



WHITE PAPER

Solar Panel Cleaning And Your Warranty: What Manufacturers And O&M Standards Require

How commercial solar owners can keep cleaning consistent with module and roof warranties, based on NREL's PV O&M best practices: approved methods, water quality, methods to avoid and the records to keep.

Executive Summary

Owners of commercial solar arrays often ask whether cleaning can void a warranty. The governing document is always the module manufacturer's own installation and maintenance manual, which varies by product. What does not vary is the industry baseline: the U.S. Department of Energy's National Renewable Energy Laboratory (NREL) publishes O&M best practices that tell operators to follow the manufacturer and set out which cleaning methods to avoid.

Key Points

- **Manufacturer Rules Come First:** "Follow the PV module manufacturer's recommendations with any array cleaning." NREL/TP-7A40-73822 §5.7.1
- **Gentle Methods Only:** Clean "with plain demineralized water and mild detergent recommended by the manufacturer." §5.7.1
- **Methods To Avoid:** "Do not use high-pressure water, brushes, or any types of solvents, abrasives, or harsh detergents." §5.7.1
- **Warranties Shape Maintenance:** Scheduled maintenance is often carried out to conform to manufacturers' recommendations "as required by the equipment warranties." NREL/TP-7A40-73822
- **Keep Records:** Record keeping and enforcement of warranties are core O&M functions. NREL/TP-7A40-73822

What Warranties Typically Say About Cleaning

Module warranty and maintenance terms differ by manufacturer, so this paper does not summarize any one brand. NREL's guidance is the practical rule: read the manual for the installed modules and follow it. NREL notes that preventive maintenance frequency is influenced by equipment type, site conditions and warranty terms, and is "often carried out at intervals to conform to the manufacturers' recommendations, as required by the equipment warranties." NREL/TP-7A40-73822, O&M functions

On rooftop systems there is a second warranty to protect: the roof. NREL states that roofs under warranty require annual preventive roof maintenance to maintain the roof warranty, and recommends identifying roof-warranty conditions, "including the selection of cleaning agents." NREL/TP-7A40-73822, roof considerations

NREL O&M Best Practices

NREL's *Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, 3rd Edition* (NREL/TP-7A40-73822, December 2018) explains why cleaning matters: "Soiling reduces the energy output of the PV array and can lead to localized hot-spot failures if the soiling is uneven," so uneven soiling such as bird droppings should be addressed. §5.7.1

Cleaning "may be on a defined interval or 'condition based,'" with soiling measured by instruments to trigger a cleaning. Frequency may be seasonal, depending on local rainfall and dust. §5.7.1 The report lists sources that may call for a cleaning regimen, including construction dust, pollen, bird populations, diesel soot in cities and industrial sources such as kitchen exhaust. §5.7.1

Approved Methods And Water Quality

Method	NREL Guidance
Water	Plain demineralized water
Detergent	Mild detergent recommended by the manufacturer; no harsh detergents
Tools	Bucket, strip cleaner and squeegee with overlapping vertical strokes, "in the same way window glass is cleaned on commercial buildings"
High-Pressure Water	Do not use
Brushes, Solvents, Abrasives	Do not use
Robotic Systems	Available for large systems; many require the system design to accommodate them

Source: NREL/TP-7A40-73822 §5.7.1

Documentation To Keep

- The Module Manufacturer's Installation And Maintenance Manual For Your Exact Model
- Cleaning Dates, Method, Water Type And Any Detergent Used
- Before And After Photos, Especially Of Uneven Soiling Or Damage
- Roof Warranty Terms And Any Roof Maintenance Records For Rooftop Arrays
- Production Data Around Each Cleaning, If Monitoring Is Available

NREL lists record keeping and enforcement of warranties among the core operations functions of a PV O&M program. NREL/TP-7A40-73822 A cleaning log built around the manufacturer's manual is the simplest evidence that the array was maintained as the warranty expects.

Sources

- NREL, Sandia National Laboratory, SunSpec Alliance and SuNLaMP PV O&M Best Practices Working Group, Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, 3rd Edition, NREL/TP-7A40-73822, December 2018 (OSTI ID 1489002). <https://www.osti.gov/servlets/purl/1489002>

This paper summarizes published technical guidance for general information and is not legal advice. Requirements may change and vary by city; consult the current text, your local agency and qualified professionals.

