

Ingegneria dei sistemi elettrici
Electric systems

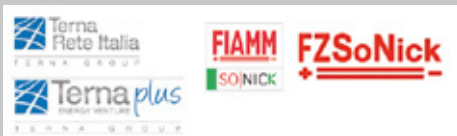
DII research group
Power System Group



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Main research topics:

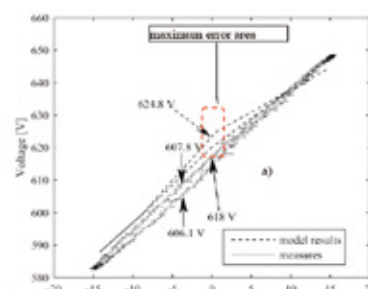
- Smart grids: the operation and control of active network
- Voltage regulation in the distribution network with high penetration of distributed generation
- Large-scale energy storage in the network
- EHV/HV dc and ac innovative transmission lines e.g. insulated cables and gas insulated lines
- Synergy 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)

Large-scale electrochemical energy storage in high voltage grid: the Italian experience

The Italian transmission system operator has moved towards two different directions with regard to electrochemical energy storage systems (with acronym EESS) in the high-voltage network. In the first one, the electrochemical energy storage is conceived to release renewable generation from electric loads and to avoid overload conditions in the existing overhead lines. This use implies longer charge/discharge intervals (about 8 h) and a kind of "energy service" more than a "power service"; therefore, these installations have been called "energy intensive" installations. For Italian "energy intensive" installations, Terna has chosen, because of its extensive history of successful installations, the Sodium-Sulphur (Na-S) electrochemistry, supplied by the Japanese NGK. There have been three installation sites located in the South of Italy (around Benevento city): two installations of 12 MW and one of 10,8 MW (wholly 34,8 MW Na-S storage has been installed). It is worth remembering that Na-S batteries belong to the Na-beta battery family (as Na-NiCl₂). The other direction has involved electrochemical technologies with short charge/discharge intervals (from 0,5 to 4 h). The tested technologies have been the Li-ion family and sodium-nickel chloride. The installation sites have been Sardinia (9,15 MW installed power in Codrongianos) and Sicily islands (6,8 MW installed power in Ciminna). Due to their high flexibility use allowed by the Power Conversion System (with acronym PCS), power intensive installations have been applied in the field of grid ancillary services. The power system group of the Department of Industrial Engineering has actively participated in the planning and realization of these installations: for energy intensive applications the research group has theoretically and experimentally demonstrated the environmental compatibility and safety operation of large scale installations of such technologies; for power intensive applications, the research group has developed two electrical models based on a given set of experimental tests which have demonstrated an extremely high agreement with real behaviours both in steady-state and in transient operations.



Some photos of Italian large scale stationary electrochemical storage installations



Comparison between experimental volt-ampere curves and model results



Fiamm Sonick 7,8 kW ST523 Na-NiCl₂ module