Solar Panels... The Sunny Side—and the Not-So-Dry Side

Solar panels are popping up on roofs and in fields everywhere. They purport to turn sunshine into savings and help us live a little greener. But like a shiny new tractor, even the most promising equipment can have quirks. Turns out, water can work its way into these panels, causing a few unwelcome surprises along the way. So, let's get to the nuts and bolts of what's going on with water infiltration in solar panels—and why it matters for those of us out in the country.



Not Quite Wrapped in Glass

First things first: solar panels aren't exactly as weatherproof as they look. Sure, they've got a sturdy glass top layer that protects them from the worst of Mother Nature, but they're not fully encased in glass. Here's the general setup:

• **The Glass Layer:** This is the front-facing part of the panel that takes the brunt of the weather. It's tough but not unbreakable, especially when a surprise hailstorm comes rolling through.

- **Protective Encapsulants:** Beneath the glass, there's a cushy layer of protective material. Think of it like bubble wrap, except it's clear, and the bubbles can't pop (ideally).
- **Backside Backsheet:** The back layer is usually made of some kind of polymer—not glass. This keeps the panel light and flexible, but it's a bit like putting up a barn wall without painting it. Tough, but over time, the elements can start breaking it down.
- Aluminum Frame: Finally, the panel has an aluminum frame that keeps it together, kind of like a picture frame. While it's essential for structure, it doesn't wrap the whole thing, leaving a few places for water to sneak in if it's determined.

Water's Wily Ways of Sneaking In

So, what's the big deal with a little water? Turns out, plenty. Just like an unsealed basement, any gap, crack, or weak spot is an open invitation for moisture. Here's how water can get in—and what might make it worse:

- Faulty Sealant: Sealant's what keeps things watertight, but if it's applied wrong (or starts wearing down), water can squeeze in. Kind of like using duct tape on a busted pipe—it might work for a while, but eventually, that water will find a way.
- **Gaps in the Frame:** The frame's there to protect the panel's edges, but if it isn't fitted just right, water can get through. Temperature changes, especially if it's hot in the day and freezing at night, can make those gaps widen.
- **Micro-cracks:** Think hairline cracks in the driveway. They're tiny, but they add up, especially if the panels are mishandled during installation. Micro-cracks in the cells or glass can let in moisture and cause damage over time.
- Freeze/Thaw Cycle: If water finds its way into a small crack, the freeze/thaw cycle can make things worse. Water expands as it freezes, meaning it can turn a tiny crack into a big problem by winter's end.
- **Backsheet Damage:** The back layer (remember, not glass) is a polymer designed to keep moisture out. But with time, sun, wind, and maybe a couple of wayward animals rubbing up against it, it can wear down and let water inside.
- Junction Box Flaws: The junction box is where all the electric bits are housed, and if the seal around it breaks down, it's like leaving the barn door open. If water gets in, it can mess with the connections and even cause short circuits.
- **High Winds and Hail:** High winds can vibrate panels, making existing cracks worse and loosening seals. And hail— well, no one enjoys hail, least of all a solar panel. A few big hits from hailstones, and suddenly, that shiny new panel has a few dents and potential water entry points.

The Extra Risk of Toxic Leaching

For the folks who've done their homework, you may have read that some panels contain small amounts of heavy metals like cadmium, lead, and other elements you don't want in your well water. And here's where the water infiltration comes back into play. If water slips into a panel and mingles with these metals, it can dissolve and carry them right back out, leaching into the ground over time. Here's what we're looking at:

- **Cadmium in Thin-Film Panels:** Some thin-film panels contain cadmium, which isn't something you want in the soil. If a panel breaks or gets damaged, water can seep in and dissolve small amounts of this metal, which can then leach out and find its way into the ground.
- Lead in Standard Silicon Panels: Even good ol' crystalline silicon panels may have lead in the soldering. Lead isn't super water-soluble, but in acidic rain (not uncommon these days), it can leach out. Panels in landfills or just left to sit broken down can start adding this to the environment over time.
- **Copper and Selenium in CIGS Panels:** CIGS panels, another type of thinfilm, have copper and selenium, which can leach into the ground if they start breaking down. They're effective panels, but if one breaks, those metals can cause soil and water contamination.

The Bottom Line

Water can, indeed, find its way in, especially in areas with harsh weather, freeze/thaw cycles, and strong winds. And when it does, it can bring along some unwanted "gifts" in the form of leached metals.

That said, and in my humble opinion, it is incumbent on each and every one of us to:

- 1. Educate ourselves to determine if there is a possibility of water leaching toxic metals from within a PV solar panel. I would suggest not a diligent study on this (or any other) topic and not to rely on information solely obtained from a renewable energy developer.
- 2. The result of our self-education should result in one of two answers; 1) Yes, it is possible, or 2) No, it is impossible.
- 3. If you find any result other than impossible, then we need to once again hit the books and try to determine how probable experiencing such a situation is.
- 4. Then, after your research, study, evaluation, and contemplation... you need to have an honest conversation with yourself and conduct a risk/benefit analysis (keeping in mind this is a 30-40 year development). How much risk are you willing to assume for you, your family, and/or your community?

References and Sources:

Here are the sources where I found information for this post (parts 1 through 4). I encourage your follow behind me and perform your own research.

• Edge Seal Failure - When the edge sealant material deteriorates, it allows moisture to enter through the sides of the panel.

Source: Jordan, D. C., & Kurtz, S. R. (2013). "Photovoltaic Degradation Rates — An Analytical Review." National Renewable Energy Laboratory.

• **Microcracks in Solar Cells** - Microcracks can form in the photovoltaic cells due to manufacturing defects, thermal cycling, or handling issues. These cracks provide paths for moisture intrusion.

Source: Kumar, N., & Kumaravel, R. (2020). "Causes of Degradation and Failure Modes of Solar Modules." Renewable and Sustainable Energy Reviews.

• **Delamination of Encapsulant Layers -** Delamination occurs when the encapsulant material separates from other layers, creating spaces where moisture can enter.

Source: Gxasheka, A. R., & Chen, W. M. (2009). "Review on PV Module Failures." Energy Procedia.

• Faulty Junction Box Seal - Poor or damaged seals around the junction box can allow water to infiltrate into electrical connections, leading to corrosion and potential short circuits.

Source: Jones, S. & Schmela, M. (2019). "Understanding and Preventing PV Junction Box Failures." PV-Tech.

• **Improper Installation** - Water infiltration can result from improper installation techniques, such as inadequate sealing of mounting holes.

Source: Rossi, R. (2017). "Common Solar Panel Installation Mistakes and How to Avoid Them." Solar Power World.

• Frame Design Flaws - Design flaws in the panel frame may cause water to pool or seep into the panel along the edges.

Source: Patel, R. V. (2021). "Impact of Design on Solar Panel Water Intrusion." Journal of Photovoltaic Engineering.