



## PV Management / Solar Panel Recycling

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Photovoltaic (PV) panels, or commonly known as Solar Panels, currently generate about 3 percent of the world's electricity. Solar energy is a renewable and green energy, so it is important that the end-of-life disposal of the solar panels does not affect its popularity as a green technology. Much of the current global infrastructure has been installed over the past two to three decades. By the year 2030, some of those panels will reach end-of-life (EOL) status, leaving roughly 8 million metric tons of material to be dealt with. Scientists estimate that by 2050, that number will increase tenfold. At that point, spent PV materials will account for 10 percent of all electronic waste. (I hate to break it to you, folks, but no technology is entirely benign. Sustainability is about using technology that causes the least amount of damage. In that regard, solar and wind are still cleaner than fossil fuels.)

The good news is that nearly 80 percent of a solar panel's weight consists of aluminum and glass, both of which are easily recyclable. The bad news is that separating the glass is complicated, and the remaining 20 percent of the materials can be difficult to recover.

By 2024, 2.5% of all homes in the U.S. will have solar installation. New homes install PV within the initial building plans. Large solar farms are providing power to the power grid. Panels are used to provide power computers, mobile phones, household devices, cars, trucks and Power Supply Units in facility management. Installations vary in size from a couple of panels on residential home to a complete commercial solar farm, covering acres of ground. ERI services are designed around the safe recovery, transportation and processing of Photovoltaic equipment (PV), or Solar Panels.

Over the next three decades, the world will accumulate roughly \$15 billion worth of recoverable materials from EOL solar panels—enough to make 2 billion new modules that total more than 600 GW of generating capacity.

ERI is able to safely recycle the following PV equipment:

- PV modules (mono or polycrystalline, thin-film, shingle-type, etc.)
- Inverters or microinverters
- Racking equipment or trackers

Recycling a solar panel can be broken down into three basic steps:

1. Remove the frame and junction box (a mechanical process)
2. Separate the glass from the silicon wafer (a thermal, mechanical or chemical process)
3. Separate and purify the silicon and various metals (a chemical and electrical process)

