

Recycling of CdTe Thin Film Photovoltaic Panels

The Blythe Solar Power Project is a proposed 1,000 megawatt (MW) photovoltaic (PV) project. It is currently in the process of being re-permitted from thermal solar to PV. Thin film cadmium telluride (CdTe) PV panels are one of the possible PV technologies for this project. This memorandum summarizes the recycling process for thin film CdTe PV panels.

Thin film CdTe PV panels are manufactured from heat-strengthened laminated glass sheets designed to withstand handling and thermally induced stress. A semiconductor made of CdTe is applied to the laminated glass in a thin layer (typically two microns thick) to form the active photovoltaic panels. The laminated glass and the semiconductor are then sealed from the environment using a laminate material. These panels are expected to last approximately 30 years.

Under the assumption that CdTe panels are recycled or properly disposed of at the end of their useful life, atmospheric emissions during installation, operation, and decommissioning are zero. Cadmium telluride is insoluble in water and has a high sublimation temperature; therefore any release to the environment, although highly unlikely, can be contained. Once CdTe has been properly captured and encapsulated, it may be considered harmless. It is also important to note that CdTe panels pass the Environmental Protection Agency's (EPA) Toxicity Characteristic Leaching Procedure (TCLP) test.

Cadmium telluride is toxic if ingested, if its dust is inhaled, or if it's handled improperly (i.e. without wearing gloves). However, research conducted by the U.S. Department of Energy's Brookhaven National Laboratory shows that the glass sheets surrounding CdTe material completely seals, thus preventing the release of the compound to the environment. The research also found that large-scale use of CdTe panels does not present any risks to health or the environment, and recycling panels at the end of their useful life completely resolves any environmental concern.

Most manufacturers of CdTe panels have self-imposed recycling programs that allow for the transportation and recycling of their panels. As part of the recycling program, manufacturers typically have a prefunded recycling program which allows for the collection of panels that need to be disposed of. Most programs are free of charge at the time of disposal, and the costs are included at the time of purchase. The funds are held and managed by a third party to allow for proper disposal of the panels regardless of the financial status of the company.

First Solar is among the leading manufacturers of PV panels in the world. Their recycling program follows an eight-step method described below:

1. Collection: panels are collected in hoppers and loaded into a shredder
2. Breakdown: the panels are reduced in size using a two-step process
 - a. Shredder: breaks down the panels into larger pieces



- b. Hammermill: crushes the broken glass into four to five millimeters (mm). This allows for the lamination bond to break.
3. Film Removal: the semiconductor films are removed by using acid and hydrogen peroxide into a rotating stainless steel drum.
4. Solid-Liquid Separation: the drum is drained into a classifier which separates the glass from the liquids. The glass is transported on a conveyor up an incline, leaving the liquids behind.
5. Glass-Laminate Separation: using a vibrating screen, the glass is separated from the larger pieces of laminate material.
6. Glass Rinsing: the glass is rinsed to remove any residual semiconductor material. The glass is then packaged for recycling.
7. Precipitation: the metal-rich liquid is pumped to the precipitation unit. The compounds are precipitated out of solution by increasing the pH.
8. Dewatering: the precipitated compounds are concentrated in a thickening tank. This results in unrefined semiconductor which can be recycled to be used in new panels.

The recycling process for the panels achieves approximately 90 percent efficiency, thus reducing the environmental footprint of producing solar energy. The manufacturing of CdTe panels also offsets the need for disposal of cadmium. Both cadmium and telluride are byproducts of smelting base metals, such as zinc, copper, and lead. Therefore, the encapsulation of cadmium in PV panels and recycling them at the end of their useful life provides a more environmentally-friendly solution to the current uses and disposal methods.

Cadmium telluride PV panels provide a safe and environmentally-friendly alternative from the manufacturing process through the end of their useful life. By manufacturing the panels using byproducts from the smelting of metals, combined with a design that protects the environment from any toxic releases, and a highly efficient recycling program, CdTe PV panels are able to provide the solar industry an emissions-free, reliable and sustainable solution for electricity generation.

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