MARYLAND COMMISSION ON CLIMATE CHANGE

# The Solar Photovoltaic Systems Recovery, Reuse, and Recycling Working Group

## Meeting Minutes

Monday, July 15, 2024, 1:00pm-3:00pm E.T.

Meeting Location: Online via Google Video

**Attendees**

| **Member Names** | **Affiliation** | *Present* |
|---|---|---|
| Sen. Benjamin Brooks | Senate of Maryland | X |
| Del. Mike Rogers | Maryland House of Delegates | |
| Tyler Abbott, Chair | Maryland Department of the Environment, designee | X |
| Evie Schwartz | Maryland Energy Administration, designee | X |
| Josh Kurtz | Maryland Department of Natural Resources, designee | |
| David Chy | Public Service Commission | X |
| Diana Menendez | Chesapeake Climate Action Network | |
| Pearl Donohoo-Vallett | Pepco Holdings | |
| David Beugelmans | Gordon Feinblatt, LLC | X |
| Stacey Onoh/Oriaifo | Exelon | X |
| Scott Elias | CleanCapital | X |
| Bob Sadzinski | Maryland Department of Natural Resources | |

**Non-members**

Stephanie Vo, Andrew Grenzer, Ben Maier, Benjamin Brooks, Bradley Phelps, Carrie Anne Klein, Cliff Engle, Dave Mrgich, David Comis, Diana Reighart, Duwane Rager, Ed Dexter, Ed Hammerberg, John Miller, Kathleen Kennedy, Kristin Fitzgerald, Morgan Mills, Nicole Butler, Noun Sekhpossian, Phoebe O'Connor, Bob Nicholson, Sabrina Fu, Sahle DeMessie, Steve Hellem, Duwane Rager, Mariia Liubarskaia, Victoria Nellis, Desmond Gladden, Ashlee Treece

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## Roll Call and Meeting Overview - Decommissioning Solar Panels Recycling Markets & Reuse Markets

- Tyler Abbott completed roll call of members

## EPA Solar Panel Recycling Presentation, Endalkachew Sahle-Demessie

- This presentation will be focused on the model EPA developed for the flow of end-of-life (EoL) solar panels to help forecast how much scape panels there will be
    - The presentation will also touch on what are the drivers and barriers for sustainable recycling, handling and management
- Renewable energy is growing and the US has an advantage due to the amount of open land and resources
- Federal and state policies can give incentives to promote adoption and growth of solar energy generation
    - Costs for renewable and solar energy are decreasing
- EoL could be an eco-disaster waiting to happen or an opportunity
- EPA Model that develops the mass and composition of panels over the next 20-30 years
- There are many different types of solar PV modules and the technology has evolved over time
    - Most common are mono- and polycrystalline silicon (currently about 80% of solar panels installed)
    - The more complex and robust the design of the panel, the more difficult it is to dismantle and recycle—panels are not being designed to be recycled
    - Generations of modules are made of different components
- Solar panels contain heavy metals, which can be health and environmental safety issues at high levels, so they must be properly handled
- Circular economy of solar panels includes more than recycling; includes reducing materials, maintaining, etc.
- The guiding methodology for EPA's model comes from the International Renewable Energy Agency (IRENA)
    - Basic methodology steps
        - Determine PV capacity that is already installed
        - Convert PV capacity to mass
        - Estimate the probability of panel loss (using expected life time)
        - Multiplied the panel loss by assumed panel weight
- Important to consider what percentage of panels come from residential and commercial sectors
- There are many different reasons to decommission panels, such as damage, manufacturing issues, installation issues, etc.
- Some general model assumptions
    - Fixed 30-year lifetime for all generations of panels
    - Used Weibull Probability Distributions to model panel life
- Residential panels are usually lower in weight compared to commercial panels
- For the top states under the regular loss scenario, EoL panels start to increase more rapidly around 2030
- Maryland contributes to about half of EPA Region 3's estimated loss
- The low levels of recycling we see is primarily due to technical feasibility of recycling
    - Other challenges include need for processing and recycling plants, policies and programs for EoL management, and demonstrating the economic benefits of PV recycling

