Multi-megawatt battery storage substations

Innovative solutions to integrate renewable energies

06/09/2012 - 4.14 pm

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Renewable energies are increasingly being integrated into transmission grids – as an important element of smart grids – and, although there are still some hurdles, there are also some innovative solutions.

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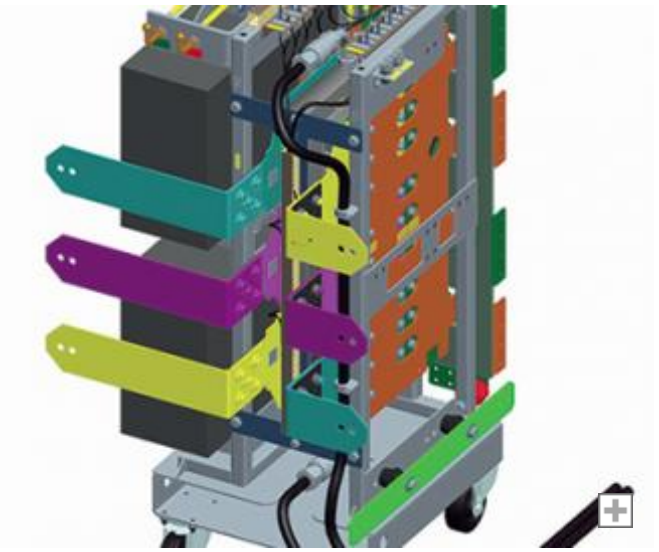
The introduction of photovoltaic and wind turbine generation systems has been accelerating around the world, and the case for using renewable energy remains strong.
However, because of the intermittency of the renewable sources, the power generation level, or capacity factor, of these renewable energy systems is relatively low and the generation level is not fixed. Generation capacity with these characteristics is sometimes termed non-dispatchable. In order to realise their potential, these technologies must somehow overcome the hurdle of their intermittent nature so that they can be seamlessly integrated into the power grid.



“One significant and viable solution is to couple a stable form of large-scale electricity storage to a voltage source converter (VSC) with associated control and automation equipment,” explains Ludovic Gris, Power Electronics architect. “The stored energy can be accessed and injected into the grid when power generation is low, or demand is high, and it can be a self-sufficient solution for some regions.”

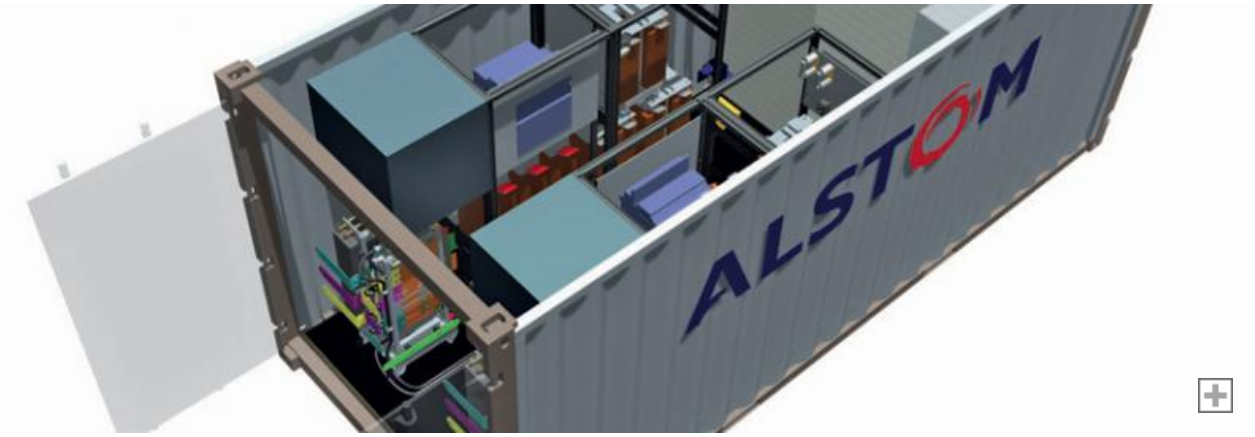
Efficiency is a key weakness of storage solutions, with batteries delivering only 80 % of the energy input. But on a large scale, this solution based on batteries and VSC can be more economical than others. Community storage schemes could have mid-sized, decentralised storage facilities to manage fluctuations from renewable sources and to reduce the strain on conventional distribution grids. Operators would need to strike a balance between the size of their investment and the potential revenue streams – larger investments can enable the parallel provision of reserve capacity.

1 __ Energy storage with power control

Power supply instability and frequency fluctuations become more significant as the proportion of power generated by renewable energy and injected into electrical networks increases. Any surplus or deficit in active or reactive power must also be accommodated by the system. This difference in power needs to be kept within a given band to keep the AC voltage within the desired tolerances. The weaker the system or the further away one is from a generation source, the more responsive the power exchange must be to stay within the desired voltage tolerance. The Alstom energy storage solution allows smooth integration of renewable energy into the grid, getting rid of power variability due to weather hazards.

The VSC is based on the association of a DC/DC converter and an inverter. A precise and rapid-response power control keeps the voltages within the specified band, providing increased stability of the power system thanks to availability of the stored power.
VSC is a technology for today's meshed network – and that of the future. It permits continuous and independent control of real and reactive power, thereby increasing system stability and the overall power flow.

"This turnkey storage substation solution includes transformers, converters and complete hierarchical control. The ultimate goal is to have a product with a storage capacity of 1 to 20 MW – and we already have all the control and automation functions that will go with this solution," explains Gris.



2__Technology agnostic

The solutions discussed here for storage and integration are agnostic with respect to the storage technology deployed, which helps promote multi-technology solutions. The overall installation increases the load-carrying capacity of the network by reducing the voltage dip that follows a system disturbance and provides dynamic voltage stability by reducing the load shedding needed to manage under-frequency conditions that occur during disturbances.

Advanced software takes care of most of the above issues, as well as the different grid codes around the world. It also takes into account the different requirements and qualification tests of battery manufacturers.

3 __ Smoothing power across the grid

The power conversion system (PCS) and the generic control unit in this system "smooth out" the electricity before injecting it into the grid. "It can be associated with a wide range of leading battery solutions and is modular enough to meet the specific requirements of particular sites," Gris specifies. "The control system also offers unparalleled flexibility for energy management as well as several operating modes." The world is currently on the threshold of a new paradigm for electricity generation, transmission and consumption; historically, electricity generation was designed to follow demand, "but now we are moving towards a world where virtually continuous demand is expected to be met" – to a large extent by renewable sources that are not themselves intrinsically continuous by nature. This challenge makes electricity storage critical in crossing the next frontier in electricity infrastructure, as the march towards a fossil-free energy landscape gathers pace.

Teaming up for energy storage
Alstom and the teams of the French state-owned research entity CEA-INES (Institut National de l'Énergie Solaire) have created a joint research and development centre in Chambery in the French Alps. This joint laboratory is focused on developing advanced energy storage solutions and integrating renewable energy farms into smart

transmission and distribution grids. The CEA-INES brings its core expertise in storage and solar applications, as well as its existing testing capability across various ranges of solar and storage technologies, while Alstom brings its expertise in power electronics, power conversion and smart grid control room integration. This partnership has been put in place to develop advanced innovations to accelerate the deployment of embedded storage into smart grid systems and facilitate the integration of renewables beyond the European target of 20 % of the energy mix by 2020. The teams will also investigate the potential use of direct current (DC) applications in smart cities projects.

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Ludovic Gris

Power Electronics architect

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