Operations and Maintenance Guide

PV Booster™

Rooftop Tracker

PVB_OM_061918

pvbooster.com

Operations and Maintenance Guide

Solar installations using PV Booster require substantially less maintenance than any other tracking system.

Solar O&M providers can easily anticipate costs to maintain a PV Booster tracking system, compared to an ordinary fixed-tilt solar array. We've used NREL's Photovoltaics Operations and Maintenance Best Practices Guide as the central reference for our assumptions. In this document we will discuss the following O&M related items:

Preventative Maintenance Requirements: **+ 3.5¢/kW/yr**
As compared to NREL's 10 degree fixed-tilt rooftop racking cost assumptions. Regularly scheduled visual inspections of PV Booster components. Required for valid PV Booster warranty claims.

Corrective Maintenance Expectations: **+ $1.44/kW/yr**
Regularly scheduled component repairs based on PV Booster failure rate data. These labor costs are covered under our Warranty Plus program and will be reimbursed pending RMA approval.

Spare Parts Plan
Recommended spare parts inventory for annual corrective maintenance. Spare parts will be replaced following approved corrective maintenance activities.

Example Field Layout

The PV Booster tracking system is designed to be extremely flexible and modular. Never before have solar tracking systems controlled a single solar panel individually. Throughout this document we address financial metrics on a per panel basis and use the following assumptions to provide preliminary guidance on a one megawatt (1MW DC) rooftop project.

Assumptions	
DC System Size (watts)	1,000,000
Module Size (watts)	400
Number of Modules	2,500
Number of PV Boosters (PVB)	2,500
Number of Tracker Distribution Boxes (TDB)	22
Number of Field Control Units (FCU)	1

Please see the "PV Booster Installation Guide" for explicit design, installation, commissioning, and component details. Each tracker distribution box (TDB) allows up to 36 PV Booster trackers to be powered, controlled, and monitored per string. Once TDB can control up to three (3) 36 tracker strings totaling 108 units per TDB.

Preventative Maintenance Requirements

Additional 3.5¢ kW/yr

Preventative maintenance is critical to the function of a high-quality PV Booster installation and required for valid warranty service claims. Each preventative maintenance service task highlighted must be performed annually for the entire array. Alternatively, the array can be split into phases and divided among regular O&M visits (quarterly or bi-annually). For convenience we highlight the O&M service tasks required for a fixed-tilt racking system and call out the additional preventative maintenance required by the PV Booster warranty. Please see the "PV Booster Warranty Guide" for more information.

PV Booster Required Preventative Maintenance

O&M Service Task*	Service Description	Additional Time
Visual Inspection: Each PV Booster Tracker Unit	Check PV clamps [S] Check electrical connections and cables for wear [S] Check grounding cable for wear [S] Check galvanization for excessive rust or oxidation [S] Check racking torque marks if applicable [S] Check for signs of animal nesting [S] Check wire management is secure [S] Check mechanical attachment [S]	1min/unit
Visual Inspection: Anemometer	Check anemometer for functionality [S]	10min/unit
Visual Inspection: TDB	Check each TDB for water ingress and animal nesting [A]	2min/unit
Visual Inspection: FCU	Check field control unit system status for functionality [A]	10min/unit

S = Standard O&M task, A = Additional O&M task for PV Booster
*PV Booster requires no lubrication or greasing as anticipated by NREL based on existing trackers today.

Example Annual Preventative Maintenance O&M Cost for 1MW$_{DC}$ Project

O&M Service Task	Units	Min/ Unit	Total Min	Total Hrs	Rate*	Total Cost
Visual Inspection: Anemometer	1	10	10	0.2	$33.12	$5.52
Visual Inspection: TDB	22	2	44	0.7	$33.12	$24.29
Visual Inspection: FCU	1	10	10	0.2	$33.12	$5.52
Total			**64 min**	**1.1 hrs**		**$35.33**

*Based on NREL's Photovoltaics Operations and Maintenance Best Practices Guide (PV O&M Guide)

Corrective Maintenance Expectations

Additional **$1.44** kW/yr

We've designed and built PV Booster with the highest quality possible but realistically, corrective maintenance is inevitable. We've identified the following expectations for corrective maintenance, please see the "PV Booster Installation Guide" for more details. These labor costs are covered under our Warranty Plus program.

