Sandia National Laboratories

Recommended Practice for ESMS in Grid Applications

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Project Objective

Provide a reference of best practices to develop hardware and software functions needed by energy storage management systems (ESMS) to dispatch and coordinate energy storage systems (ESSs) in the performance of grid applications

Why This Work Is Needed

- This document will fill a gap in existing standards projects regarding the role of ESMS in grid applications.
- This document will provide a reference of best practices to close the gap between IEEE 2686-2024 on battery management systems (BMS) in energy storage applications and IEEE 1547.9-2022 on interconnection of energy storage to the grid.
- Topics addressed include ESMS role in microgrid applications, ESMS role in performance of ancillary services for the grid, ESMS interoperability with the grid, and prioritization/scheduling of ESMS functions.

Progress

ESMS Roles in **"Grid-Forming"** Mode

"Grid-forming" mode is when PCS is connected to a grid at a voltage and frequency the PCS controls. In this mode, PCS adjusts its output current to influence voltage and sets its frequency using an internal timing reference or a grid operator reference. PCS then adjusts its current very quickly (<1 ms). Despite this speed, ESMS still has roles it can perform in grid-forming mode:

- ESMS commands PCS to enter or leave grid-forming mode and set desired grid parameters.
- ESMS monitors grid conditions and reacts by adjusting how each ESS lineup dispatches power.
- ESMS adjusts dead band in PCS gain curves enabling lineups to respond faster to grid events.
- ESMS in blackstart adjusts PCS ramp rates to prevent PCS from becoming overloaded.

Progress

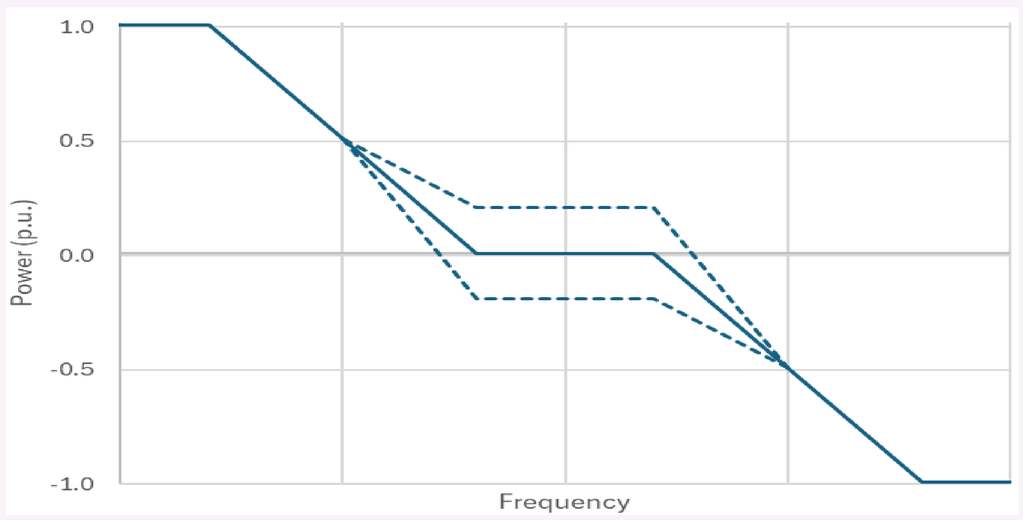
Prioritization of ESMS Functions

In an ESMS managing multiple applications, functions should be **prioritized** to avoid conflicts. Prioritization examples [a) is highest priority and g) is lowest]:

a) Capacity test (to verify battery SOH)
b) Black-start function
c) Fast frequency response (to arrest major frequency excursions)
d) Power system stabilizer (to mitigate system oscillations)
e) External dispatch (discharge commanded by grid operator)
f) Reactive power control (e.g., volt-var support)
g) Charging (or discharging) to restore system SOC to a desired level

Case Studies/Results

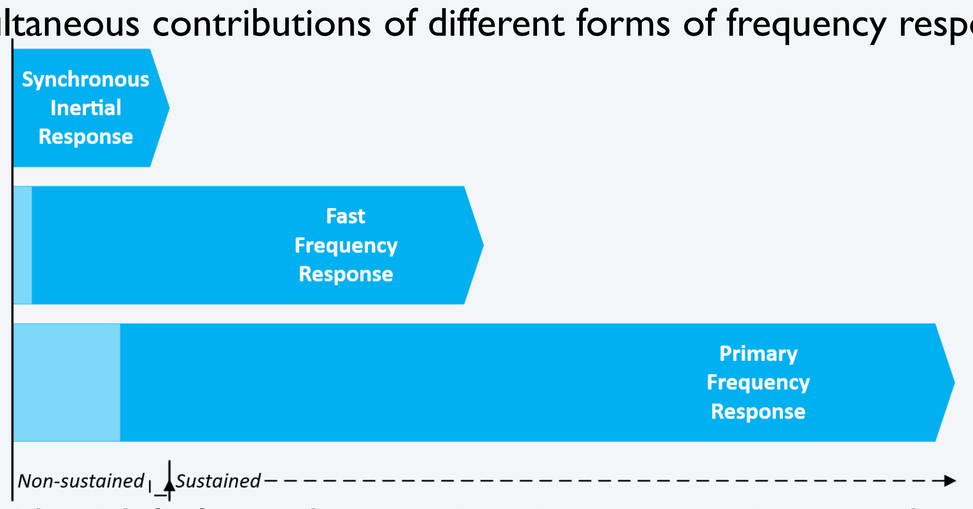
Frequency response droop curve with allowance for SOC management



For an ESS contracted to supply ±1 MW of regulation service, a baseline shift to −0.2 MW results in the ESS discharged up to 0.8 MW and charged to −1.2 MW charge. Large baseline shifts in the charge direction can increase battery degradation and require a significantly larger PCS.

Case Studies/ Results

Simultaneous contributions of different forms of frequency response



For grids with little synchronous inertia, response times need to be <100 ms, then frequency response should be performed by the PCS firmware. The ESMS should take over frequency response after initial response. For grids with more synchronous inertia, response >100 ms is okay,, then frequency response should be performed by ESMS.

Current Status

1. Propose ESMS Project to ESSB – Q2 2020 ✓
2. Draft PAR, then submit to ESSB – Q3 2020 ✓
3. PAR Approval from ESSB – Q4 2020 ✓
4. PAR Approval from IEEE-SA – Q1 2021 ✓
5. Form WG & Kickoff WG Meetings – Q3 2021 ✓
6. Draft Rec Practice – Q3 2021– Q3 2026 (current)
7. Ballot the Recmd Practice – Q4 2026
8. Approval and Publication – Q1 2027

Next Steps

Action Plan: Subgroups of 3-5 individuals will draft new content to discuss at full WG monthly meetings
Topics of Primary Focus: (1) Prioritization/Scheduling of functions, (2) Ancillary services, (3) Communications
Future Plans: IEEE P1547.X – Draft Guide for Grid Frequency Support Through Application of ESSs-IBRs

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