CIGRE Study Committee B4

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG [1]N° B4. 84	**Name of Convenor:** Hani SAAD (France) **E-mail address**: hani.saad@rte-france.com	
Technical Issues #[2]: 1-3-4-5-7	**Strategic Directions #[3]:** 1-2-3	
The WG applies to distribution networks[4]: Yes		
Potential Benefit of WG work #[5]: 1-2-4-7		
Title of the Group: Feasibility study and application of electric energy storage systems embedded in HVDC systems		

Scope, deliverables and proposed time schedule of the WG:

Background:

The number of Battery Energy Storage Systems (BESS) connected to power systems is increasing at a rapid pace throughout the world due to their ability to provide the flexibility needed to integrate intermittent RES and deliver superior energy efficiency. In addition to Li-ion, new technologies such as Supercapacitors and Super-conducting Magnetic Energy Storage Systems seem a promising solution to provide fast frequency response to the network. Thanks to the continuous costs decrease and technical improvements (e.g. energy density, safety), large storage installations (from 20 to hundreds of MWh and from 10 to 100 MW) are now installed at distribution and transmission level in different countries.

To date, the energy conversion part of energy storage systems is generally based on an AC/DC converter (2-level or 3-level Neutral point Clamped Converter NPC are the most common types) and a DC/DC converter to adjust the storage bus voltage. Since HVDC and MVDC industrial solutions currently propose more efficient and modern converter topologies, their application and potential benefits needs to be considered, all the more with the increase in storage system ratings and their connection at higher AC voltage levels. Among others, the MMC topology could be investigated for a more efficient power conversion in storage applications, as well as variants which may enable to manage the variations of DC voltage with one single converter (full-bridge Multi Module Converter MMC, mixed-cell MMC, etc.) without any supplementary DC/DC converter.

Another approach when considering electric energy storage is to investigate their insertion in DC systems (HVDC or MVDC), which can result in two approaches: the first option is to connect energy storage through a dedicated DC/DC converter to the DC bus (hence with the suppression of the AC/DC converter used in existing solutions). Another option consists in integrating extra energy storage directly in AC/DC converters; this second option, similar to some existing industrial FACTS (SVC, STATCOM) enhanced with storage elements (e.g. supercapacitors), can be addressed in different manners (uprated capacitors in sub-modules, design of specific converter topology) and would avoid the need to coordinate between the converter station and a separated storage system.

Both approaches are likely to extend the capabilities of HVDC converters (or DC links), thus enabling the provision of augmented or new features: superior stability or dynamic performance, FRT capability, ancillary services provided to the AC network, grid forming support, energy source for black-start, etc. Assessment of such benefits will be performed in this WG resulting in a comparison for the different options; in addition, preliminary economic aspects will be considered to complement this comparison and assess the overall techno-economic benefits of all options.

Scope:

a. State of the art of current and envisioned use cases for large electric storage systems (greater than 20MWh / 10MW)
b. New converter topologies for large electric storage systems:
   - Application of MMC converters, suppression of DC/DC converters with MMC variants (Full-Bridge, Mixed-Cell, others).
   - Control and protection of the electric storage system using alternative converters
   - Comparison with existing converter topologies (2-level, 3-level converters): losses, footprint, costs, etc.
c. Connection of electric storage to HVDC/MVDC systems:
   - Technologies for DC/DC converters with high step-up ratio
   - Control and protection of the DC/DC converters and associated storage equipment
   - Communication and coordination of the AC/DC and DC/DC converters
d. AC/DC converters with inherent storage capability
   - Topology options (uprated sub-module capacitors, specific converter topology, others)
   - Specific control and protection of the converters to manage both power exchange through the DC systems and storage energy.
e. Assessment of techno-economic benefits of electric storage in DC systems (cf. options c. and d.)
   - Stability, Fault Ride Through FRT capability, superior or new ancillary services, grid forming capability, blackstart…
   - Preliminary economic assessment
   - Comparison the two options (c. and d.)

Deliverables:

☒ Technical Brochure and Executive Summary in Electra

☒ Electra Report

☒ Tutorial[6]

☒ Webinar[6]

Time Schedule: start: Jan 1-2020 **Final Report**: Dec 31-2022

Approval by Technical Council Chair:

Date: December11, 2019

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

Table 1: Technical Issues for creation of a new WG

1	Active Distribution Networks resulting in bidirectional power and data flows within distribution levels up to higher voltage networks
2	Digitalization of the Electric Power Units (EPU): Real-time data acquisition includes advanced metering, processing large data sets (Big Data), emerging technologies such as Internet of Things (IoT), 3D, virtual and augmented reality, secure and efficient telecommunication network
3	The growth of direct current (DC) and power electronics (PE) at all voltage levels and its impact on power quality, system control, system operation, system security, and standardisation
4	The need for the development and significant installation of energy storage systems, and electric transportation, considering the impact they can have on the power system development, operation and performance
5	New concepts for system operation, control and planning to take account of active customer interactions, and different generation types, and new technology solutions for active and reactive power flow control
6	New concepts for protection to respond to the developing grid and different generation characteristics
7	New concepts in all aspects of power systems to take into account increasing environmental constraints and to address relevant sustainable development goals.
8	New tools for system technical performance assessment, because of new Customer, Generator and Network characteristics
9	Increase of right of way capacity through the use of overhead, underground and submarine infrastructure, and its consequence on the technical performance and reliability of the network
10	An increasing need for keeping Stakeholders and Regulators aware of the technical and commercial consequences and keeping them engaged during the development of their future network

Table 2: Strategic directions of the Technical Council

1	The electrical power system of the future: respond to speed of changes in the industry
2	Making the best use of the existing systems
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, 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.
7	Work addressing environmental requirements and sustainable development goals.