## EPA Universal Waste Update, Phoebe O'Connor

- Part of the EPA's Office of Resource Conservation Recovery
- Universal waste regulations: alternative management pathway for hazardous waste under RCRA (Resource Conservation and Recovery Act), which are designated by EPA or by states

- Currently there are five universal waste categories
- Petition from 10 utility industry associations in November 2021 to add solar panel universal waste category (some states have already done this, like California and Hawaii)
- Experiencing difficulty determining whether a panel is hazardous at EoL
    - Hazardous materials are unevenly distributed throughout the panel, so it's hard to get a representative sample for TCLP (toxicity characteristic leaching procedure)
- We understand that many panels might not be hazardous at EoL, but it's difficult to to make that determination
- Currently drafting the rule (began working in October 2023), will publish proposed rule in June 2025
    - Schedule for rule making can be found in the unified regulatory agenda
    - Rule must go through OMB (Office of Management and Budget), so the election could affect timelines

## Discussion

- John Miller: As a note, 25 years is the standard warranty for solar panels. The lifetime of a solar panel is more tied to site control limitations (length of a lease) or required decommissioning timeframes imposed by utilities or the state, rather than the efficiency of the panel in the later years.
    - Also, poly / mono silicon panels are the primary technology used here in the Mid-Atlantic. Thin film modules are largely used on the west coast in areas of high temperature and large available land areas. I would not anticipate much utilization of think film technology here. The mono / poly modules do not include the metals, such as cadmium, that are sometimes in thin film modules
- Sahle Demessie: I agree with John Miller. PV system reliability is dependent on many factors which makes it challenging to model PV system and component lifetimes. In the literature, several factors have been leveraged to model system and component lifetimes. We used the current average PV warranty period of 30 year. Using this fixed lifetime assumption in a model involves a simple time shifting from deployment, which is mathematically simple and provides a rough estimate of mass flow over time.
- Steve Hellem: Sahle, are you beginning to see comments that suggest that at the end of life of a solar farm that the ground on which the panels were placed can no longer be used for agricultural purposes. Thanks, Steve
- Scott Elias: Steve, that should not be the case. Solar can allow land to recover since soil can be improved by planting native grasses/pollinators and effectively letting the soil rest. In the future, when a solar project is decommissioned, farming can once again resume on that land. This is a stark contrast to other development, which often leaves land unusable for agriculture. This may be a useful factsheet about solar and agricultural land.
    - https://www.seia.org/research-resources/solar-agricultural-land-use
    - https://www.seia.org/sites/default/files/2019-11/Solar%20Ag%20Land%20Usage%20Fact Sheet%202019-PRINT.pdf
- Sabrina Fu: To add to what Phoebe is sharing, the test to determine hazardous waste is TCLP and the process makes it difficult to consistently have the same surface area for the test. The test is essentially placing 100 grams of the waste that is less the 3/8" into acetic acid and tumbling and then examining the leachate after a period of time....As you can imagine, it is hard to break down solar panels consistently into the same sizes of less then 3/8" diameter

## Solar Recycling, University of Maryland Global Campus Capstone Projects, David Comis

- Not speaking for the Maryland Energy Administration
- Projects considered factors that should be taken into consideration for siting a solar recycling facility in the Mid-Atlantic

