Sandia National Laboratories

Recommended Practice for Energy Storage Management Systems in Grid Applications

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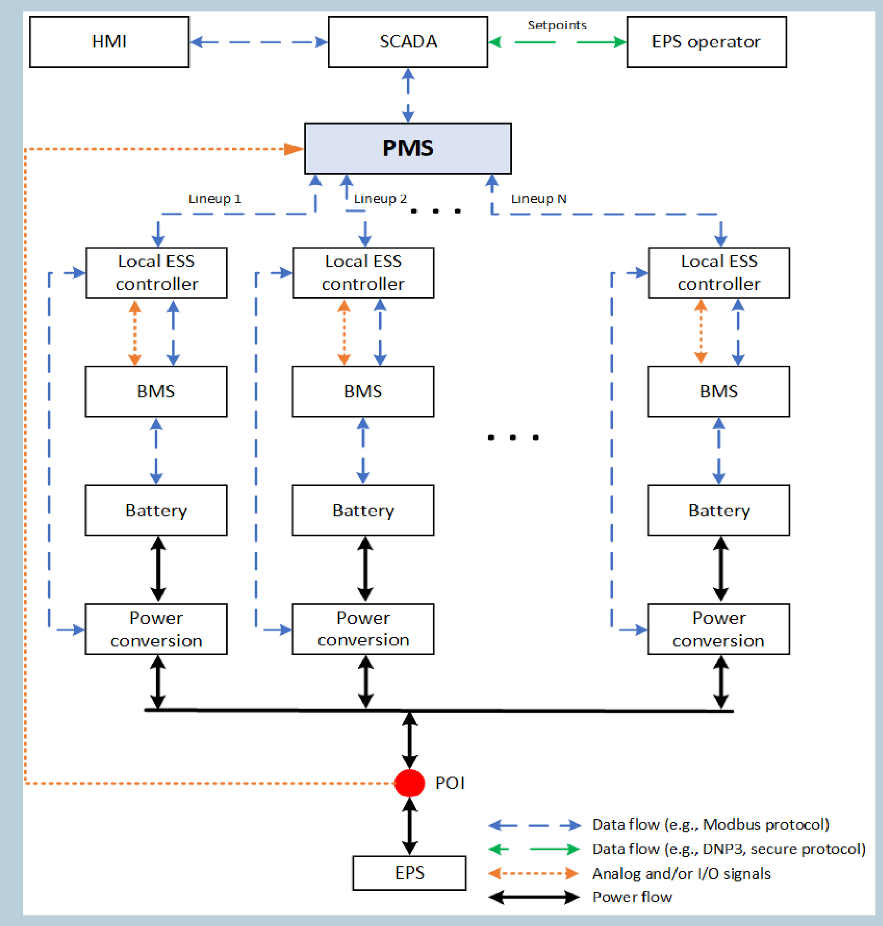
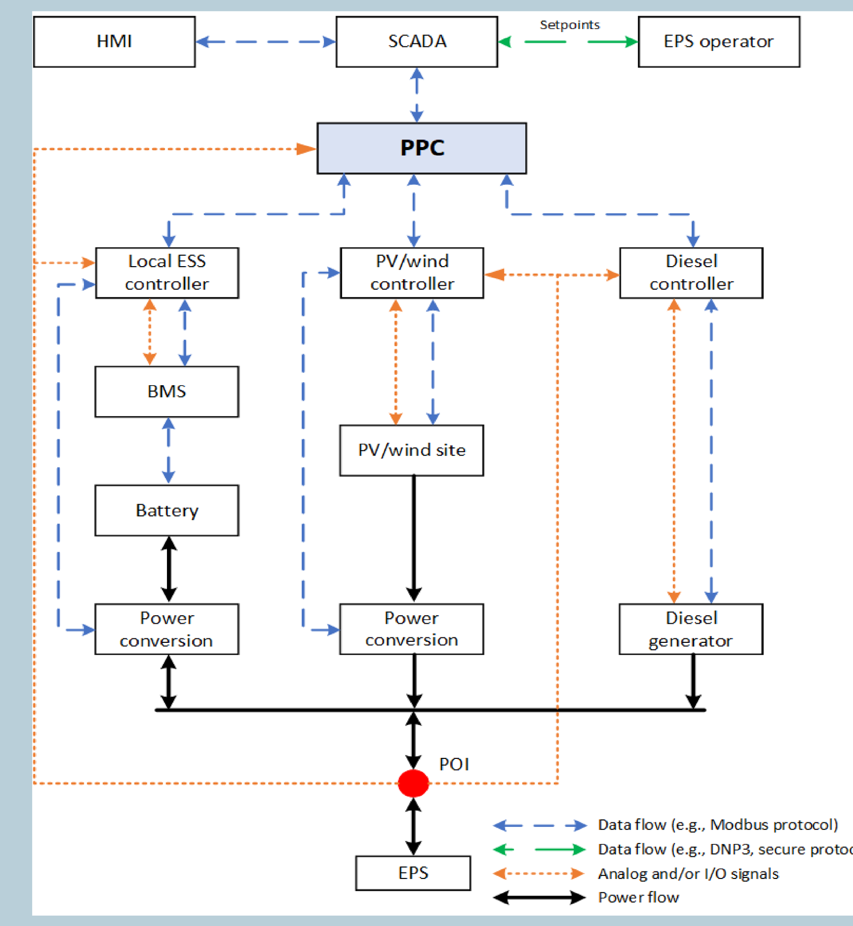
Scope

