Research topic:

Electrical systems engineering

DII research group

Power System Group

Sebastian Dambone Sessa
RTDa
sebastian.dambonesessa@unipd.it
Phone: +390498277510

Roberto Benato
Associate Professor
roberto.benato@unipd.it
Phone: +390498277532

Mauro Andriollo
Associate Professor
mauro.andriollo@unipd.it
Phone: +390498277706

Andrea Tortella
Associate Professor
andrea.tortella@unipd.it
Phone: +390498277568

http://www.dii.unipd.it/en/power-system-group

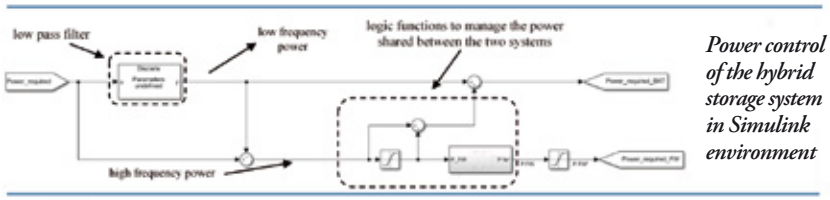
This work was financially supported by the Department of Industrial Engineering-University of Padova under the project entitled "Flywheels and Li-ion Batteries for Stationary Hybrid Energy Storage Systems".

Main research topics

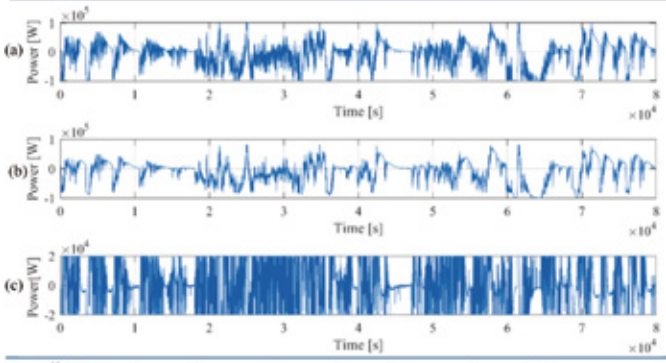
- Large-scale energy storage in the network;
- EHV/HV dc and ac innovative transmission lines e.g. insulated cables and gas insulated lines;
- Synergy between railway and highway infrastructures and insulated cables;
- Multiconductor cell analysis (MCA) of asymmetric systems by means of self-implemented matrix procedures (insulated cables with screens and armours, gas insulated lines with enclosures, overhead lines with one or more earth wires);
- Availability assessment of whole HVDC-VSC links
- Sinergy between insulated cable power transmission systems and transport infrastructures;
- Smart grids: the operation and control of active networks;
- Voltage regulation in the distribution network with high penetration of distributed generation.

Hybrid Storage Systems to Counter the Battery Aging During the Grid Services

The massive introduction of photovoltaic or wind farms in the electrical networks involves several crucial issues for the safe and reliable operation of transmission and distribution grids. Foremost among these are the non-programmability of renewable energy sources, which involves traditional power plant manage difficulties and congestions in the power transmission lines, and the decrease of the network regulating energy, which leads to network instability. The installation of energy storage systems in a high voltage network could be one of the key elements to effectively help in solving these problems, postponing or avoiding the grid reinforcement .This solution seems to be very effective, but recent studies demonstrated that battery aging during a grid frequency regulation operation could be higher than expected and difficult to foresee, especially for some battery technologies. In this research, starting from experimental measurements, a hybrid energy storage system consisting of flywheels and batteries with a Lithium-manganese oxide (LMO) cathode has been modelled and analysed in Simulink environment. The simulation results suggest that a suitable control of the power shared between the batteries and the flywheels could effectively help in countering Li-ion battery accelerated aging due to the grid frequency regulation service. In particular, by means of a low-pass filter, the low frequency components of the required power are supplied by the batteries whereas the high frequency ones are supplied by the flywheel.



Power control of the hybrid storage system in Simulink environment

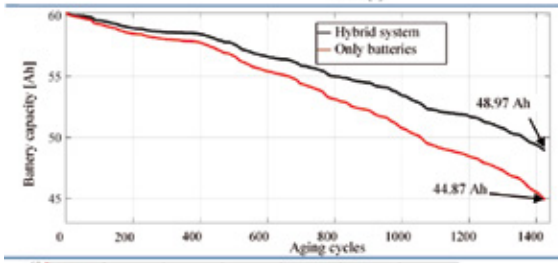


Hybrid system aging test simulation:

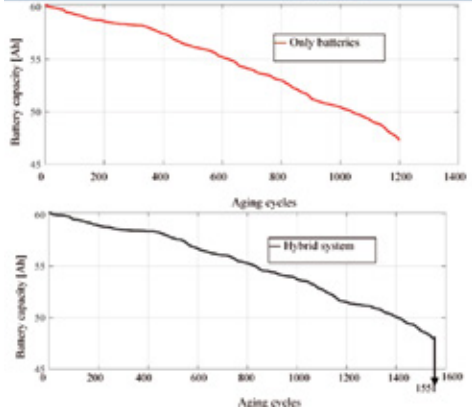
(a) Total required power

(b) battery power

(c) flywheel power



Comparison between the battery residual capacity after 1424 aging cycles for the two systems.



Maximum number of cycles that the batteries can tolerate before their capacity decreases by 20%