White Paper

Implementing a Successful O&M Strategy for Solar PV

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Date: March 3, 2014
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Table of Contents

1 Executive Summary .................................................................................................................. 4
2 Overview .................................................................................................................................. 4
3 Analyze Your Company and PV site(s) Needs: ........................................................................ 5
   3.1 Company Analysis: ......................................................................................................... 5
   3.2 Plant Level Analysis ....................................................................................................... 6
      3.2.1 Monitoring ............................................................................................................... 6
      3.2.2 Maintenance - How Much or How Little: What is the Correct Answer? 6
      3.2.3 Scheduled vs. Corrective vs. Predicative ................................................................. 7
4 Implementation for Lifecycle of Plant: .................................................................................. 7
   4.1 Division of Responsibilities ............................................................................................ 7
   4.2 Operations ...................................................................................................................... 8
5 Summary .................................................................................................................................. 8
6 For Questions in Your Region: .............................................................................................. 8
7 More Information .................................................................................................................... 9
1 Executive Summary

Each solar photovoltaic (PV) plant has individual characteristics and needs; from rooftop generation providing supplemental green energy to multi-megawatt (MW) transmission interconnected utility plants with strict power purchase agreement (PPA) and interconnection contractual requirements. Implementing your solar operations and maintenance (O&M) strategy can be separated into three steps:

- Analyze your Company and PV site(s) needs
- Plan for lifecycle maintenance
- Implement O&M, monitor sites, document and maintain compliance

With asset lives planned for twenty years and longer, solar power systems will require maintenance. Some of the considerations in your successful O&M program include: What is cost effective, how resources should be deployed, how often maintenance will be performed, how to maintain warrantee compliance, and O&M budget needed or what can be done if resources are limited. These are some variables inherent in a successful O&M strategy.

A plan can be self-developed or assisted by a solar PV O&M provider. Key components for developing and implementing a successful O&M strategy are presented in this white paper to assist owners and operators in ensuring their solar plants have a successful operating life.

2 Overview

Plants with high performance or availability requirements will be better designed with high levels of site monitoring, with the ability to pinpoint issues immediately at a monitored control room. Plants with poor economics may only need annual inspection for warrantee or insurance compliance. Considering a plant’s criteria at a core level of an O&M plan details the maintenance philosophy, (preventative, corrective or predictive) on a site, system and equipment basis.

- Preventative maintenance and testing on equipment and systems based on a schedule or conditional wear monitoring.
- Corrective maintenance or “breakdown” maintenance where maintenance is initiated on an as-needed basis with alerts from monitoring or reporting
Predictive maintenance in solar through use of monitoring and knowledge base can identify cost effective cleaning cycles, pinpoint and speed repairs

3 Analyze your Company and PV site(s) needs

With a little thought, planning and execution, O&M will prove to enhance your return on investment by balancing corrective, preventative and predictive maintenance techniques for a “best plan” for solar assets.

3.1 Company Analysis

To best adopt solar O&M into your Company, review your resourcing strategy during this phase. Skill sets needed in management of solar plants include asset management, electrical testing, monitoring, grounds maintenance, panel cleaning, networking and database administration.

Next, develop a list of factors which define success for the Company while developing the plant level strategy for O&M.

Some of Key Success Factors Include;

- Contractual Obligations
  - KWHR generated, Plant Availability, Grid Support, Reporting
- Internal Commitments
  - O&M Budget, Green Power, Revenue, Up-time, Internal or Local Labor for Operations, Visual Upkeep, Poor performing Plant Turn-Around
- KPIs (Key Performance Indicators)
  - Performance Ratios (PR)
  - Plant Availability
  - Generation Output- Actual vs. Planned
  - Energy Losses
  - Unscheduled Outages

Third, for the Company, review operating philosophies for solar, who and how maintenance will be performed, determine if O&M service provider(s) will be bid or negotiated and if a longer term “partner” in operations will make sense for Solar O&M.
3.2 Plant Level Analysis

During the plant level review each facility will be researched for Permit, PPA, Landowner and Interconnection obligations, equipment and EPC warrantees, contract requirements and external stakeholder reporting. For the equipment under operation, spare parts requirements, manufacturers recommended and required maintenance are identified. An easy way to document these items is with the use of a spreadsheet table with listing of equipment, quantity, OEM recommended maintenance cycle. This provides for the start of scoping the work requirements at each site.