- This document will cover the development and deployment of ESMS in grid applications and will provide recommendations and best practices to inform designers and integrators.
- ESMS is an umbrella term that includes a range of systems that generally fall into one of several categories:
  - Power management systems (PMS)
  - Power plant controllers (PPC), also known as microgrid or site controllers
  - Energy management systems (EMS)
- ESMS contains software functions and hardware capabilities to address requirements needed to operate ESSs in supply-side and demand-side applications.
- Out of scope: mobile applications such as electric vehicles; vehicle-to-grid applications.

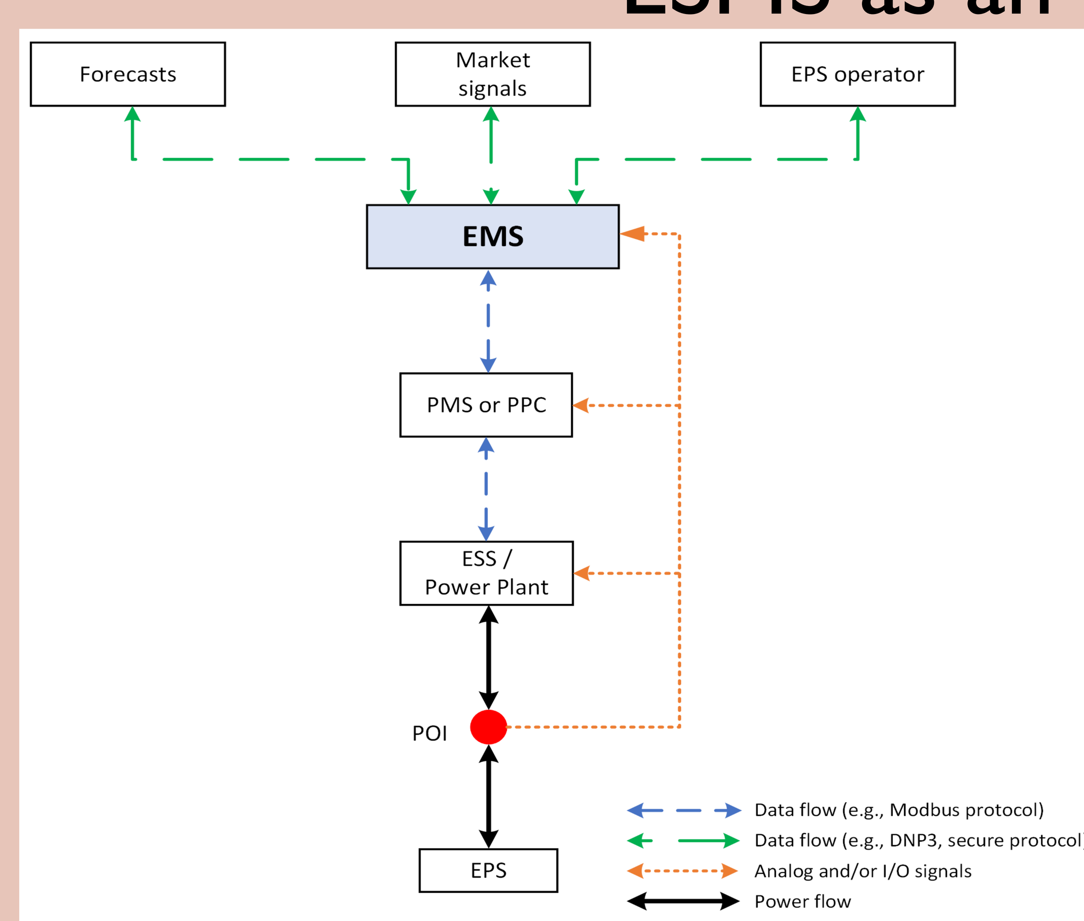
ESMS as a PMS



ESMS as a PPC



ESMS as an EMS



EMS is a high-level controller that may have PMS or PPC functions or may operate in conjunction with a separate PMS or PPC.

EMS is typically a 'smart' device, such as using machine learning to optimize dispatch levels.

ESMS Architecture Considerations

- The ESMS is typically built on a personal computer (PC), a programmable logic controller (PLC), or a distributed control system (DCS) platform.
- For applications that require high uptime such as a microgrid (e.g., PPC), a PLC or DCS would be a better choice, as it is easy to build redundancy in a PLC or a DCS.
- For applications that require a large amount of computation (e.g., EMS), a PC would be a better choice, as it has high computing power and can process large amounts of data.
- For applications with a large number of devices and data (e.g., PMS of a large facility), a DCS would be a better choice to reduce latency and increase flexibility.

