Sandia National Laboratories

RECOMMENDED PRACTICE FOR ENERGY STORAGE MANAGEMENT SYSTEMS (ESMS) IN GRID APPLICATIONS

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PROJECT PROFILE

Topic: Analytics & Tools | Vertical: Analytics
Strategic Pathway: Optimize
Project start and finish: FY21-FY27

PROBLEM

- Project Objective: Provide a reference of best practices to develop hardware and software functions needed by ESMS to dispatch and coordinate energy storage systems to perform grid applications.
- This document will fill a void in existing standards regarding the role of ESMS in grid applications.
- Specifically, this document will close the gap between IEEE 2686-2024 on battery management systems (BMS) in grid 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 ancillary services for the grid
  - ESMS interoperability with the grid
  - Prioritization/scheduling of ESMS functions

APPROACH

Project Timeline:

- Propose ESMS Project to ESSB – Q1 FY21 ✓
- Draft PAR, then submit to ESSB – Q2 FY21 ✓
- PAR Approval from ESSB – Q3 FY21 ✓
- PAR Approval from IEEE-SA – Q4 FY21 ✓
- Form WG & Kickoff WG Meetings – Q3 2021 ✓
- Draft Rec Practice – Q1 FY22 – Q1 FY27 (in progress)
- Ballot Recmd Practice – Q2 FY27 – Q3 FY27
- Approval and Publication – Q4 FY27

Fig. 1. Process to create IEEE Standards (denotes current status).*

RESULTS

Maintenance Mode:

- Highest priority operational state for ESMS
- This state disconnects all possible power paths
- Enables workers to safely perform service and maintenance on the ESS
- ESMS should not respond to remotely sourced commands in this mode

1. Maintenance mode
2. Capacity test (verify SOH)
3. Black start function
4. FFR (major freq. excursions)
5. PSS (damp system oscillations)
6. External dispatch (operator command)
7. Reactive power (volt-var support)
8. Charge/Discharge (restore SOC to desired value)

Table 1. Example prioritization of modes by ESMS.

CONCLUSIONS & IMPACT

- Energy storage stakeholders – Storage manufacturers, technology suppliers, utilities, regulatory agencies, industry trade groups, national labs, universities, local co-ops, etc., and of course, DOE-OE Energy Storage Division have worked together and contributed to the P2688 Draft, which is now very close to beginning the balloting process
- Data handling: This document leverages the recommendations of P2689 for uniformity in energy storage data management
- Recent progress: Draft is benefiting greatly from WG members who contributed significant new content in FY26

FUTURE DIRECTIONS

- Near term – Topics to be addressed in P2688:
  - Sequencing of Operations: State Diagram
  - Adaptive Dispatch Functions: AI/ML
  - ESMS in managing large loads, e.g., data centers
- Longer term – ES industry has asked for a new standard:
  IEEE P1547.9.X – Guide for System Frequency Support Through Application of ES-IBR Performing Fast Frequency Response (FFR) and Active Damping

Normative References

IEEE Std 2686-2024, Battery Management Systems in ESS Applications
IEEE Std 1547.9-2022, Interconnection of ESS in Distribution Systems
IEEE Std P2689, Electrical Energy Storage Data Management (in progress)

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