Frequent Questions About Solar Panel Recycling and Disposal

This informal guidance, prepared by the NCDEQ Division of Waste Management, serves to answer frequent questions about solar panel recycling and disposal.

Frequently Asked Questions

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

- Is it a Hazardous Waste?
- Is it a Universal Waste?
- Are there any exemptions or exclusions?
- Accumulation
- Training requirements
- Managing broken solar panels
- Disposal
- Recycling

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 and/or 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. 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) may contain hazardous constituents such as lead, arsenic, cadmium, selenium, and chromium.

Q: What are the requirements for determining whether a solar panel is a hazardous waste?

A: A person (that is not classified as a household) must determine whether a waste is a hazardous waste (in accordance with 40 CFR 262.11, adopted by reference at 15A NCAC 13A .0107(a)).

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

A: No. Sampling and analysis is conducted when determining whether a waste is a hazardous waste. However, a generator may use its generator knowledge (as described in 40 CFR 262.11(d)) and may forego sampling and

analytical testing, though documentation supporting the determination must be maintained and made available for review. Alternatively, a generator may use the manufacturer's representative testing on a specific make and model

As for any waste, the generator must make a hazardous waste determination in accordance with 40 CFR 262.11 and manage any hazardous waste by all applicable hazardous waste regulations. See the below question/answer about using Safety Data Sheets (SDS) to help make the waste determination. See the "Accumulation" Section of this document for links to guidance documents for the management of hazardous waste.

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

A: Yes. One can consult with the manufacturer from which the solar panel came from to learn about the product and to see if the manufacturer has performed representative sampling to show the product is non-hazardous. The 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.

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: 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 the required waste determination when the solar panel is taken out of service.

Just knowing the type of solar panel is not enough information to make a waste determination. In other words, it is difficult to say if it is hazardous or not without performing testing. However, if the manufacturer has performed representative testing (Toxicity Characteristic Leaching Procedure or TCLP) on a specific make and model, this data can be used to show the solar panel is hazardous/non-hazardous.

Q: Can I use a Safety Data Sheet (SDS) to make the determination on whether a solar panel is hazardous waste or not?

A: No. While a SDS can sometimes be useful when determining hazardous waste characteristics like corrosivity (since the SDS often provides information on pH) or ignitability (since the SDS often provides information on flashpoint), the SDS is not the appropriate document to use for information about toxicity characteristics. OSHA regulations do not require manufacturers to identify constituents present in material at concentrations below 1% (10,000 ppm) for non-carcinogens and 0.1% (1000 ppm) for carcinogen. The product may contain toxicity characteristic constituents above RCRA regulatory levels even when not identified on the SDS. An SDS can be used to assist with making a waste determination but should not be the sole information used to make a waste determination on a solar panel.

Is it a Universal Waste?

Q: Are solar panels a universal waste?

A: No. Solar panels are not currently considered a universal waste in North Carolina.

Q: Can the batteries associated with the solar panels be managed as a universal waste?

A: Yes, any non-integrated components associated with the solar panel that meet the current definition of a universal may be managed under the universal waste requirements. Since batteries are designated as a universal waste in North Carolina, any batteries associated with the solar panel (that is not integrated with the solar panel, itself), may be removed and managed as a universal waste. Alternatively, any lead acid batteries removed from service may be managed under the existing lead acid battery being reclaimed rules under 40 CFR 266 Subpart G. As always, if the generator performs a waste determination under 40 CFR 262.11 and finds the battery is non-hazardous, the battery would not be subject to the hazardous waste or universal waste requirements.

Q: *If* North Carolina adopted rules making solar panels a universal waste, would non-hazardous solar panels need to be managed under the universal waste requirements?

A: *If* North Carolina adopted rules making solar panels a universal waste, any solar panels determined to be non-hazardous or that are subject to the household hazardous waste exclusion (40 CFR 261.4(b)(1)) would only need to meet the North Carolina Solid Waste requirements. Non-hazardous waste solar panels (or ones meeting the household hazardous waste exclusion) would NOT be required to be managed under a hazardous waste or universal requirements. If North Carolina adopted universal waste requirements for solar panels, the requirements would apply to the solar panels that are hazardous waste or if a site opts to not test the solar panel.

Please note: North Carolina has **NOT** adopted rules making solar panels a universal waste.

Are there any hazardous waste exemptions or exclusions for solar panels?

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. However, solar panels that are derived from a household may be excluded from regulation as a hazardous waste under the household hazardous waste exclusion described at 40 CFR 261.4(b)(1), adopted by reference at 15A NCAC 13A .0106(a).

- "Household waste" means any material (including garbage, trash, and sanitary wastes in septic tanks) derived from households (including single and multiple residences, hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds and day-use recreation areas). Household waste, including household waste that has been collected, transported, stored, treated, disposed, recovered (e.g., refuse-derived fuel) or reused is a solid waste but not a hazardous waste (even if the household waste exhibits a characteristic of hazardous waste).
- In order for household waste to be exempt from regulation, it must meet two criteria: the waste has to be generated by individuals on the premises of a temporary or permanent residence, and the waste must be composed primarily of materials found in the waste generated by consumers in their homes. (49 FR 44978, November 13, 1984)
- No hazardous waste determination is required on household hazardous wastes (unless or until ash is generated from the combustion of household hazardous waste when it exits the combustion building following the combustion and air pollution control processes (60 FR 6666, February 3, 1995 and RO 11901)).

Q: Can solar panels be managed as a scrap metal under the scrap metal exclusion of 40 CFR 261.6(a)(3)(ii)?

A: Solar panels typically cannot be considered a scrap metal since they are not more than 50% metal. The non-integrated components of the solar panel (e.g., wiring, frames, etc.,) that are more than 50% metal that can be legitimately recycled could be removed from the solar panel and managed under the scrap metal exclusion of 40 CFR 261.6(a)(3)(ii).

Accumulation

Q: Can hazardous waste solar panels be accumulated and/or consolidated with universal waste?

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

If the solar panel that can no longer be used for its intended purpose is determined to be hazardous waste, all applicable hazardous waste requirements apply. Accumulation time limits vary with generator category. 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. See the "Generator Category Guidance" document on the Hazardous Waste Section website at the following link for information determining the hazardous waste generator category based on threshold amounts of a hazardous waste generated in a calendar month and/or maximum amount on-site at any time.
https://files.nc.gov/ncdeq/Waste%20Management/DWM/HW/Guidance%20Document%20table%20documents/2018/Generator%20Category%20Guidance.pdf

The following guidance document provides a summary of the hazardous waste generator requirements for the three hazardous waste generator categories:
https://files.nc.gov/ncdeq/Waste%20Management/DWM/HW/Guidance%20Document%20table%20documents/2018/Summary%20of%20Generator%20Requirements.pdf

Other North Carolina hazardous waste guidance documents can be found at this link on the Hazardous Waste Section website:
https://deq.nc.gov/about/divisions/waste-management/hw/technical-assistance-education-guidance/documents

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 hazardous waste category.

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?

A: Whether broken or intact, if the waste is disposed, a waste determination in accordance with 40 CFR 262.11 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: Check with your local government to see if they have requirements associated with solar farms. 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 list of elements could 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 farm:

- 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 can 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/recycling 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:
https://deq.nc.gov/conservation/recycling/deacs-recycling-staff