Guidance in Hardware Platform Selection

Attributes / Platform	Cost (initial and upkeep)	Data handling capability	Ease of use and troubleshoot	Uptime and ease of redundancy
PC	II	II	II	III
PLC	I	III	I	II
DCS	III	I	III	I

Platforms are ranked for each attribute where I represents the best in that category, II is in the middle, and III is the lowest.

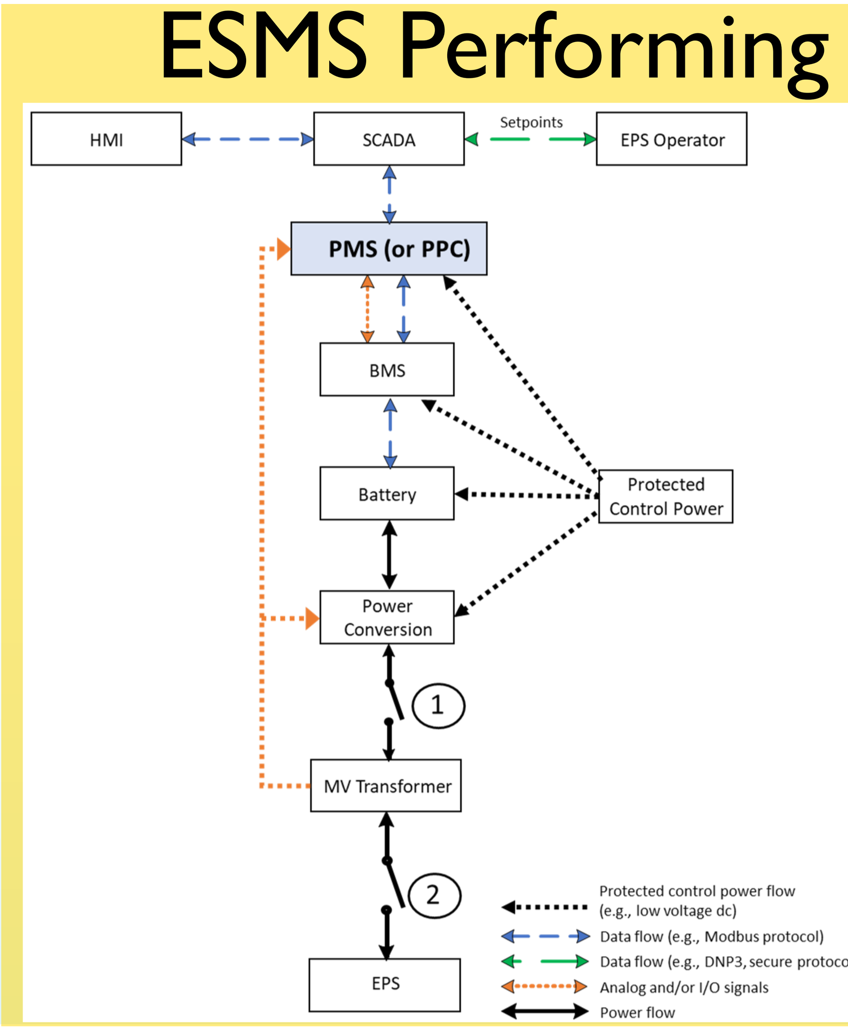
Example ESMS Applications

- Frequency regulation: track a signal (e.g., from ISO) to maintain stable frequency.
- Ramp rate control: limiting up and down rate of change of power output.
- Remote/scheduled dispatch: receive signal or schedule from remote signal.
- SOC management: dispatch power to maintain SOC balance across battery arrays.
- Curtailment avoidance: instead of curtailing PV/wind, ESS can store the energy.
- Economic dispatch: charge ESS at low price; discharge ESS at high price.
- Peak shaving: ESS limits peak power consumption to lower peak demand charge.
- Load shifting: dispatch using signal from EPS Operator to levelize system loading.
- Application stacking: manage SOC/power dispatch to perform multiple use cases.
- Resynchronization: modify off-grid voltage/frequency to match grid-side of the PPC prior to reclosing onto the grid.

Tentative Project Schedule

1. Propose ESMS Project to ESSB – June 2020 ✓
2. Draft PAR, then submit to ESSB – July 2020 ✓
3. PAR Approval from ESSB – August 2020 ✓
4. PAR Approval from SA – Q1 2021 ✓
5. Form Working Group – Q2 2021 ✓
6. Kickoff Monthly ESMS WG meetings – Q3 2021 ✓
7. Draft Recmd Practice – Q3 2021– Q4 2024 (in progress)
8. Ballot the Draft Recmd Practice – Q1 2025
9. Approval and Publication – Q2 2025

ESMS Performing Blackstart Operations



In this example, the ESMS functions as a PMS (or PPC) in which one of the ES lineups is the designated blackstart unit. The POI to the grid (or microgrid) is a medium voltage (MV) transformer in grid forming mode. The switches numbered 1 and 2 represent the POI between the ESMS and the MV transformer (Switch 1) and the POI between the MV transformer and the EPS (Switch 2).

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