PV Booster Expected Corrective Maintenance

Component	Mean Time Between Failures	Time to Replace One Unit
Field Control Unit	7 years	60 min
Tracker Distribution Box	10 years	20 min
Anemometer	10 years	30 min
Control Cable and Connector	20 years	15 min
Actuator Assembly	25 years	15 min
Panel Clamp	40 years	5 min
Tracking Tri-Pod	40 years	30 min

In our example 1MWDC project, here are the expected corrective maintenance costs:

Example Annual Corrective Maintenance O&M Cost for 1MW$_{DC}$ Project

O&M Service Task	Additional O&M Time	Labor Rate	Average Annual Expense
Replace Field Control Unit*	0.12	$32.01	$3.84
Replace Tracker Distribution Box*	0.17	$32.01	$5.54
Replace Anemometer*	0.04	$29.30	$1.25
Replace Control Cable and Connector	13.13	$29.30	$384.81
Replace Actuator Assembly	16.01	$29.30	$469.21
Replace Panel Clamp	2.78	$32.01	$89.06
Replace Tri-Pod	16.69	$29.30	$489.06
Total	**48.96 hrs**		**$1,442.77**

*Potentially Critical Failures

Non-Critical and Critical Failures

PV Booster has an advantage over every other tracking system. Each unit tracks PV panels individually so there are very few central failure points. Central failures are considered critical failures. E.g. If a central inverter responsible for half the electricity produced at a 1 MWDC plant fails, the investor loses half of the expected electricity for as long as it takes to repair - including lead time for replacement parts. A central inverter failure as described would be a critical failure costly enough to warrant significant corrective actions to remedy immediately and preserve expected electricity revenue. However PV Booster is different.

Assumptions

kWh Value*	$0.15
Module Size	400
Cost of Truck Roll	$1000

*www.EIA.gov

An individual PV Booster unit failure has a much smaller impact on total electricity produced. If a single PV Booster stops tracking, it becomes a fixed rack and continues to produce electricity. Assuming a 400 Watt module, 15¢/kWh value, and mobilization cost of $1,000/truck roll, the following chart modules the impact of individual unit failures between quarterly preventative maintenance service calls.

	PV Booster	Ordinary Fixed Rack	Boost
Yield (kWh/kWp)	2,100	1,600	500
Production (kWh's)	840	640	200
Annual Value per Unit	$126.00	$96.00	$30.00
Quarterly Value per Unit	$31.50	$24.00	$7.50

If a PV Booster unit stops tracking, the system investor loses approximately $7.50 for every 3 months that the PV Booster unit operates as a fixed rack. At $1,000 per truck roll to repair the system, 132 PV Booster failures for 3 months would cost the investor $990 – still less than the cost to repair ($1,000).

For the purposes of this document, critical failures are failures that affect more than 5% of the system simultaneously. Alternatively, failures affecting less than 5% of the system are non-critical failures which are best handled during regular preventative maintenance service visits.

In our 1 MWDC example that means:

1. **PV Booster Units:** 132+ units affected
2. **Tracker Distribution Boxes:** > 1 TDB affected
3. **Field Control Unit:** Any failure is critical
4. **Anemometer:** Any failure is critical

PV Booster will respond to critical failures within 48 hours and log non-critical failures for troubleshooting and repair during quarterly preventative maintenance service calls.

Spare Parts Plan

We recommend sufficient spare parts be kept on site for corrective maintenance

Although final recommendations will be project specific, the spare parts plan is based on corrective action incident rates highlighted in the expected corrective maintenance section previously. Once corrective action has been recommended, the technician is free to use inventory for these items which will be replaced under warranty pending RMA approval. This reduces down-time by storing the components on site so repairs can be made as needed. The RMA process simply replenishes depleted inventory following corrective action.

PV Booster Spare Parts Plan

(in our 1 MWDC example)

Component	Spares
Field Control Unit	1
Tracker Distribution Box	2
Anemometer	1
Control Cable and Connector	10
Actuator Assembly	10
Panel Clamps	10
Tracker Tri-Pod	10

PV Booster For Your Project

Interested in PV Booster for your project?
Contact sales@edisun.com to receive an estimate.

Please include:

1. **Site Address**
2. **Expected PV Module size**
3. **Target kWh or kWp for this project**

We'll quickly provide a PV Booster system cost, O&M cost, and your anticipated spare parts plan so you can get more kWh per panel on your rooftop projects. Thanks for your interest!