Operations & Maintenance (O&M) Considerations for Utility-Scale Solar + BESS Projects

An Article by Yildiray Cezooglu. August 2025.

Disclaimer: This article summarizes publicly available guidance from sources such as the U.S. Department of Energy (DOE), Sandia National Laboratories, the National Renewable Energy Laboratory (NREL), IEEE, NFPA, and other recognized authorities, along with independent professional experience in the field of utility-scale solar and battery energy storage operations. It is intended solely for general informational purposes. This content should not be interpreted as formal engineering advice, regulatory compliance guidance, or a replacement for site-specific O&M planning. Readers are strongly advised to consult with qualified professionals, applicable codes, and relevant regulatory bodies before making any decisions based on the information provided.

Introduction

As utility-scale solar and battery energy storage systems (BESS) continue to proliferate across the energy landscape, establishing a robust, standardized O&M program has become essential. Effective O&M not only ensures performance and safety, but also extends asset lifespan, minimizes downtime, and reduces lifecycle costs.

This article outlines key industry best practices, informed by field experience and supported by guidance from national laboratories and standards organizations.

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1. Program Management and Workflow Design

A comprehensive O&M program should start with clear leadership and structure. Designating an O&M Program Manager early helps align contractual, technical, and operational expectations across all project phases. Work Management Systems (WMS) should be adopted to track preventive maintenance (PM), corrective maintenance (CM), inventory, and warranty claims. According to NREL, digital workflow systems improve uptime and data accuracy in solar and storage plants.

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2. Key Elements of an O&M Framework

A well-defined O&M strategy typically includes the following components:

- Defined team roles and standard operating procedures (SOPs)
- OEM interface and warranty tracking
- Preventive maintenance protocols
- Annual work planning and budgeting
- KPI and asset performance tracking
- Safety and training programs

Incorporating these components into a centralized O&M manual is highly recommended.

Typical maintenance tasks include but are not limited to the following actions:

- Inspections
- Routine Maintenance
- Major Maintenance
- Lifecycle Upgrades
- Warranty Repairs / Replacement
- Security
- Vegetation Management
- Pest Control

In addition to those typical tasks, O&M team should also be responsible for the management of administration, purchasing, and equipment. The items that will likely require action include but are not limited to the following:

- Safety Program
- Training Programs
- Staff / Craft Management
- Spares Purchasing and Management
- WMS Support
- Provision tools, equipment, and safety equipment
- Compliance reporting

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3. Remote Monitoring and Diagnostics

Modern BESS and PV systems are often monitored through Remote Operations Centers (ROCs), which provide 24/7 supervision, alerts, and real-time diagnostics. Predictive maintenance using AI or thermal scanning has gained ground in recent years, helping operators address minor issues before they escalate. Integration with SCADA platforms or cloud-based portals allows asset owners to visualize plant performance remotely.

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4. Field-Level Maintenance and Inspections

Routine tasks such as vegetation control, inverter cleaning, system torque checks, and thermographic inspections remain essential. For BESS, additional safety procedures must address battery degradation, fire suppression system integrity, and voltage control checks. NFPA 855 and IEEE 1635 provide detailed O&M considerations for energy storage safety and lifecycle planning.

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5. Administrative and Compliance Oversight

O&M teams must track spare parts inventories, training logs, service reports, and compliance documentation to ensure audit readiness. Standards like OSHA, NERC CIP (for grid-connected facilities), and EPA stormwater rules may apply. Use of centralized digital WMS tools is considered industry best practice.

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6. Coordination of Substation and Interconnection O&M

If the point of interconnect (POI) or substation is outside the solar+BESS O&M contract, site owners should clarify roles and scopes to avoid operational blind spots. Some developers choose to consolidate these responsibilities under one service provider to streamline risk and ensure continuous system integrity.

Summary of O&M Responsibilities for Solar + BESS Systems

Category	Typical Responsibilities (Not Limited with the listed ones)	Notes
1. Program Management	- Assign O&M manager - Develop SOPs - Oversee work planning & budgeting	Establish early in project lifecycle
2. Work Management Systems (WMS)	- Track PM/CM tasks - Schedule inspections - Maintain asset logs - Interface with OEM warranties	Enables digital workflows and performance reporting
3. Remote Monitoring (ROC)	- 24/7 system surveillance - Alarm response - Diagnostic analytics	Often run via SCADA or cloud portals
4. Field Maintenance	- Inverter/transformer checks - Vegetation control - Torque checks - Battery inspections	Critical for reducing failures and extending asset life
5. Predictive Maintenance	- Thermographic scans - AI-based fault prediction - Component degradation tracking	Enhances reliability; reduces unplanned downtime

Category	Typical Responsibilities (Not Limited with the listed ones)	Notes
6. Inspections & Testing	- Semiannual inspections - Performance ratio (PR) testing - Electrical integrity testing	Required for performance assurance & compliance
7. Safety & Compliance	- Fire suppression checks (BESS) - Lockout/tagout procedures - Safety audits - Spill/HAZMAT procedures	NFPA 855, OSHA, EPA, NERC CIP may apply
8. Warranty Management	- Coordinate OEM repairs - Track replacement cycles - Manage documentation	Protects long-term financial exposure
9. Spare Parts Management	- Inventory tracking - Reorder forecasting - Critical spare listing	Essential for minimizing service delays
10. Reporting	- Availability vs. generation reporting - Environmental summaries - Monthly & annual maintenance reports	Shared with owner/operators and stakeholders
11. Substation & POI O&M	- Grounding system checks - Switchgear maintenance - Relay protection testing	May be handled by separate utility or integrated with plant O&M scope

7. O&M Related Standards and Best Practices

7.1. Commissioning & Testing Procedures

NFPA 855

- Requires a formal commissioning process—including fire alarm and protective system tests, battery fault isolation, emergency shutdown simulations, and functional performance verification during startup.

EPRI / CESA Commissioning Guides

- These reference documents outline structured commissioning steps, including checklist-based validation, safety controls, interlock verification, data communication testing, and system performance validation before energization. (newenergynexus.com+15cesa.org+15energy.gov+15)

IEEE 2030.3

- Offers a framework for test and evaluation of BESS performance—such as power quality checks, response automation, SCADA integration, ramp-rate behavior, and round-trip efficiency.
- Ensures technical validation aligns with contractual requirements. (aesindiana.com)

7.2. Operation & Maintenance (O&M) Best Practices

NFPA 855

- Includes provisions for O&M continuity, inspection frequency, thermal runaway mitigation, and event response planning during service life. (wired.com)

IEEE P2962 O&M Section

- Provides guidance on periodic inspections, ventilation system checks, safety interlock testing, capacity fade monitoring, and replacement thresholds.

Technical Standards Frameworks (e.g. CleanPower.org QEW Guidelines)

- Defines the role of a Qualified Electrical Worker (QEW), training levels, skill verification, and safe field implementation practices for BESS operations. (ACP)

Conclusion

An effective O&M program serves as the backbone of long-term plant reliability. As the grid evolves and more intermittent renewables come online, the need for predictive maintenance, skilled workforce development, and integrated monitoring systems will only grow. By following industry guidance and customizing strategies to site-specific needs, developers can ensure safe, reliable, and profitable operations.

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