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

Meeting Minutes

Monday, October 21, 2024, 1:00pm-3:00pm E.T.

Meeting Location: Online via Google Video

Attendees

Member Names	**Affiliation**	*Present*
Sen. Benjamin Brooks	Senate of Maryland	
Del. Mike Rogers	Maryland House of Delegates	X
Tyler Abbott, Chair	Maryland Department of the Environment, designee	X, Bradley Baker
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	X

Meeting Overview and Roll Call

- Bradley Baker introduced the meeting and took roll of members

First Solar - Karen Drozdiak

- Largest American solar manufacturer for thin film Cd-Te solar panels, founded 25 years ago
  - Manufacture in Ohio, Alabama, and soon in Louisiana
- Established first global recycling program in 2005
  - ~400,000 metric tons solar panels to date recycled
  - Closed loop semiconductor to reuse in solar panels
- Circularity across product lifecycle
  - 90% of materials recovered through recycling
- Recycling facilities are scalable

    - Today is mostly manufacturing scrap (because of panel lifetime)
- Recycling services
    - Pre-funded recycling
        - Cost of recycling is at sale
        - Works for products with short lifetime
        - +30 years - makes more sense to pay for recycling closer to end of life
            - Pay as you go
            - Scalable to meet future needs
- Recycling process
    - 5-10% that can't be recovered are made of glass fines created through mechanical crushing process
    - Cd-Te refining is done at a separate facility
- First Solar has improved its recycling process over the years
- High-value recycling R&D
    - Partnered with ReMADE, universities, national labs and other organizations
    - How to close the loop on materials like glass and aluminum to come back into solar supply chain
    - Trace materials with high value
- PV Recycling history
    - Voluntary programs in Europe encountered free rider challenge before mandatory WEEE
    - Recycling standards are increasingly being created
- EPEAT Ecolabel
    - Created in 2020
    - Addresses entire lifecycle of solar product, includes recycling
    - Organizations must have an inhouse solar recycling program
    - Criteria for environmentally responsible products
    - Only recognized ecolabel by EPA for solar for public procurement
- Assessing worst-case risks from improper disposal
    - CdTe does not need unique EoL management requirements
    - Comparable to Crystalline Silicon
- Hazardous waste requirements
    - Cannot determine whether a panel is hazardous based on tech, rather it requires in TCLP test
- Lessons learned
    - High value recycling is important for all technology
        - Can be facilitated by ecolabels
    - Recovering mass fractions like glass and frame, but important to get semiconductor and materials
    - Pay as you go is more cost effective due to long lifetime of solar panels
    - Make it easier to facilitate transportation across state lines to recycling facilities
        - Out of state recycling might make it more affordable for end users
- Bradley Baker: Reverse logistics? What are some things you want to see in policy?
    - Karen Drozdiak: We're recycling and manufacturing the product.
        - Things that would help is ensuring that recyclers are ready and able to accept them then they should be able to be sent to the recycler.
- Bob Nicholson: Is First Solar receiving broken panels for recycling?
    - Drozdiak: Yes, the only challenge is something that includes mixed debris, which we can't recycle.
- Scott Elias: How does First Solar view EPR policy models?
    - Drozdiak: WA state is a good example for why EPR doesn't work for this industry because of the lifetime of panels. It's hard to enforce due to foreign manufacturers - it would ultimately burden domestic manufacturers. When selling to independent power producers and utilities, who have experience with decommissioning, makes more sense to allow for contractual decisions around recycling rather than mandating that the

manufacturer pays for it. Solar generates revenue throughout its lifetime, so makes more sense to pay for recycling closer to end of life.
    - We only sell at the utility scale; residential is a little trickier
- Shannon McDonald: Where is the best way we can capitalize on bringing those panels and materials to the east coast? Have you thought about expanding within the very south southeast or northeast region? Have you considered any modular processing operations to handle the spike that wouldn't have to be a permanent operation long-term?
    - Drozdiak: Closest would be the Alabama facility or Ohio facility. Recycling costs will vary depending on how far away the project site is from recycling facilities.
        - We are thinking of expansion, we are looking at where are the largest number of panels will reach EoL the soonest - this will be mostly on the west coast.
        - Modular recycling facilities is an option for the future, but we haven't made any decisions yet on that front.

