PV Storm Hardening Costs

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Abstract

- *Photovoltaic (PV) systems can provide added resilience to the power sector (through distributed generation, backup power, and more)*
- *In some cases, PV systems can provide power after a severe weather event when other grid infrastructure may be down*
- *PV systems have survived hurricanes and other severe weather events with no or minimal damage*
- *Some hurricanes and high-wind events have caused damage to PV systems, rendering them powerless when their power is most needed*
- *By designing, installing, and maintaining PV systems to be stronger in the face of storms, we can increase their value and the resilience of the power system*
- *Previous work (Robinson 2018) has identified best design and maintenance practices for PV systems in severe weather regions*
- *This poster summarizes estimates for initial cost premiums to implement these best practice measures*

Photo from Gerald Robinson, LBNL

PV Storm Hardening Measures And Estimated Costs

For select measures only. The forthcoming report analyzes additional measures.

1. System Audit Torque Check — 0.10 ¢/W

Loose bolts have led to modules blowing off racking. Performing bolt torque checks regularly can help secure the modules and is an easy, low-cost measure.

2. Improved Fasteners — 0.12 – 1.4 ¢/W

Fasteners, especially module-racking bolts, are a common point of failure in wind-damaged PV systems. The fastener solutions below can help mitigate loss from the various modes of bolted joint failure.

2a. Wedge-lock Washers Lock into place when tightened and can resist bolted joint self-loosening from wind vibrations

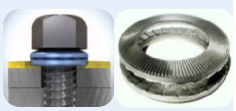
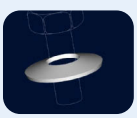


Image from NordLock

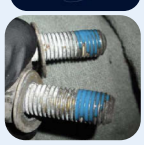
2b. Nylon Insert Nuts can also help mitigate self-loosening. They are inexpensive and commonly available. Potential concerns over UV degradation.

2c. Rivet-Lock Bolts are one-time assembly locking fasteners

2d. Belleville Washers act as springs and help hold load through preload relaxation of a bolted joint



2e. Thread Lock is applied to the threads of a bolt and creates a seal when tightened



Images from Wikimedia Commons

3. Modules — 20.1 ¢/W

Select modules with uplift rating that match site conditions. For hurricane-prone regions, modules with >3600 Pa dynamic load test uplift rating.

4. Through Bolting — 0.24 ¢/W

Photo showing bent end clamp recovered from a PV site after a hurricane.

Photo from Andy Walker, NREL

Through bolting attaches individual modules to the racking directly. It is more secure than top down clamps and attachment clips and prevents the possibility of cascading domino failure of adjacent modules.

5. Three Framed Rail System — 15.6 ¢/W

Three rails are more secure than two and limit module flexing when wind loaded. It also allows more module attachment points. The cost is higher and includes additional hardware.

Image from Commercial Solar Guy 2019

6. Racking Material Design

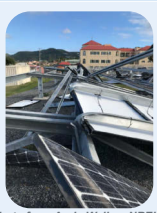


Photo from Andy Walker, NREL

Light gauge, cold-rolled steel "C" channels can bend when subject to loads in certain directions. Tubular steel racking components provide more resistance to damage from storms.

7. Wind Calming Fence — 14.1 ¢/W

A wind-calming fence can reduce wind loads on the crucial perimeter modules of an array. It could also reduce dust, block debris, embers from wildfires, and reduce perimeter design and installation costs.

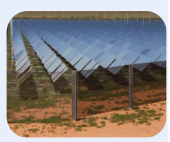
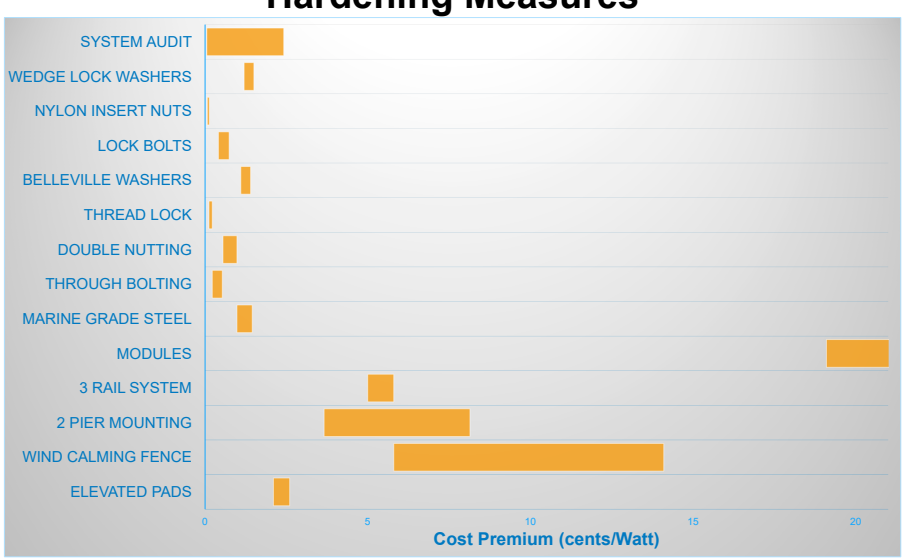


Image by DCT-Dust Solutions, Inc.

Estimated Cost Premiums of Select PV Storm Hardening Measures



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This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office Federal Energy Management Program. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

PV Reliability Workshop
Lakewood, CO
February 25-27, 2019
NREL/PO-7A40-76045