



# Solar and Battery End of Life Study

Prepared for Connecticut Green Bank / Working Group Meeting

July 17, 2024



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# 1. Introductions

# Introductions

Power Advisory is pleased to be leading these Working Group meetings in conjunction with CT Green Bank

Our goal for each working group session is to provide clear information to members, and make sure feedback and perspectives of members are incorporated into our recommendations and deliverables to CT Green Bank

Meetings will be recorded and posted along with presentations and meeting notes on the working group webpage:

[End-of-Life Working Group - CT Green Bank | Accelerating Green Energy Adoption in CT](#)

Introductions for new attendees (those who didn't attend the prior Working Group meeting):

- Please briefly introduce yourself: Name, Company and Role within the Company

# Working Group Members

Category	Organizations
Connecticut Agencies	<ul style="list-style-type: none"> <li>• Department of Energy and Environmental Protection (DEEP)</li> <li>• Connecticut Innovations (CI)</li> <li>• Office of Consumer Council (OCC)</li> </ul>
Electric Distribution Companies (EDCs) (Utilities)	<ul style="list-style-type: none"> <li>• Eversource</li> <li>• United Illuminating</li> </ul>
OEMs / Developers	<ul style="list-style-type: none"> <li>• Tesla</li> <li>• Sunrun</li> <li>• Enphase</li> </ul>
State Contractors	<ul style="list-style-type: none"> <li>• PosiGen</li> <li>• Skyview Ventures</li> <li>• Harness the Sun</li> <li>• Earthlight Technologies</li> <li>• RWE Clean Energy, LLC (formerly ConEdison Solutions)</li> </ul>
Waste	<ul style="list-style-type: none"> <li>• Battery Council International</li> <li>• Solar Panel Recycling</li> <li>• Ontility</li> <li>• Bluewater Battery</li> <li>• Comstock Metals Corp</li> <li>• Redwood Materials</li> <li>• PRBA - The Rechargeable Battery Association</li> </ul>
Other	<ul style="list-style-type: none"> <li>• Yale University</li> <li>• Tuck School of Business</li> </ul>



# Proposed Monthly Topics

## March 27: Introduction and Objectives Overview

- Overview of working group objectives and review of the Public Utilities Regulatory Authority's (PURA) specific objectives.
- Review of end-of-life technologies and practices in other jurisdictions.

## April 29: Needs Assessment and Policy Landscape

- Current and future needs:
  - Introduction to factors impacting size of solar and battery end-of-life markets
  - Analysis of current demand for solar and battery recycling and end-of-life management services
  - Future market growth opportunities
- Policy and regulatory landscape and business model:
  - End of life management regulatory frameworks
  - Current decommissioning plans and recycling plans
  - Business model and issues to discuss for CT policy

## May 28: Indicative Economics and Funding Options

- Presentation of Indicative Economics for solar panels and batteries
- Exploration of potential funding sources for recycling frameworks.
- Discussion of options

## June 26: Development of Recommendations

- Review and finalize recommendations.
- Outline steps for the preparation of the final report to PURA.

## July 17: Finalization and Report Preparation

- Discuss next steps, including further research areas and/or legislation.
- Formal closure of the working group sessions.

# Discussion Format

- During the discussion portion of today's meeting:
  - To contribute to the discussion, simply raise your virtual hand
- After today's meeting:
  - Power Advisory and the Green Bank will finalize our report and submit it to PURA

## Requests of Working Group members:

- Active Listening
- Engaged Involvement
- Time Conscious
- Agenda Adherence

## 2. Review of Recommendations and Q&A



# Stakeholder Feedback on Recommendations

- The complete draft report was circulated to working group members on July 3, with feedback due on July 12
- We received feedback from five working group members: PosiGen Solar, United Illuminating, Ontility, Redwood Materials, and DEEP
- Feedback included both comments on/recommendations for relatively minor clarifications or tweaks to the report, as well as a smaller number of more substantive concerns about one or more recommendation(s)
- Stakeholder feedback will, broadly, be incorporated and acknowledged in the report. The main changes that we have made to the recommendations themselves include:
  - Addition of Recommendation 5h, relating to regional coordination of recycling policy (discussed further below)
  - Minor changes to the wording of Recommendation 5c to more accurately characterize the EPA process currently underway with respect to its universal waste rule

# Recommendation 1: Segmentation

- We recommend that distinct solutions be designed for each of residential-scale solar, commercial-scale solar, and stationary battery energy storage systems
- Due to the vastly different economics involved in recycling solar panels compared to recycling batteries, different end-of-life management options are likely necessary for each technology. Our conclusion is based on the following observations:

