



Solar Panel Recycling and Disposal

This informal guidance, prepared by the NCDEQ Division of Waste Management, serves to answer frequently asked questions about solar panel recycling and disposal. This guidance includes a brief description about solar panel design and is followed by answers to frequently asked questions about solar panels.

Information on Solar Panel Regulation

North Carolina House Bill 479 directs the North Carolina Environmental Review Commission to study matters related to the decommissioning of utility-scale solar projects. The term "utility-scale solar project" means a ground-mounted photovoltaic (PV), concentrating photovoltaic (CPV), or concentrating solar power (CSP or solar thermal) project directly connected to the electrical transmission grid for sale to wholesale customers. The term includes the solar arrays, accessory buildings, transmission facilities, and any other infrastructure necessary for the operation of the project. The Environmental Review Commission shall report its findings and recommendations, including any legislative proposals, to the 2020 Regular Session of the 2019 General Assembly upon its convening.

North Carolina does not currently have laws or rules specific to solar panel disposal and recycling. Instead, the management requirements are based on whether the solar panel is recycled or disposed. When disposed, a determination must be made on whether the solar panel is a hazardous waste.

Brief Description of Solar Panel Design

A solar panel converts the sun's radiant energy into electricity using photovoltaic cells commonly known as solar cells. Key ingredients in a solar panel include solar cells, photovoltaic modules, and semiconductors.

The solar cell is the first building block of a solar panel. Within each solar cell are semiconductors that perform an important role in the overall function of the solar panel. Semiconductors contained beneath the antireflective surface absorb photons of sunlight energy and turn that energy into electric current. Each cell is soldered together in series into one large unit called a photovoltaic module. Multiple photovoltaic modules are soldered together to form a larger unit called a solar panel. Electrons leaving the solar panel require an inverter to convert the electron flow from DC current into usable AC current to power devices such as TVs, computers, or appliances.

Solar panels are increasingly used by homeowners and industry as an alternative to non-renewable energy.

Frequently Asked Questions

Questions and answers on the following pages are grouped into the broad categories described below:

- Types of Solar Panels
- Is it a Hazardous Waste?
- Is it a Universal Waste?
- Are there any Exemptions?
- Accumulation
- Training requirements
- Managing broken solar panels
- Disposal
- Recycling
- Decommissioning of Solar Farms

Types of Solar Panels

Q: How many types of panels are in circulation and what are the main types?

A: There are numerous types of solar panels in circulation. The main types are the monocrystalline silicon, polycrystalline silicon, the cadmium telluride (CdTe) types and the newer thin film types such as copper indium gallium selenide (CIS/CIGS). It is difficult to tell the type just by looking. Most owners will have documentation regarding what they purchased and had installed. This documentation can help with these determinations.

Is it a Hazardous Waste?

Q: When do solar panels become a waste?

A: A waste is any material that is discarded. A material is discarded if it is: abandoned, recycled or considered inherently waste like. In general, a hazardous solar panel becomes hazardous waste when:

- 1) For unused solar panels, when the generator decides to discard them, and
- 2) For used solar panels that will not be reused, when they are disconnected /removed from service.

Q: What can cause a solar panel to be considered a hazardous waste?

A: Solar panel wastes include heavy metals such as silver, lead, arsenic, cadmium, selenium that at certain levels may be classified as hazardous wastes.

Q: What does data show? What are the constituents that make the panels hazardous?

A: In general, data shows that older silicon panels may be hazardous due to lead solder. Some older silicon panels are hazardous for hexavalent chromium coatings. Cadmium tellurium (CdTe) panels are typically hazardous due to the cadmium. Gallium arsenide (GaAs) panels may be hazardous due to the arsenic. Thin film panels, such as copper indium gallium selenide (CIS/CIGS) panels, may be hazardous due to the selenium.

Q: What about electronic components associated with the solar panels? What are they hazardous for?

A: The electronic components associated with the solar panels (e.g. drivers, inverters, circuit boards) contain all of the common electronic device hazardous constituents such as lead, arsenic, cadmium, selenium, and chromium.

Q: Does a generator have to test the solar panels it generates?

A: No. Sampling and analysis is conducted when determining whether or not a waste is a hazardous waste. However, a generator may use its generator knowledge and may forego sampling and analytical testing, though documentation supporting the determination must be maintained and made available for review.

As for any waste, the generator must make the hazardous waste determination and manage the waste as hazardous waste if it determines the waste to be hazardous waste. I.e., if the waste solar panel is hazardous waste, it needs to be managed according to hazardous waste regulations.

Q: Are some types and brands of solar panels hazardous waste, and others not?

A: Yes, that is possible. One can consult with the manufacturer from which it came from to learn about the product. Below is a link to a database that profiles solar manufacturers and solar products which may be of helpful. <http://www.enfsolar.com/directory/panel>

Q: Are there any markings or identifiable traits to look for?

A: Just like any manufactured article, the article, or panel, should have a make and model number. Identification tags affixed to the solar panel provide specific information such as product name, trade name and part number. One can consult with the manufacturer from which it came from to learn about the product.

Q: What if you know the type of panel? Can you tell if it's hazardous just by knowing what type of solar panel you have?

A: No, even when you know the type of solar panel, it is difficult to say if it is hazardous or not without performing testing.

Is it a Universal Waste?

Q: Are solar panels electronic devices under the universal waste regulations?

A: No. Solar panels are not considered electronic devices or universal wastes in North Carolina. A solar panel produces electricity to power devices such as TVs, computers, and appliances. The solar panel itself is not an electronic device that performs specific tasks such as processing data or sending emails. A solar panel is more akin to a battery in a car. Like a battery, solar panels produce electricity to power a device.