- Study scope includes:
    - Looked only at modules for commercial applications
    - Looked only at silicon-based solar modules (95% of market)
- Four potential options for panels coming offline, regardless of module materials: immediate reuse, recertification, repair, full recycling
- Immediate ruse doesn't require repairs or replacement and reduces transportation and handling; market here is small
- There are different tests that can be completed for module refurbishment and recertification
    - I-V (current vs voltage) Curve
    - Infrared Imaging (thermal scan)
    - Advanced stress testing
- Testing facilities need to be able to work with different sized modules
- There are many questions to consider when recertifying and repairing modules
- In the recycling process, EVA (ethylene vinyl acetate) is the biggest challenge
    - Very stable, adheres to glass, solar cells, and backsheet
    - Produces toxic gas when burned
    - New technology being developed to get around this issue
- Factors that should be considered when siting a recycling plant
    - Method of recycling, Modes of transportation, Size of area, Proximity to raw materials market, Disposal of waste products, Taxation and incentives, Cost vs. landfill, Workforce
- Inspection could occur at:
    - Mobile testing center
    - Regional testing centers near large solar arrays
    - Centralized recycling center
- Repairing, refurbishing and reusing can push out the wave of EoL solar panels coming into the 2050s
- Potentially consider offering incentives to companies or resellers for second hand modules, potentially growing this market
- Limiting damage during decommissioning and transportation is a big concern

## Discussion

- Tyler Abbott: Do you have an idea about how much capacity out there for recycling? How much expansion do we need to be successful?
    - Bob Nicholson: SEIA operates a recycling partnership program. The intention of the program is to identify companies that (1) have legitimate processing capability and (2) have an appropriate capacity. Currently, the program has 12 recycling partners, which represent about 10 million panels of recycling capacity per year. We expect our partners to double over the next year and put us in the mid-20 million range of annual capacity. The number of companies reaching out is growing exponentially. We have a backlog of companies that want to be partners and we'll be conducting the vetting process, but we have a secondary list of companies that we don't have time to review.
        - Currently, one big challenge for recyclers is finding the volume to recycle. None of our recyclers are near capacity.
- Abbott: Is the volume we're experiencing, the volume we were expecting in 2024?
    - Nicholson: The volume just isn't there yet when you consider that 80% of all deployed solar today has been deployed in the last 7 years. It's hard to make capital investments when business that would come to you won't come for another 5-10 years. As we see volumes tick up, I expect the recycling capacity to grow.
- Abbott: How large are the facilities for processing?
    - Nicholson: Processing facility floor and equipment is surprisingly small – the space requirement is the storage portion. There's a concentration of recyclers in the southwest, and they all have a significant amount of outdoor storage.

- Comis: This study looked at a regional approach and not a state approach. Whichever state gets the recycling facility, gets the jobs. But if you break it up and have different warehouses that do the sorting testing, recertifications, you can do jobs in multiple locations. The initial load of solar is going to come from VA and NC, so an initial thought is to have a warehouse along the rail corridor in southern VA. To get volumes to support recycling, we need to take a regional approach.
- Abbott: As we look at different recycling programs across the board, regional approaches help with scale and efficiencies.
- Sen. Benjamin Brooks: What do you mean by "cleaning" - are you suggesting that solar panels should be cleaned periodically to enhance performance?
    - Comis: In the field, there is a normal maintenance procedure depending on how much rainfall you get. But I was referring to the first thing that should be done after the panel is removed from the field to start the testing process for repair/recertification. You can lose 1-4% just due to dust and dirt on the panel.
- Sen. Brooks: So the viability of repairing, could one make an argument that it would make more sense to just replace a particular panel instead of repairing it, due to cost?
    - Comis: As the students looked at it, there were very few repairs that made economic sense. But there might be new techniques that allow you to repair the modules without having to remove the glass and EVA layer. There is a very small subset of repairs that make economic sense right now.
- Demessie: There is a lot of study about extending the service life of panels, at least by 10-20 years. This could be done by enhancing PV reliability and improving the electronics. Even when the panels are decommissioned they are still 80% efficiency of when they were installed. There are current studies on scenarios about if lifetimes are increased to 50 years, will that decrease the need for raw materials and how reliable and feasible is that.
- Comis: Do these studies show what tests need to be done at EoL to ensure that the solar panels won't fail?
    - Demessie: It's not necessarily technical reasons that panels are retired, it's mostly business reasons.

## Public comment

- Ed Hammerberg: Could EPA talk about the Issue of whether panels from residential settings are going to be considered household hazardous waste and is it on the same timeline as the universal waste ruling?
    - Kristin Fitzgerald: Under review and consideration. This will be part of the universal waste rulemaking.