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Potential Value of Storage for Distribution Systems

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Where does Distribution Energy Storage Reside?

- Substation batteries
  - MW/MWh scale batteries located within the substation fence line.
  - NAS and flow.
- Pole top or pad mounted batteries
  - kW/kWh scale batteries located near the secondary transformers.
  - NiMH and Li-Ion.
- Electric Vehicles (EVs) and Plug in Hybrid Electric Vehicles (PHEVs)
  - kW/kWh scale batteries that are in vehicle at varying locations.
  - NiMH and Li-Ion.
- Building energy storage
  - kW/kWh units where energy is stored in the form of heat.
  - Air or water.

Characteristics of Distribution Storage

- There are many forms of energy storage and not all are suitable for distribution level applications.
  - NiMH, Li-ion, NAS, and flow batteries have shown to be cost effective at various points on the distribution system.
  - Pumped hydro, flywheels, ultra-capacitors, and superconducting magnetic energy storage in general have not been shown to be cost effective at the distribution level.
- While the storage medium may vary there are some basic characteristics to energy storage:
  - A real world energy storage device will consume energy through internal losses and inverter inefficiencies.
  - Despite being located on the distribution system, there are still transmission level impacts.
  - The control algorithm for a specific energy storage device will determine what its primary function is.

Uses of Distribution Level Energy Storage

- Transmission level uses of distribution level units
  - Peak shaving at the system level
  - Congestion management at the sub-transmission level
  - Regulation services (e.g. spinning reserve and ramping services)
  - Reactive power support *
  - Defer capital upgrades
- Distribution level uses of local units
  - Peak shaving at the feeder level
  - Congestion management at the feeder level
  - Ancillary services for local intermittent renewables
  - Reactive power support *
  - Voltage control when islanded *
  - Defer capital upgrades

* Not currently supported under IEEE std. 1547

Control Signal

- Single input control signal
  - A simple control signal can be used to peak shave by commanding an energy storage device to discharge when load is above a set level, and to charge when load is below a set level.
  - Charge and discharge could also be controlled by a local photo voltaic system in order to mitigate the effects of cloud transients.
- Multiple input control signal
  - Single input control signals do not maximize the value of the energy storage asset.
  - In order to make a business case for the relatively high cost of energy storage the asset must be used to achieve multiple goals.
  - A multiple input control signal could be a combination of local voltage control and transmission level balancing. Local voltage control is aided by adjusting output power factor to offset local PV transients while simultaneously adjusting real output power to aid transmission level balancing.

Questions or Comments?