As for any waste, the generator must make the hazardous waste determination and manage the waste as hazardous waste if it determines the waste to be hazardous waste. I.e., if the waste solar panel is hazardous waste, it needs to be managed according to hazardous waste regulations.

Are there any Exemptions?

Q: What kinds of regulatory exclusions or exemptions, if any, apply to solar panels?

A: There are no regulatory exclusions or exemptions specific to solar panels.

Accumulation

Q: Can hazardous waste solar panels be accumulated and/or consolidated together with universal waste electronic devices (UWEDs)?

A: No. Solar panels are not considered universal waste and may not be managed as such.

If the solar panel that is being disposed is determined to be hazardous waste, all applicable hazardous waste requirements apply. Accumulation time limits vary with generator status. Typically, a generator will be required to send the solar panels offsite within 90, 180 or 270 days depending upon their monthly hazardous waste generation quantity.

Training requirements

Q: What kind of training do personnel have to receive on hazardous waste solar panel management?

A: Training requirements for generators of hazardous waste depends on the generator's status.

Generators that produce no more than 2,200 lbs. of non-acute hazardous waste per month are required to comply with personnel training requirements described at 40 CFR section 262.16(b)(9)(iii). These requirements are intended to ensure that generators of less than 2,200 lbs. of non-acute hazardous waste per month are adequately prepared to properly handle the types of hazardous wastes generated at the site and to respond to any emergencies that may arise.

Generators that produce more than 2,200 lbs. of non-acute hazardous waste per month are required to comply with personnel training requirements described at 40 CFR 262.17(a)(7). These requirements are intended to ensure that generators of greater than 2,200 lbs. of non-acute hazardous waste per month receive instruction which teaches personnel hazardous waste management procedures relevant to the positions in which they are employed.

Managing broken solar panels

Q: How should I manage broken solar panels? Can solar panel debris be swept up and containerized separately from intact panels while being accumulated as HW? How do I use a spill kit?

A: Whether broken or intact, if the waste is disposed, a waste determination must be done to determine whether the waste is a hazardous waste. Solar panels determined to be a hazardous waste must be managed according to the hazardous waste regulations. Broken pieces must be cleaned up and properly packaged/containerized as to minimize the potential release. Containers shall be structurally sound and prevent releases under reasonably unforeseeable conditions. A release of hazardous waste to the environment could be considered hazardous waste disposal without a permit.

Disposal

Q: What is the current status for disposal of solar panels?

A: Waste solar panels that are hazardous are fully regulated hazardous wastes. Hazardous waste solar panels must be managed according to all applicable hazardous waste laws and regulations.

Non-hazardous waste such as glass, copper wire and aluminum framing from the non-hazardous solar panels can be taken to a non-hazardous landfill or to recycling centers to be disassembled and reclaimed for value through recycling activities.

Q: Can hazardous waste solar panels be taken to Household Hazardous Waste (HHW) collection events?

A: HHW collection events are intended for hazardous waste generated at a residence. Qualifying residents should contact the HHW collection facility and verify that the hazardous waste solar panel wastes will be accepted.

Recycling

Q: Where can I find information on recycling solar panels?

A: For solar panels that have been determined to be non-hazardous, the state recycling program in the North Carolina Department of Environmental Quality operates a Recycling Markets Directory that can be utilized to identify recycling companies that can accept solar panels for recycling. To use the directory, follow these steps:

- Open this Web Site: <http://www.p2pays.org/dmrm/start.aspx>
- In "STEP 1" select "Electronics & Related Products"
- In "STEP 2" select "Photovoltaics"

The marketplace for recyclers of photovoltaic panels changes and continues to grow. Many materials associated with the installation have positive scrap value including metal racks and structure supporting the panels, aluminum frames enclosing the panels, as well as copper wire and related electrical equipment associated with the connection to the electric grid. At the very least, the scrap value associated with these materials should help offset the cost of decommissioning.

Decommissioning of Solar Farms

Q: What items should be considered when planning to decommission solar farms?

A: Communities concerned about the end of life management of solar farms have the option of establishing a requirement that property owners or solar farm developers must prepare and submit a plan for decommissioning installed photovoltaic systems at the end of life in order to become authorized to develop the property.

End of life solar decommissioning plans that become mandatory by the local government could also be required to be recorded on the property plat/ deed. With this recording requirement, subsequent property owners would inherit and be subject to the plan.

The following is a list of elements may be considered when determining which elements to include when developing a plan to decommission utility scale solar project. Knowledge of these items may provide valuable guidance and information to assist with the responsible decommissioning of a solar power plant:

- Name and contact information for the manufacturer of the installed power generating panels including exact model number(s);
- Name and contact information for company / contractor performing the installation;
- Date of Installation;
- Description of the physical properties of the installed equipment including detailed information about the technology, chemical make-up of panels, and results of a Toxicity Characteristic Leaching Procedure (TCLP) Test providing the analytical results illustrating whether the panels are able to legally be disposed of in a Municipal Solid Waste (MSW) Landfill. While recycling is a desired end-of-life management solution, the results of the TCLP test will determine whether the panels may legally be disposed of in a Municipal Solid Waste Landfill in North Carolina;
- Copy of manufacturers recommendations for end of life management of equipment; and
- Primary and secondary contact information for the party responsible for management of installed equipment at the end of its useful life including copies of agreements if any assigning responsibility to a party other than the property owner.

Regulatory Assistance

For questions about the disposal of solar panels determined to be **hazardous waste**:

https://files.nc.gov/ncdeq/Waste%20Management/DWM/HW/Compliance/Compliance_Map_by_Inspector.pdf

For questions about the disposal of solar panels determined to be **non-hazardous**:

<https://files.nc.gov/ncdeq/Waste%20Management/DWM/SW/FieldOpMap.pdf>

For questions about **recycling** non-hazardous solar panels:

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