SOLAR PHOTOVOLTAIC SYSTEM RESILIENCE

Weather Vulnerabilities Checklist*

WEATHER VULNERABILITIES	RISK (SAFETY / PERFORMANCE / FINANCIAL)	CORRECTIVE ACTIONS	COST
STRUCTURAL			
☐ Fastener loosening from transverse slip or improper field assembly	🔴 🔴 🔴	Properly torque and replace inadequate fasteners with rated locking fasteners	$
☐ Top-down module clamps: vibrational loosening, bent open or failure	🔴 🔴 🔴	Fix top-down clamp vulnerabilities	$$
☐ Soft joint issues in top-down module clamps & racking assemblies	🔴 🔴 🔴	Modify joints so clamping forces are maintained	$$
☐ Use of back side clamping and self-tapping sheet metal screws	🔴 🔴 🔴	Replace clamps & self-tapping screws with through-bolts/modify joints	$$
☐ Inadequate bolted joint design	🔴 🔵 🔴	Modify bolted joints in racking assemblies to avoid bolt shearing	$$
☐ Module clamps & rails not installed properly, unbraced racking, deflection of subframing	🔴 🔴 🔵	Add stiffening bracing or use top-down clamps with improved features	$$
Special Considerations for Roof Arrays			
☐ Inadequate structural attachment to building	🔴 🔴 🔴	Add mechanical attachments to building to improve structural integrity	$$
☐ Inaccessible and wind-damage-prone PV array	🔴 🔴 🔴	Reconfigure PV array to allow interior access	$$ to $$$
☐ Mounting position of PV array resulting in high wind exposure	🔴 🔴 🔴	Redesign PV system to reduce potential for damage from heavy wind forces	$$$
☐ Array tilts (>15°) resulting in high turbulence and front and back pressure on modules	🔵 🔵 🔴	Redesign PV system to a lower tilt angle to reduce potential wind damage	$$$
☐ Flexible PV array glued to roof membrane	🔵 🔵 🔴	Remove and/or replacing a flexible PV system glued to the roof	$$ to $$$$
ELECTRICAL			
☐ Electrical equipment located below the site's 100-year flood level	🔴 🔴 🔴	Relocate electrical equipment above 100-year flood level to prevent flooding	$$$
☐ Improperly supported wires	🔴 🟢 🔴	Support wires with EPDM rubber-lined clamps, metallic module or rail wire clips, metallic wire ties or conduit	$$
☐ Electrical enclosures with inadequate NEMA rating located outdoors	🔴 🟢 🔴	Replace inadequate and/or corroded electrical equipment; apply outdoor-rated sealant to penetrations; install weep hole, vent or drain plug	$ to $$$
☐ Conduit-related vulnerabilities	🔴 🟢 🔴	Install durable conduit supports or expansion joints to accommodate thermal movement; replace conduit fittings with ones that are watertight and replace damaged conduit, install a ramp or walkway over roof mounted conduit	$ to $$
☐ Poor installation practices leading to damage of PV and other DC wires	🔴 🟢 🔵	Replace damaged DC wiring	$ to $$
☐ Animals nesting under modules, chewing and damaging wires	🔵 🟢 🔵	Remove existing animal nests; install wire-based critter guard or netting to flush mounted arrays; install bird spikes on top of array	$ to $$
☐ Field-applied labels and markings showing signs of significant degradation	🔵 🟢 🟢	Replace all field labels and markings that are showing signs of degradation	$
☐ Corroded grounding components due to environmental conditions or dissimilar metals	🔵 🟢 🟢	Replace corroded grounding components with non-corrosive components	$ to $$$
☐ PV connector failure	🟢 🟢 🔵	Replace damaged PV connectors	$ to $$
SITE			
☐ Unobstructed wind forces on the PV system	🔴 🔴 🔴	Use a wind calming fence to reduce wind forces on the PV system	$$$
☐ Loose debris and/or equipment scattered around a PV array	🔴 🟢 🟢	Clear debris and secure loose equipment around the PV system	$
☐ Improper site stormwater management around a ground-mounted PV system	🟢 🟢 🔴	Plant pollinator habitat; install site water management; perform regular O&M	$ to $$$
☐ PV array covered in snow, making it susceptible to damage	🔵 🔵 🔵	Clearly mark the presence of the PV array and its boundaries	$
☐ Clogged roof drainage system	🟢 🟢 🔵	Inspect and clear roof drains to avoid electrical and structural damage	$
☐ PV equipment in direct contact with the roof membrane	🟢 🟢 🔵	Repair roof; install protective sheet under PV arrays that come in contact with or are close to roof membrane	$ to $$$
MODULES			
☐ Damaged modules from wind/snow loading and hail, cracked or failed backsheet	🟢 🔴 🔴	Replace modules with broken glass top-sheet, cracked or failed backsheet or cracked cells; conduct an I-V curve test on string and module level	$ to $$$$

Federal Solar Photovoltaic Arrays: PV System Owner's Guide to Identifying, Assessing, and Addressing Weather Vulnerabilities, Risks & Impacts, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Gerald Robinson (LBNL) 12/2020

RISK KEY

- 🔴 High
- 🔵 Medium
- 🟢 Low

COST	COST PER WATT	COST FOR 50 kW PV SYSTEM
$	≈ $0.01/W (± $0.01/W)	≈ $500 (±$500)
$$	≈ $0.06/W (± $0.04/W)	≈ $3,000 (± $2,000)
$$$	≈ $0.30/W (± $0.20/W)	≈ $15,000 (± $10,000)
$$$$	≈ $1.50/W (± $1.00/W)	≈ $75,000 (± $50,000)