Observation	Implications
Economic dynamics	<ul style="list-style-type: none"><li>• The residual value of solar panels and batteries significantly influences the recycling cost</li><li>• Recycling cost is the primary determinant of the feasibility and desire to recycle for manufacturers, consumers, and recyclers</li><li>• The feasibility and desirability of recycling are crucial factors in the success of any end-of-life management framework</li></ul>
Technology-specific considerations	<ul style="list-style-type: none"><li>• Different technologies involve distinct economic considerations, leading to different incentives and feasibility issues</li><li>• Therefore, end-of-life management options should be tailored to specific technologies</li></ul>
Customer segmentation	<ul style="list-style-type: none"><li>• Customers' ability to recycle varies, necessitating further segmentation into residential and commercial categories</li></ul>

# Recommendation 2a: Residential-scale Solar



- Recommendation: Connecticut should adopt an advanced fee administration (AFA) model for residential-scale solar installations
- Assessment:
  - A fee would be assessed to one or more parties (e.g., ratepayers, manufacturers, panel owners) in advance of recycling (e.g., at the time of system installation, purchase, or energization) to cover the cost of recycling, or collection and recycling, of small volumes of solar panels
- Justification:
  - Residential-scale installations, and particularly host-owned panels, present several challenges that can be mitigated by AFA:
    - Volume of panels available for recycling from a single source is, at present, low and sporadic
    - Dispersion of panels across individual properties means higher transportation costs
    - Unwillingness or inability of individual homeowners to pay for disposal/recycling costs at end-of-life

# Recommendation 2b: Residential-scale Solar



- Recommendation: Connecticut should require third-party-owned residential-scale systems to have formal end-of-life protocols
- Two models for residential solar installations have been observed:
  - Host-owned – homeowner owns system; may use installer, who may or may not have responsibility for removal
  - Leased/third-party-owned systems – lessor is responsible for removal of system at end-of-life
- Notwithstanding their deployment at residential sites, third-party-owned residential systems also bear some similarities to larger-scale projects, insofar as the third-party owner:
  - Owns a large number of panels
  - Has an established network of labor/employees for installation, and likely removal, of panels, and may have specialized logistics infrastructure for transportation and storage of panels
  - Deploys panels under contractual arrangements, which may provide a convenient opportunity to introduce requirements for recycling
- While lessors have various obligations to the site host at end-of-life, ensuring panels are actually recycled after they have been removed is not necessarily a contractual or legal obligation
- Formal end-of-life protocols should therefore be developed and introduced for third-party-owned systems, e.g., requiring owners to demonstrate that they have an end-of-life management/recycling plan (e.g., via submission to PURA or DEEP)

# Recommendation 3: Commercial-scale Solar



- Recommendation: Connecticut should enhance the present model of decommissioning plans and bonds by requiring the preparation of decommissioning plans that include detail of how panels will be recycled at end-of-life
- Justification:
  - Commercial/utility-scale solar sites have a much larger number of panels and degree of geographic concentration
  - Power Advisory understands that decommissioning plans are often required by lenders or asset owners for such infrastructure, and provide a good framework for end-of-life protocols for the overall site
  - Formalizing this framework in Connecticut would ensure proper management of panels at end-of-life or when facilities are repowered
- Thus far Power Advisory has not observed strong language relating to panel recycling in decommissioning plans, where such plans have even been made available to Power Advisory
  - This seems like a significant shortfall/gap given the potential volume of panels that could be disposed of from commercial-scale facilities
- The Solar Energy Industries Association is developing a decommissioning standard that could ultimately be adopted by one or more states
  - At this time, it is not known whether recycling requirements in the standard will meet the needs of Connecticut
- North Carolina is in the process of introducing requirements around recycling as part of solar farm decommissioning

# Recommendation 4: Batteries

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- Recommendation: Connecticut should adopt an extended producer responsibility (EPR) model for stationary batteries
- In addition, this approach should include:
  - Measures to ensure that end-use customers, installers, and contractors can readily access information about where and how to recycle batteries using existing infrastructure
  - An alternate option for producers to submit an end-of-life plan in lieu of participating in EPR, as long as this plan meets the 'floor' requirements of the EPR framework
- Justification:
  - This recommendation aims to balance several key aspects of battery recycling and Connecticut state goals:
    - Given the value of battery materials, manufacturers are eager to retrieve and recycle the batteries and expect to make a profit in doing so
    - Some key stakeholders from the battery industry expressed strong preference for an EPR framework
    - Others advocated for minimal government involvement, believing that industry-led recycling programs, or market-based approaches, foster competition and are more efficient and profitable
    - Connecticut would aim to become a leader and create a model that other states can follow

# Recommendation 5: Miscellaneous

- In addition to the end-of-life framework recommendations set out above, a number of other supporting policy recommendations have emerged from our research and interviews
- These recommendations relate to both matters of process and next steps for further developing, and ultimately implementing, the respective end-of-life management frameworks, as well as to ancillary or enabling policies that Connecticut may wish to consider implementing in tandem with the end-of-life management frameworks

