CIGRE Study Committee C6

PROPOSAL FOR THE CREATION OF A NEW WORKING GROUP

WG N° C6.30	**Name of Convenor:** Nikos Hatziargyriou **E-mail address**: nh@power.ece.ntua.gr
Technical Issues #: 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	**Strategic Directions # : 1** The electrical power system of the future

Title of the Group: The Impact of Battery Energy Storage Systems on Distribution Networks

Terms of Reference

Background :

Electric power systems are heading towards a massive use of renewable energy sources based on wind and solar power. Those energy sources are random and intermittent by nature and introduce stabilization, operation, control and power quality issues into the network. Further to that, already today weak grids with long lines have needs for voltage support.

One clean alternative to mitigate the problems mentioned above is the use of Battery Energy Storage Systems (BESSs). Batteries have been employed for a number of years and are a proven technology, but their integration into the power systems as a source of additional generation and/or auxiliary services is more recent, in addition to not being widely known. BESSs can be connected to AC grids through standardized power conversion equipment so that the combined system provides both active and reactive power.

Electrical Energy Storage (EES) systems have been well documented in the technical literature ("Electric Energy Storage Systems", CIGRE Technical Brochure 458, April 2011), and guidelines to specify the power conversion equipment are also available (IEEE P1031™/D1+1, "Draft Guide for the Functional Specification of Transmission Static Var Compensators", 2010).

In 2011 the IEC Market Strategy Board also published a white paper on Energy Storage Systems (IEC MSB, "Electrical Energy Storage", 2011). The paper presents market needs and technological features for EES systems, and gives recommendations for the different participants of such markets, i.e. policy makers and regulators, research institutions and companies carrying out R&D, and standardization committees. Currently several pilot projects are ongoing to further develop algorithms and strategies to integrate storage into distribution systems.

Distribution system operators, suppliers, vendors and policy makers lack a common framework in terms of guidelines and recommended practices on the way BESSs should be integrated into the distribution networks of the future.

Scope :

Complementing and updating earlier work carried out by the WG C6.15 (Electric Energy Storage Systems), the specific objectives of this WG will be:

1. Review international practices and classify BESS technologies, structures (layouts) and applications for the grid and for the market with emphasis on the distribution networks (peak shaving, frequency regulation, voltage support, capacity firming, ramping support, power quality, demand response, etc.)

2. Provide insight on experiences in pilot installations at the distribution level. The idea is to understand the impact of BESSs on the distribution network operation as regards:
- Power quality
- Safety

- Simultaneous use of different BESS technologies in the same network
- Renewable energy interactions with BESSs
- Expected impact (e.g. in terms of power quality and safety) of a large number of BESSs (mostly together with renewable energies) in a distribution network
- Operation of aggregated distributed BESSs
- Varying control system strategies, for instance time or voltage dependent
- Fault ride through capability of existing BESS inverters & control systems

3. Elaborate guidelines on the integration of BESSs into distribution networks of up to 132 kV. In principle the topics to include are battery services for grid operation and service to the energy market as follows:

- Planning and design:
  - Energy system planning (location/placement of BESSs, e.g. distributed at household levels, feeder levels, and/or transformer/substation levels)
  - BESS models and equivalents for power network applications
  - BESS design and optimal sizing including power conversion equipment for delivery of both active and reactive power
  - BESS life-cycle assessment for power network applications
- Distribution system operation:
  - Integrating energy storage control in network management systems
  - Operating modes (microgrids, island mode, backup, frequency fluctuation smoothing, PV energy storage, etc.)
  - BESS operation in faulted networks: Technical characteristics and operation modes for BESS/Inverter combinations to contribute to network fault current for fault clearing purposes
  - Optimum technical characteristics and control settings for enhanced fault ride-through, possibly by opening up frequency & voltage windows on inverters, or other
- Services to the market:
  - Aggregation and coordinated control of BESS units for services to the energy market
  - Other ancillary and back-up services around energy storage
- Standardization aspects:
  - Interoperability and communication (with focus on the way the expected interfaces should look like)
  - BESS testing and performance measurement (for most common applications, e.g. peak shaving and voltage support, or others)
  - BESS safety
- Environmental aspects (of the batteries over the environment and vice versa)

4. Use cases

- Technical and electricity market models in selected countries
- International examples for use cases including new business models
- International experiences on cost effectiveness according to BESS delivered services

5. Relate and coordinate the report with existing (and under development by IEC/CIGRE/IEEE) guidelines and standards for BESSs.

Deliverables: Report to be published in Electra, technical brochure with summary in Electra, material and concept for tutorial

Time Schedule : start : August 2014 **Final report** : August 2016

Comments from Chairmen of SCs concerned :

Approval by Technical Committee Chairman : M. Waldron **Date** : 01/07/2014

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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 within distribution level and to the upstream network.
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 (cf. 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	Interactive communication with the public and with political decision maker