voltage reaching ±800kV and transmission power capacity of up to 10GW. Meanwhile, more than 30 VSC-HVDC systems have been put into operation, of which the transmission voltage is up to ±320kV and the transmission capacity is up to 1GW. VSC-HVDCs with higher transmission voltage (±500~800kV) and larger capacity (3~5GW) are expected to go into operation in the next few years.

LCC-HVDC offers the advantages of larger transmission capacity, but generally has a large footprint which means large site area. The inverter station must be supported by an AC system with sufficient short circuit capacity as defined in broad terms by the short circuit ratio (SCR) to ensure reliable operation and satisfactory performance. The disturbances caused by commutation failure due to AC and DC disturbances, as well as the reactive power requirements of an LCC converter certainly have an impact on the connected AC system. On the other-hand VSC-HVDC does not suffer commutation failures, and the active power and reactive power can be controlled independently. These technical advantages enable the VSC-HVDC to ride through AC system faults and to control the reactive power to the connected AC system. To this end each have been utilized on a standalone basis.

The concept of combining the LCC and the VSC technologies in one HVDC link seems to be gaining popularity. It combines the LCC and VSC technology within one HVDC system. For example, in the SK4 project the LCC and VSC are used in different poles in a bipolar system, in the Luxi back-to-back project the LCC and VSC converters are connected in parallel, in the application of power supply to offshore drilling platform and integration of offshore wind power the LCC and VSC can be installed at the rectifier and inverter respectively and in application of overhead line transmission (OHL) the LCC and VSC can be connected in series in one station. There are many other scenarios that need investigation. The hybrid HVDC system offers great technical value and application prospects, since it combines the lower cost of LCC and the absence of commutation failure and the flexible control of VSC.

At present, there are no systematic discussion on hybrid HVDC. The purpose of this working group is to comprehensively discuss the definition and configuration of hybrid HVDC systems, as well as the necessary equipment, control, applications and prospects. It will also highlight any issues related to implementation.

Scope:

1. Define hybrid HVDC systems and the possible configurations, with typical examples and assess their pro's and con's
2. Discuss the technical requirements of main equipment and their function in the hybrid HVDC systems as defined in 1
3. Discuss the difference in the performance of different hybrid HVDC systems
4. Analyze the harmonics at the AC and DC sides
5. Discuss the control strategy for different hybrid HVDC systems, and their coordination
6. Analyze the impacts of AC and DC faults

Deliverables:

☐ X Technical Brochure and Executive summary in Electra

☐ X Electra report

☐ X Tutorial[5]

Time Schedule: start: October 2018 **Final Report**: January 2022

Approval by Technical Council Chairman: M. Waldron

Date: 26/07/2018

Notes: [1] or Joint Working Group (JWG), [2] See attached Table 2, [3]See attached Table 1, [4] Delete as appropriate, [5] Presentation of the work done by the WG, [6] See attached table 3

Table 1: Technical Issues of the TC project "Network of the Future" (cf. Electra 256 June 2011)

1	Active Distribution Networks resulting in bidirectional flows
2	The application of advanced metering and resulting massive need for exchange of information.
3	The growth in the application of HVDC and power electronics at all voltage levels and its impact on power quality, system control, and system security, and standardisation.
4	The need for the development and massive installation of energy storage systems, and the impact this can have on the power system development and operation.
5	New concepts for system operation and control to take account of active customer interactions and different generation types.
6	New concepts for protection to respond to the developing grid and different characteristics of generation.
7	New concepts in planning to take into account increasing environmental constraints, and new technology solutions for active and reactive power flow control.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics.
9	Increase of right of way capacity and use of overhead, underground and subsea infrastructure, and its consequence on the technical performance and reliability of the network.
10	An increasing need for keeping Stakeholders aware of the technical and commercial consequences and keeping them engaged during the development of the network of the future.

Table 2: Strategic directions of the TC (ref. Electra 249 April 2010)

1	The electrical power system of the future
2	Making the best use of the existing system
3	Focus on the environment and sustainability
4	Preparation of material readable for non-technical audience

Table 3: Potential benefit of work

1	Commercial, business or economic benefit 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 direction
5	Guide or survey related to existing techniques. Or an update on past work or previous Technical Brochures
6	Work likely to have a safety or environmental benefit