Solar Cycle - Pablo Dias + HG Ventures, Kip Frey

- Solar startup launched in 2022
    - CE company to make best use of solar EoL
    - To create circular market
- Factors for solar CE
    - Need more solar
    - Media perspective on solar industry
    - Learning rates
    - Recycling advancements
    - Offtaker market
- To meet net zero goals, 15-60 terawatts of installed solar will be needed
    - This will require more resources
    - Aluminum is a huge market
- If solar is handled properly at EoL, it won't be an issue
    - Communities are misinformed about solar panels
- Outputting more energy with less material
    - Material consumption per unit of power has decreased consistently
- Increasing recycling rates
    - Getting better at collection, pre-processing and end-processing
- Competing with two things
    - Landfill - cost to landfill is cheaper than recycling
    - Recyclers - "sham" recyclers around the world
- Is CE possible? How relevant is recycling to future solar panel production?
    - Research shows that newly mined silver is not needed in the future, if recycling rates are increased
- 2nd hand PV farm right next to Solar Cycle facilities
    - About to open new facility in Georgia
    - Recycling and 2nd hand PV farms, and rolled PV glass manufacturing
    - Rolled glass mostly come from China
- Offtaker market to take the material after recycling
    - Not enough to have recycling process, we need someone to take it and use it
    - Plastics is a difficult material to reuse - this is a gap in the market
    - Some offtaker markets for low iron glass: solar, electronics, construction/architecture, automotive, fillers, aquariums, packaging
- HG Ventures
    - Invested in SOLARCYCLE
    - Questions from investors: Is there a market for solar panels and will recycling take place?
        - Warranties are based on power degradation
        - Repowering, panels have become more powerful over the decades

        - Seeing way more solar panels than we expected due to transportation damage, installation damage
        - Can panels travel through the interstate? → relevant for policy
        - Is landfilling allowed in your state? → needs to be interstate coordination
        - Product stewardship in place?
- Baker: Has SOLARCYCLE considered getting into reuse?
    - Dias: We have the secondhand life farm. Issue with reuse is there's a big difference between reusable and resellable. There's a big market in the US to buy reused panels and send them overseas. Once panels go overseas, there's a lack of oversight and infrastructure there. We've seen this play out with e-waste. Best way to reuse is to reuse domestically but it's hard to do because the cost of new panels have decreased and the power efficiency has increased dramatically, so old panels don't have the same appeal as the new ones.
- Elias: Could you speak to your experience in Washington and California with EPR? And how you view policy constructs for customer-owned vs noncustomer owned modules?
    - Dias: EPR has success cases and non-success cases
        - Key thing is to keep whatever policies in place flexible
            - Rapid technology change
                - Examples is a lot of panels don't have lead anymore
            - Wide range of solar panels and different sectors need different solutions
                - Hard to do bulk reverse logistics in households
                - EPR for exclusively for household rather than utility
                - Don't go against that is already working
                - Who are the asset owners? Most asset owners have been going to recycling
            - Costs and quality
                - Set a bar with recycling quality
                - About 40% of revenue comes from aluminum frames and people will try to capitalize on this
            - Low-cost solar programs for encouraging solar
- David Comis: What percentage of panels are actually reused? Is there a method to recertify panels so that there's belief that it will last 10-15 years?
    - Dias: No certification for this yet. Very little studies around second hand panels. Our knowledge around manufacturing is well versed. Second life panels are actually a world of panels; they could be EoL for a variety of reasons. Amount of solar panels that can be reused varies and is generally very small and not significant: rough estimate would be 15-25% of panels should be reusable.

Policy Discussion

- Two sets of recommendations in the statute
    - Infrastructure needed & financing mechanisms
- Policy ideas
    - Landfill bans - regional and paired with other policy and appropriate infrastructure
        - Beugelmans: From the utility scale perspective, if you look at PPRP's conditions there basically is a landfill ban. Thinking about residential rooftops, what about waste diversion so that county collections people can recognize panels can be diverted to recyclers to make sure it doesn't end up in a landfill.
        - Baker: The recommendation could be: explore the feasibility of this or require counties to recycle, etc.
        - Beugelmans:Some kind of program to get these panels to the right place, like paint collection programs.
        - Baker: Maryland is setting up a program with PaintCare. We did just hear that because of solar's long life, this might not be as comparable of a model.

