Energy Storage **Integration**

FOR MORE INFORMATION:

Clean Energy Ministerial (CEM) | http://www.cleanenergyministerial.org
IEA International Smart Grid Action Network (ISGAN) | https://www.iea-isgan.org
ISGAN Annex 6 Power T&D Systems | https://www.iea-isgan.org/flexibility-in-future-power-systems
Mission Innovation (MI) | http://mission-innovation.net
MI Innovation Challenge 1: Smart Grids | https://www.mi-ic1smartgrids.net

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Energy storage will play a key role in the electric grid of the future; it is one of the main ways to provide power system flexibility and it will allow countries to

- install more clean and renewable energy sources,
- increase reliability and resilience to disruption; and it will
- act as a bridge between the needs of network operators and the energy users and prosumers.

Clean energy solutions are key objectives to both the ISGAN and Mission Innovation initiatives. To achieve success, innovation within the area of smart electric grids is needed; this fact sheet expands on one key area of smart grid innovation: integration of energy storage into the electric grid.

Grid-connected energy storage is not a new concept, and it is commercially operational today as a valuable tool for making facilities resilient and enabling the increased penetration of intermittent renewables in the power system with the potential to contribute to reducing electricity bills. Energy storage can refer to a wide range of technologies and approaches to managing power. While pumped hydro storage is the most widespread storage technology currently in operation globally, energy storage technologies include electrochemical, mechanical, thermodynamic and thermal storage systems. Wherever energy storage solutions are deployed in the power system, they can have an immense impact.

The roles that energy storage systems can deliver include:

- Supporting efficient system operation – such as balancing supply and demand and maintaining frequency levels – by providing services to the system operators;
- Deferring or avoiding the need for new build primary generation – energy storage can help to meet peak demand and reduce the need for additional generation;
- Deferring or reducing the need for costly network reinforcements – energy storage can provide a cost-effective solution to manage congestions where networks are constrained because of too much demand or generation;
- Maximising utilisation and enabling greater penetration of renewable generation – energy storage systems can store electricity generated at times of low demand for use at periods of higher demand, avoiding curtailment and enabling higher levels of renewable generation in the system;
- Emergency backup (resilience) – Historically, commercial and industrial facilities have invested significantly in local emergency backup infrastructure; these could be upgraded using advanced energy storage solutions which could provide not only emergency backup, but also other money-saving and revenue-earning opportunities.

Through providing these services, energy storage systems can provide the following benefits:

- Environmental benefits – energy storage can help countries to meet GHG targets by improving the overall efficiency of the power system, enabling higher penetration of renewable energy and reducing the need for conventional power generation. In terms of local environmental considerations, an energy storage system has few or no GHG emissions.
- Power system cost reductions – energy storage systems can contribute to enhance power system economics by providing cost effective alternatives to peaking plant, network reinforcement and emergency backup and by improving utilisation of renewables and overall system efficiency.
- Consumer cost savings – consumers will benefit from power system cost reductions and if they are also owners of energy storage assets which can respond to utility price or other signals. They may be able to secure income by participating in demand response and other balancing markets. Where there are time-of-use tariffs, storage owners can reduce their power costs by using power from their own storage systems when prices are highest, shifting their electricity consumption from expensive periods of high demand to periods of lower cost electricity during low demand.

Energy storage devices are not new technologies and some, such as pumped hydro, have been used in energy markets globally for decades. What is new is that technological advances, particularly in battery storage and in digital control systems, are making the functions they perform cheaper and more accessible to a wider range of users. As a result, the potential range of storage applications is increasing. While storage can be sited at three different levels in the typical power system - behind the meter, at the distribution level, or at the transmission level – it can add value to the power system at any level.

Different storage technologies will be more appropriate depending on the specific applications, for example:

- To shift energy between different times of the day (or longer): bulk energy storage technologies appropriate for this application are typically focused on price and energy density.
- To manage intermittency of renewables, i.e. smoothing out the fast and significant variability in power output of wind and solar resources: faster response technologies need to be deployed, where power density may be a greater consideration than energy density.
- To provide regulation services, including ancillary services that support power quality, such as frequency regulation, and also more localised services, such as voltage regulation: fast response is again a key characteristic.
- To provide backup power in the event of outages; this can be at an individual customer level, at the local distribution network level, or may be used to assist with grid black-start capability: the relevant storage characteristics vary across deployments.
- To defer or reduce the need for network reinforcement: large-scale storage with key characteristics focused more on price, reliability and temperature constraints, rather than response times.
- Customer energy management to manage their own site loads/generation to avoid peak demand or capacity charges: this application could be met by a range of battery technologies.
- Electric vehicles (EVs) may also play a role in future: providing a storage asset to help with home or building energy management as well as providing mobility.

Over the last few years there have been significant increases in the numbers and range of energy storage systems which are being demonstrated and commercially operated across the world. However, there remain challenges to even more widespread energy storage integration: innovation, governments and regulators, and consumers themselves can all play a role to address these challenges and help secure the benefits which energy storage can offer:

- Research and innovation will be important to help to further improve the performance, the useful life and the range of applications offered by energy storage technologies – and to reduce their lifetime costs to make storage cost competitive with conventional generation or network solutions.
- Standards development may help to secure consumer confidence and to ensure that storage systems are reliable and fit for purpose.
- In some cases, changes to policy or regulatory frameworks may be required to enable energy storage to be used in new ways and to address market barriers which may prevent energy storage solutions from competing with more established solutions.
- Consumer understanding and engagement will be required to help 'pull forward' energy storage use.

Deep decarbonisation will require increased electrification of the world's economy. For this to be achieved, the power system will have to evolve; this, in turn, will require innovation within the smart grid to capture and utilise the multiple value streams that can be provided by energy storage systems.