3.2.1 Monitoring

Monitoring is crucial to sites with high performance or availability requirements. When chosen and configured properly, the monitoring system alerts the operator to take action on underperforming areas of the solar facility. The cost of monitoring is typically a small part of the overall O&M budget for the life of the facility. The immediate and future benefits in reliability and maximizing plant performance typically warrants utilization on solar generation projects.

3.2.2 Maintenance – How much or how little, what is the correct answer?

How often tasks are performed, depends on the expectations for the solar plant, the location of the facility, and equipment installed. Typically, maintenance items include rack and solar equipment inspections, panel cleaning, electrical testing, monitoring, facility maintenance with experience and feedback from operations, the frequency of the activities is adapted into the maintenance scope of work.
3.2.3 Scheduled vs. Corrective vs. Predicative

Plan for all of it! Solar facilities require a balance of scheduled, corrective and predictive maintenance solutions. If not already established, set up corrective maintenance processes and procedures to be ready when unscheduled incidents occur. A preventative maintenance schedule is developed and issued for those assets which will be maintained on a periodic basis. And, for predictive maintenance, develop monitoring systems and alert threshold to trigger maintenance activities.

With all solar assets and their maintenance requirements documented, the site maintenance plan is ready for implementation by the Operations Manager.

4 Implementation for Lifecycle of Plant

With success factors identified, the plan is placed in motion, the operations manager should monitor adherence through monthly reporting including documenting service level agreements, outages, spare parts used and in inventory, performance guarantees. These items review the current operations against the business model, the design and theoretical maximums.

4.1 Division of Responsibilities

For each site, develop a division of responsibilities, (DOR) to identify who is responsible for monitoring, reporting, scheduled maintenance and corrective maintenance. It also can show communication and approval channels for carrying out operations. Developing a Division of Responsibility is a good step to ensure all bases are covered for the site. If required to outsource services, Alectris has developed a tool for analyzing and selecting the best O&M provider, “Alectris Solar
PV O&M Contractor Evaluation Tool”. This is a software tool and can be obtained [here](#).

### 4.2 Operations

The Operations Manager with resources identified or included in a subcontractors scope of work, places the Strategy into action. Periodic reporting will compare expected and actual operations and any items which impact the ability to meet the plan. In plants with high levels or performance requirements, reporting should also include; weather conditions, Service Level Agreement adherence, generation performance, equipment outages, grid outages, warranty work, and analysis of lost kwhrs.

At an operational level failure analysis and tracking is important to spot trends and effect quick warrantee repairs.

### 5 Summary

By setting, measuring and acting on Key Performance Indicators and Success Factors, solar assets can be monitored and managed by the Owner and Operator to consistently meet or exceed organizational expectations. A clear and concise O&M strategy utilizing predicative, preventative and corrective maintenance can be readily implemented and easily documented for each solar facility providing for the correct level of asset management over the life of the PV plant.

### 6 For Questions in your Region

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About Ken Kostok, O&M Manager, Alectris

Ken graduated from the University of Haven in Electrical and Power Engineering. Since then he has worked mostly at senior technical and operations level with many well-known companies in the solar sector. His involvement in the solar business started in 2008 in Tessera Solar as Senior Director of EPC and then later on in 2010 as Vice President with Amonix. His experience on technical and operational matters is extensive. Ken is a hands-on leader with over thirty years of leadership working in and supporting electric utilities building teams to deliver safe reliable electric energy including planning, design, construction and operations of electric systems.