- Beugelmans: State is incentivizing installation of these systems, which makes solar different. Imposing a fee for recycling might be going in the opposite direction. Some way to take what works without aggressively burdening the industry.
- Comis: Shipments out of state are likely not a huge issue if the other state has a ban too. Likely won't want to do landfill ban without a regional certified recycler.
- Elias: Gradual landfill ban, but need to have viable options before going about a ban. Need to be mindful about how to go about doing a ban.
    - Importance of encouraging actual incentives for bringing recycling facilities into Maryland.
    - WA Department of Ecology is recommending that WA walk back some of their EPR program.
- Dias: Many recyclers do serve the whole US, even if they are located elsewhere and not in the Mid Atlantic
    - Increasing the cost of landfilling is an opportunity. And shipping to another state does have increased associated costs. Announcing a landfill ban for a future date might help the market adjust
- Drozdiak: Manufacturers were deciding not to sell in WA. Part of the reason we co-locate recycling facilities with manufacturing facilities is we want to create steady flow of materials.
- Baker: You're vertically integrated, but if you have a surplus of material would you sell to other solar recyclers?.
    - Drozdiak: We do sign agreements with other recycling companies. We've designed our recycling facilities to be more than any manufacturing facility and not operating at maximum capacity, since we're not seeing those high volumes come back - which is expected beyond 2030
- Comis: Students did take a look at recycling facilities siting, and NC was the best next place. Another thing we were looking at is when would we expect to see the peak in this region? 2035 - so we have a little more time with this ban and find the financing and structure.
- Nick C (SOLARCYCLE): Worked closely with WA State. Unless there's a fair amount of volume of EoL modules – any program will struggle and instate recycling is not viable. We are supportive of a regional approach. We asked what kind of takeback program will be most effective? We found that the volume estimated of panels was low in WA (1-2 truck loads per year of crystalline modules). Hybrid policies that provides collection points for small, residential volumes (like household hazardous waste drop off). Put some recycling requirements into permitting requirements for larger systems - asset owners should have a plan.
- Beugelmans: They do require recycling. One attribute is that the state allows for the cost of recycling to be offset by resale value. Incentive for reuse because they must show a way to resale the panels. Must be readdressed every 5 years.

- Incentives for donations to overburdened and underserved communities?
    - Nick C: Recyclers who touted reuse programs have stopped doing that because the value of second hand panels has dropped so much. Leave it up to the asset owners to see if it's worth it. Graduated bonding framework to spread out costs.
- Baker: If there were to be incentives for regional efforts to bring in solar facilities? What would that look like?
    - Del. Mike Rogers: I don't know specifically, NCSL (National Council of State Legislatures) might be a helpful place to look
    - Nick C: DOE has provided regional incentives for hydrogen hubs, maybe something like this for solar would be helpful
    - Elias: The New Jersey solar recycling commission report recommends incentives but they didn't actually implement any yet to my knowledge

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    - Requiring Certifications
        - Drozdiak: SERI mentioned that there are no solar recyclers that are certified yet. For manufacturers, include EPEAT, which has requirements around recycling with percentages.
            - Baker: Would that include post-consumer recycling?
            - Drozdiak: They do have recycled content criteria, currently are optional
            - Dias: Word of caution about mass based requirements for solar panels: ~90% of the mass is basically glass and aluminum. So mass targets by themselves can backfire. This is specific to solar panels
        - Elias: Many different certifications up and coming. Need to be clear about the multitude of certifications that are available.
        - Nick C: We want standards that encourage high value recycling, i.e. recycling of the semiconductors. The R2v3 doesn't really do that, just emphasizes the quality of output streams. SOLARCYCLE's goal is to certify with ISO.
        - Drozdiak: EPEAT is globally recognized and the only EPA recognized certification for solar procurement.
    - Stewardship organizations? Potentially for the residential side only.
        - Elias: CA is talking about differentiating non-customer owned and customer-owned - maybe a fee for customer-owned?
        - Nick C: Something we're talking about Minnesota and California. Split the market a bit to create a system that can be used for residential to coordinate residential pickup. Our preference is to allow bigger projects to have an agreement with recyclers. Product stewardship organization would be helpful as coordinator at a residential/smaller scale.
    - Reuse/donation
        - Drozdiak: Be careful with providing incentives for making the waste someone else's problem. The cost is in the recycling and treatment of panels.
        - Nick C: It's fine as a legislative intent if they say "we want to do this" but would avoid mandates. Decisions should be made at the asset management level, so that they can use their knowledge about the panels.

Public comment

- No public comment