About Window Cleaning Bay Area

Window Cleaning Bay Area provides commercial window cleaning, pressure washing and solar panel cleaning across the San Francisco Bay Area. Contact: grayson@windowcleaningbayarea.com



WHITE PAPER

Soiling Losses On Bay Area Solar Arrays: What Research Says About Cleaning Frequency

What published research compiled by NREL says about solar soiling losses, how much cleaning recovers, and how Bay Area commercial owners can set a site-specific cleaning schedule.

Executive Summary

Dust, pollen, soot and bird droppings on a solar array cut its output. How much, and whether cleaning pays for itself, depends on the site. This paper summarizes the soiling research collected in NREL's *Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, 3rd Edition* and turns it into a practical way for Bay Area commercial owners to set a cleaning schedule. Every figure below is quoted from that report, with the original study named.

Key Points

- **Soiling Costs Energy:** It "reduces the energy output of the PV array and can lead to localized hot-spot failures if the soiling is uneven." NREL/TP-7A40-73822 §5.7.1
- **Typical Daily Loss:** "Studies report about 0.05% reduction in output per day due to soiling." NREL/TP-7A40-73822 §5.7.1
- **Site Matters:** Reported rates range from 0.01%/day in a clean desert to 0.36%/day near heavy agriculture and up to 0.5%/day with large bird populations. NREL/TP-7A40-73822 §5.7.1
- **No Universal Schedule:** NREL recommends a local, site-specific cost-benefit analysis. NREL/TP-7A40-73822 §5.7.1

What Soiling Is

Soiling is any material that collects on module glass and blocks light. NREL notes that losses are about twice as high in the morning and evening as at midday, because the shadow cast by each dirt particle grows at high incident angles. Rain helps: heavy rains result in "a nearly complete cleaning effect," while light rains clean much less effectively "and can even increase soiling if dust then sticks to sparse water droplets." NREL/TP-7A40-73822 §5.7.1

Published Loss Ranges

Finding	Value	Study As Cited By NREL
Annual Losses Reported	4.3% to 7.5%; many around 6%/year	Literature summary
Typical Daily Loss	About 0.05%/day	Literature summary
Daily Rate, 186 Systems	0.051%/day	Study recounted by Naeem (2014)
Naeem Experiments	0.061%/day	Naeem (2014)
Heavy Agriculture Area	0.36%/day	Literature summary
Clean Desert Area	0.01%/day	Literature summary
Large Bird Populations	As high as 0.5%/day	Literature summary

How Much Cleaning Helps

For a system in Mesa, Arizona, with 1.91% annual soiling loss, Naeem (2014) simulated one annual cleaning reducing loss to 1.52%/year (-20%), two to 1.32%/year (-31%) and three to 1.20%/year (-37%). Naeem also concluded routine cleaning was not cost-effective for residential, commercial or utility plants in that study, with cleaning costs of \$0.25/m² to \$1/m² and about 1 liter/m² of water. NREL/TP-7A40-73822 §5.7.1 NREL adds that "where special conditions ... occur, cleaning will be required on a schedule that depends on the source and nature of the soiling."

Bay Area Factors

NREL lists soiling sources that may call for prevention or cleaning. Several are common at Bay Area commercial sites: construction dust (clean after nearby construction ends), pollen (clean after pollen season), bird populations, diesel soot near bus depots and city traffic, and industrial sources such as kitchen exhaust, where "a filter added to a fryer can reduce oil in kitchen exhaust air." NREL/TP-7A40-73822 §5.7.1

Building A Cleaning Schedule

Factor (NREL)	Effect On Interval
Cost Of Cleaning	Mobilization fee plus per-area cost; higher cost favors fewer cleanings
Soil Accumulation Rate	Faster soiling favors more frequent cleaning
Capacity Factor	Better solar resource, higher reward for cleaning
Value Of Power (\$/kWh)	Higher value, higher reward
Module Efficiency	Lower efficiency means more area cleaned for the same benefit

- Track Production Before And After Each Cleaning
- Inspect After Construction Nearby, Pollen Season And The Dry Season
- Treat Bird Droppings Promptly Because Uneven Soiling Risks Hot Spots
- Consider Condition-Based Cleaning Triggered By Monitoring

NREL notes cleaning "may be on a defined interval or 'condition based'," and that the frequency "may be seasonal, depending on local rainfall and dust characteristics." NREL/TP-7A40-73822 §5.7.1

Sources

- NREL et al., Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, 3rd Edition, NREL/TP-7A40-73822, December 2018, §5.7.1 (citing Naeem 2014). <https://www.osti.gov/servlets/purl/1489002>

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