## Commodities

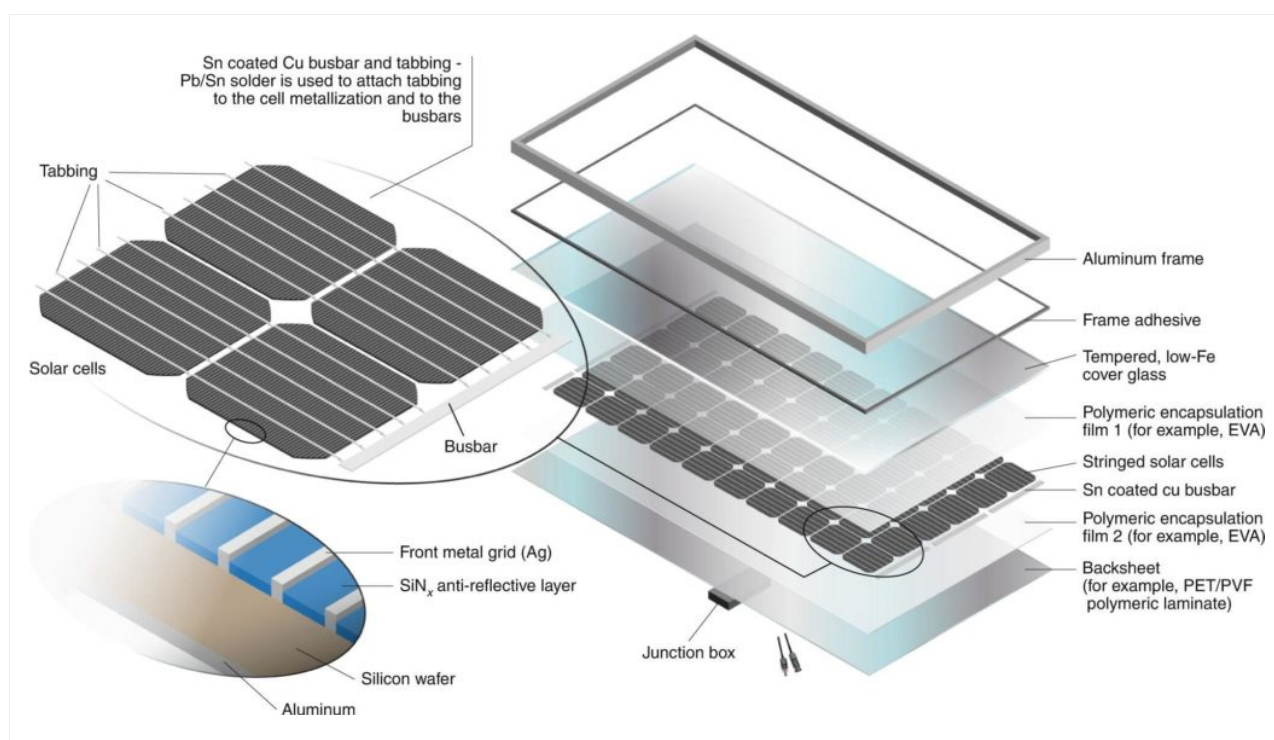
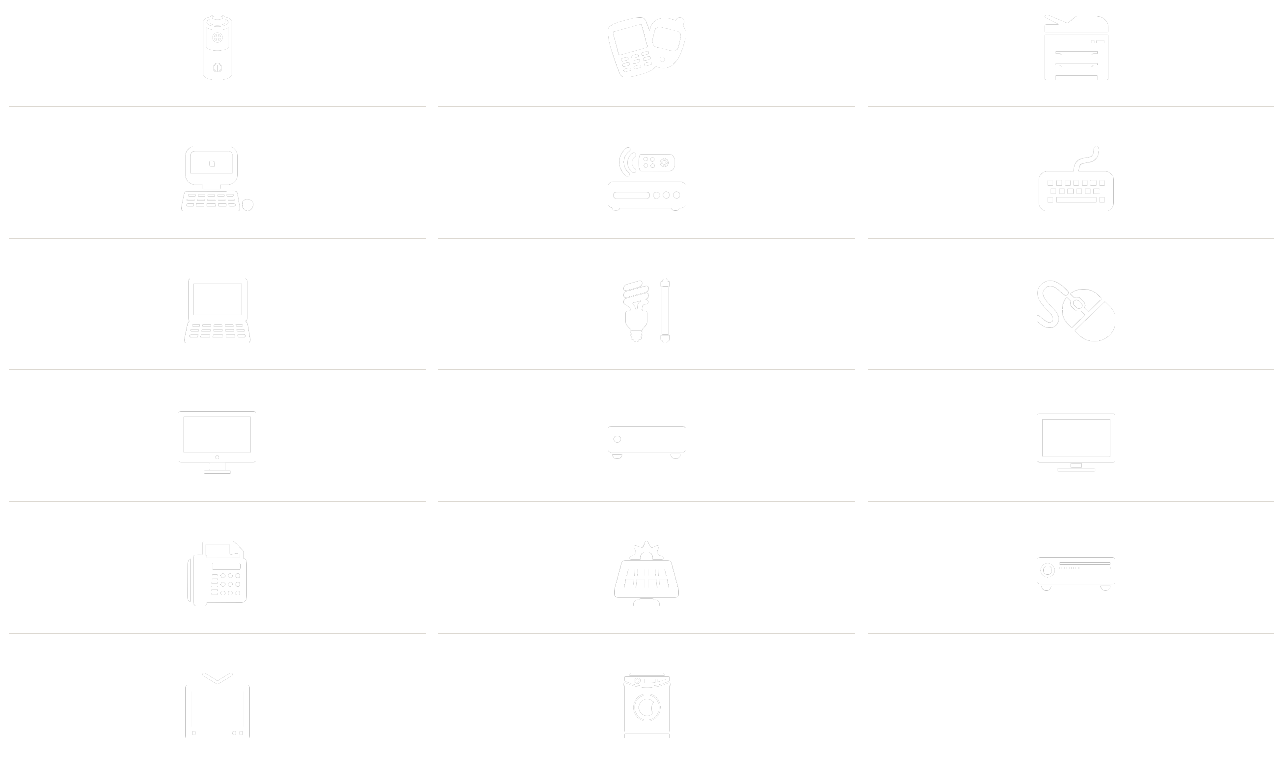


## Facts

80 percent of a solar panel's weight consists of aluminum and glass, both of which are easily recyclable.

Over the next three decades, the world will accumulate roughly \$15 billion worth of recoverable materials from EOL solar panels.

Energy.gov reports that around 173,000 terawatts of solar power constantly reach the earth.



PV Module Components (Image courtesy of NREL)

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Project end-of-life management services are designed for the recovery and handling of equipment and for the removal and recovery or large installation units. Our teams, from logistics through to processing, are specially trained to handle solar panels.

Solar panel disposal must be more than throwing old PV modules, inverters, and wires into the trash. Solar panels contain items that can be reused and turned into new things. The best solar recycling program starts by understanding how solar panels are made.