**Recommendation 5a:** The End-of-Life Working Group should be continued and brought under the auspices of PURA or DEEP. The working group has proven to be an excellent source of insight into many of the themes discussed in this report, and as Connecticut moves through the stages of detailed policy development and implementation, we expect that there will be a continuing need for the working group's input

**Recommendation 5b:** DEEP should launch a process to qualify and publish a roster of state-approved recyclers for batteries and solar panels. This would be an important interim step to allow Connecticut residents and businesses to more readily identify entities that can properly recycle end-of-life batteries and panels, while the formal frameworks set out in the preceding recommendations are being fully developed, enacted, and ultimately implemented



# Recommendation 5: Miscellaneous

**Recommendation 5c:** DEEP should continue to support federal efforts underway that would allow hazardous waste solar panels to be managed under the universal waste rule. Solar panels have been classified as universal waste in some states (e.g., California), a change that is also under consideration federally by the EPA. DEEP should support the EPA's rulemaking efforts that, if successful, would add hazardous waste solar panels to the universal waste regulations (40 CFR 273 - Standards for Universal Waste Management)

**Recommendation 5d:** Connecticut should consider banning the landfill disposal of solar panels and batteries. In particular, at present it does not appear that there is any impediment to landfilling solar panels (provided they can be confirmed as non-toxic). Although batteries may be classified as universal waste, a number of states have taken action to specifically ban landfilling them, e.g., due to fire concerns (e.g., New Jersey). Connecticut should consider the merits and downsides of a similar ban for either or both of these technologies

**Recommendation 5e:** DEEP should identify intermediate recycling steps or solutions that can be taken at the local level. Waste collection in Connecticut is the responsibility of local municipalities, but actual recycling of solar panels and batteries will ultimately take place at a small number of centralized facilities. Intermediate steps to, for example, collect, sort, and pre-treat solar panel and battery waste would be expected to make the eventual recycling of this material more efficient

# Recommendation 5: Miscellaneous

**Recommendation 5f:** PURA should encourage the replacement of solar PV and/or battery storage systems at end-of-life with new systems, rather than simply removal. It is likely that many owners and hosts of solar and battery facilities reaching end-of-life would be interested in having their systems replaced, rather than simply being removed and disposed of/recycled. Assisting such owners/hosts in doing so (for example, by tying system removal to replacement) would likely facilitate their continued enrollment in and use of these beneficial technologies

**Recommendation 5g:** Connecticut should investigate opportunities and means of reusing solar panels and batteries, in addition to recycling. Reuse of this equipment, as opposed to recycling, was not in scope for this study, but there was considerable stakeholder interest in this matter. As a result, we recommend it be formally studied through a separate process, such that equipment that is still useful in some fashion – but which no longer meets the needs of its owner/host – can be repurposed rather than being disassembled and recycled. For example, such investigation might consider if and how second-life equipment could qualify for use in Connecticut programs, and how will second-life equipment would be viewed under whatever end of life management framework is eventually adopted

**Recommendation 5h:** PURA should direct the Green Bank and DEEP to engage with nearby states on developing a regional approach to end-of-life management of solar panels and batteries. States like New York, New Jersey, and Massachusetts are, like Connecticut, early movers on deployment of solar panels, battery storage systems, and other distributed energy resources. Greater coordination between states on end-of-life policy for these technologies would reduce some of the risks of being an early mover, facilitate regulatory harmonization, and potentially also enable better economies of scale, to the advantage of consumers, manufacturers, and the recycling industry. The Northeast Waste Management Officials' Association (NEWMOA) could be a good forum for this engagement



# Audience Q&A Session

# 3. Closing Remarks and Conclusion of Working Group

# Next Steps

- Power Advisory and the Connecticut Green Bank will finalize the complete report, including recommendations, research, and other background materials
- Final report will be delivered to PURA by August 1 in the NRES, RRES, SCEF, and ESS dockets
  - We will notify Working Group members of this filing and publish the final report to the Green Bank [EOL Website](#)
  - PURA may opt to host a Technical Meeting on this subject
- As one of our recommendations pertains to the continuation of this working group, the Connecticut Green Bank plans to provide the names, affiliations, and contact details of working group members to PURA and/or DEEP if and when a determination to continue the working group is made
  - If you do not wish to have your information passed along for the purpose of inclusion in a potential future iteration of this working group, please let us know

# Thank You

Thank you to everybody for your participation in this process, we hope that you continue to be involved as we progress towards sustainable solutions for solar and storage end-of-life



Andrew Kinross

Director

[akinross@poweradvisoryllc.com](mailto:akinross@poweradvisoryllc.com)

(508) 740-9638

Rakesh Puram

Manager

[rpuram@poweradvisoryllc.com](mailto:rpuram@poweradvisoryllc.com)

(202) 641-7855

Avi Lipsitz

Senior Consultant

[alipsitz@poweradvisoryllc.com](mailto:alipsitz@poweradvisoryllc.com)

(416) 294-3117