

PV Panel End-of-Life

PV panels last a very long time, but they do not last forever. Their output declines slightly each year, but panels rarely fail in less than 40 years. The expected economic life of utility-scale PV panels is 30-40 years, at which point they may be replaced by new panels, or the entire project may be decommissioned, returning the land back to how it was before the solar facility was installed. In both instances, the original PV panels are removed from the site. At a typical solar facility, there are three possible fates for solar panels at the end of their economic life at a project, described below. At a minimum in all cases, waste management laws require that the facility owners handle and dispose of the equipment and other facility components in conformance with federal, state, and local requirements. As required by the Brooks County Zoning Ordinance, the project will provide the county with a decommissioning bond in an amount to reasonably cover the cost of the decommissioning.

Solar panel end-of-life options:

- Reuse:** It is most likely that when the PV panels at the Morven Solar project are decommissioned, they will still produce up to approximately 80% of their original output and have another decade of productive life, making them viable to be reused as solar panels on rooftops or ground-mounted applications. Markets for used solar panels exist today and are likely to be much more mature in 30-40 years when the project's PV panels near the end of their life.
- Recycling:** Any panels that are not reused as working panels could be recycled. Currently in the US it is possible to recycle the largest constituents of silicon PV panels using the existing glass and metal recycling infrastructure. Today this recycling comes at a cost premium to disposing the panels in a landfill. However, as PV recycling technology improves and the number of panels reaching end-of-life increases dramatically, it is possible that in the future recycling PV panels will more than pay for itself. Recycling plants built specifically to recycle PV panels can recycle nearly 100% of the panel, including the valuable silver and refined silicon they contain, and can be optimized for the task, significantly reducing the cost to recycle each panel. Only recently was the first industrial-scale PV-specific recycling plant built, in France, but in the coming decades it is expected that PV-specific recycling plants will become commonplace. PV recycling technology is clearly still in its infancy. However, it is expected that when the Morven Solar PV panels reach the end of their useful life in 35+ years, the US PV recycling infrastructure will be robust, such that reuse or recycling of the PV panels will be the preferred options or required by new U.S. regulations, as it has been for years in Europe.



Figure 5. PV Panels Waiting to be Recycled (Source: LuxChemtech GmbH)

First Solar, the only significant manufacturer of cadmium telluride modules, has been developing and successfully using a recycling process for their thin film modules for decades. This focus on recyclability and recycling, allows First Solar to offer recycling services for First Solar modules reaching the end of their useful life.

The Solar Energy Industries Association (“SEIA”) started the SEIA National PV Recycling Program several years ago to accelerate PV recycling in the US. Currently the program aggregates the services offered by recycling vendors and PV manufacturers, making it easier for the industry to select a cost-effective and environmentally responsible end-of-life management solution. **The program identifies Preferred Recycling Partners through an evaluation process. These partners are capable of recycling PV modules, inverters, and other related equipment today.** The current SEIA PV Recycling Partners are listed on the program’s website, and full access to the program and the Preferred Recycling Partners is available to SEIA members.

- Disposal:** For most solar facilities, if panels are not reused or recycled, federal waste management laws (Resource Recovery and Conservation Act, “RCRA”) require that PV panels, like any other commercial/industrial waste, be disposed of properly, which is typically in a landfill. In order to determine the proper disposal method, RCRA requires that all commercial/industrial waste be identified as either hazardous or non-hazardous waste, which for PV panels is determined using the Toxic Characteristic Leaching Procedure (“TCLP”) test developed by the EPA. This test seeks to simulate landfill conditions and check for leaching of 8 toxic metals and 32 organic compounds from a wide variety of commercial/industrial waste. Little data has been published about the TCLP test results of solar panels, but it is known that some early silicon panels that contain more lead than modern panels exceed the TCLP test limits for lead.