## What Happens When a Solar Panel is Recycled?

Solar panel recycling requires careful handling of these different components. Glass, silicon, metal, and plastic need to be separated and reused as much as possible. The entire process takes time and expertise because there are different steps to prevent contamination and safely dismantle the panel into raw components.

No matter which solar module you have, glass is the biggest component followed by plastic, aluminum, silicon, and other metals. The aluminum frame is separated from the silicon module before it heads to be melted down and reused. Glass can be melted down and reused to make new glass items. Before that can happen, the silicon has to go.

Silicon modules recycling is a crucial step in solar recycling. The glass and silicon must be separated before the glass can be reused. Processing at high temperatures burns up any small plastic parts or adhesive. The use of acids helps separate the silicon cells from the glass and metals. Some of the silicon is melted down for reuse during the PV recycling process.

Once silicon is removed, glass, plastic, and other components get shredded, separated as needed, and sent to companies that use them to make new products. This keeps all of the metal, plastic, and glass out of a landfill where it would sit for centuries without deteriorating.

Whether you're a homeowner with a photovoltaic solar panel array that is reaching end-of-life, or you're a manufacturer who is looking at the best practices for recycling silicon solar panels, ERI is ready to help you with your recycling needs.

## How Are Solar Panels Made?

Solar panels look simple as they are just glass, metal, and photovoltaic (PV) silicon cells. While it seems that would make for easy recycling, it's quite complex. Here are the different components.

## Three Main Types of Silicon Cells

All solar panels start as glass or plexiglass panels covered with the cells used to capture the power of the sun. That panel is coated in conductive amorphous, monocrystalline, or polycrystalline silicon cells that convert sunlight into electricity. Those cells are also treated with boron and phosphorus to make sure one side of the cell has more electrons than the other. What are the differences between the types of silicon cells and PV modules?

- Amorphous – Amorphous silicon cells create PV modules that are flexible and can be easily bent and shaped. That makes them easy to attach to almost any surface including metals like aluminum.
- Monocrystalline – Monocrystalline cells are formed into a large block that is cut into wafers and affixed onto the entire panel at once, which creates the PV module. These cells create the most efficient solar panels.
- Polycrystalline – Polycrystalline silicon cells are melted and fused to the panels to form the PV module.

## PV Modules Create the Solar Array

PV modules are then wired and added into an aluminum frame to finish the solar panel. That panel is connected to a support or hanger. That's one of them. One won't power much within a residence or business. Multiple panels are needed.

As you add multiple panels to the rooftop or field, the PV array is created to capture the sun and start converting it to electricity. Sometimes, micro-inverters and power optimizers are added to ensure problem-free operation if one of the panels is covered in snow or ice or being shaded while others are in full sun.

## Wiring Transports the Electricity to the Inverter

Solar panels produce DC electricity. People need AC electricity for their appliances and other electrical devices. That's why wiring is also a big part of the solar equipment.

Once the sunlight is turned into electricity, the energy travels to the metal casing and wiring where it's sent to the inverter. The inverter's role is to change from DC electricity to AC electricity. From there, it powers things in the home or is sent on to the area power company's grid.

Inside the inverter, a lot is going on. You have capacitors, wiring, and printed circuit boards (PCBs). All of that is in a locking plastic and metal case.

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Solar is one of the cheapest sources of energy as the sun is abundant in all corners of the globe. Energy.gov reports that around 173,000 terawatts of solar power constantly reach the earth. In just 90 minutes, enough sunlight reaches the earth to power every home and business in the world for a full year.

The first solar cell was built in the 1950s. Since then, the solar industry has boomed. Most recently, homes across the globe are installing solar panels in yards and on rooftops to help power appliances, electronic devices, and energy grids across the country. From homeowner installations to large solar farms, solar energy is taking off.

There's a problem that's just starting to gain attention. It's estimated that by 2050, China and the U.S. will have the largest amounts of end-of-life solar panels. Perhaps more worrisome are reports that PV modules will account for more than 10% of electronic waste within the next 30 years.

Most solar panels only have a lifespan of 25 to 30 years. As time goes on, production slows down and the panel is no longer viable. As the solar industry started booming in the early-2000s, people are starting to consider what happens next?

At this point, recycling is the only option. It's also a newer process for many recycling facilities and residential solar installers. This leads to a great question, "How does solar recycling work?"

Whether you're a homeowner with a photovoltaic solar panel array that is reaching end-of-life, or you're a manufacturer who is looking at the best practices for recycling silicon solar panels, ERI is ready to help you with your recycling needs.



People. Planet. Privacy.™



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