

PV End-of-Life Management

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Powering the Solar+ Decade



Who We Represent

SEIA Members represent every aspect and vertical within the solar industry (>1000 companies)



Manufacturers



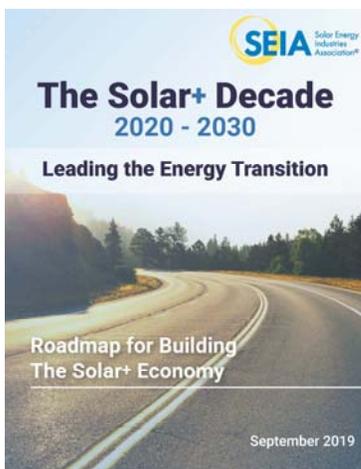
Installers



Project Developers

...and many more!

Roadmap for the Solar+ Decade



SEIA is 100% committed to leading the industry towards radical market transformation in the 2020s.

We will be taking on tough opponents, providing industry expertise and aggressively collaborating with partners that will push us all forward



PV Systems, Storage and Solar Projects



Products

- PV Modules (Silicon, Thin-Film)
- Inverters, energy storage
- Mounting / racking systems



SEIA's EOL Management / PV Recycling Initiative

Member
working
group
(>100
members)

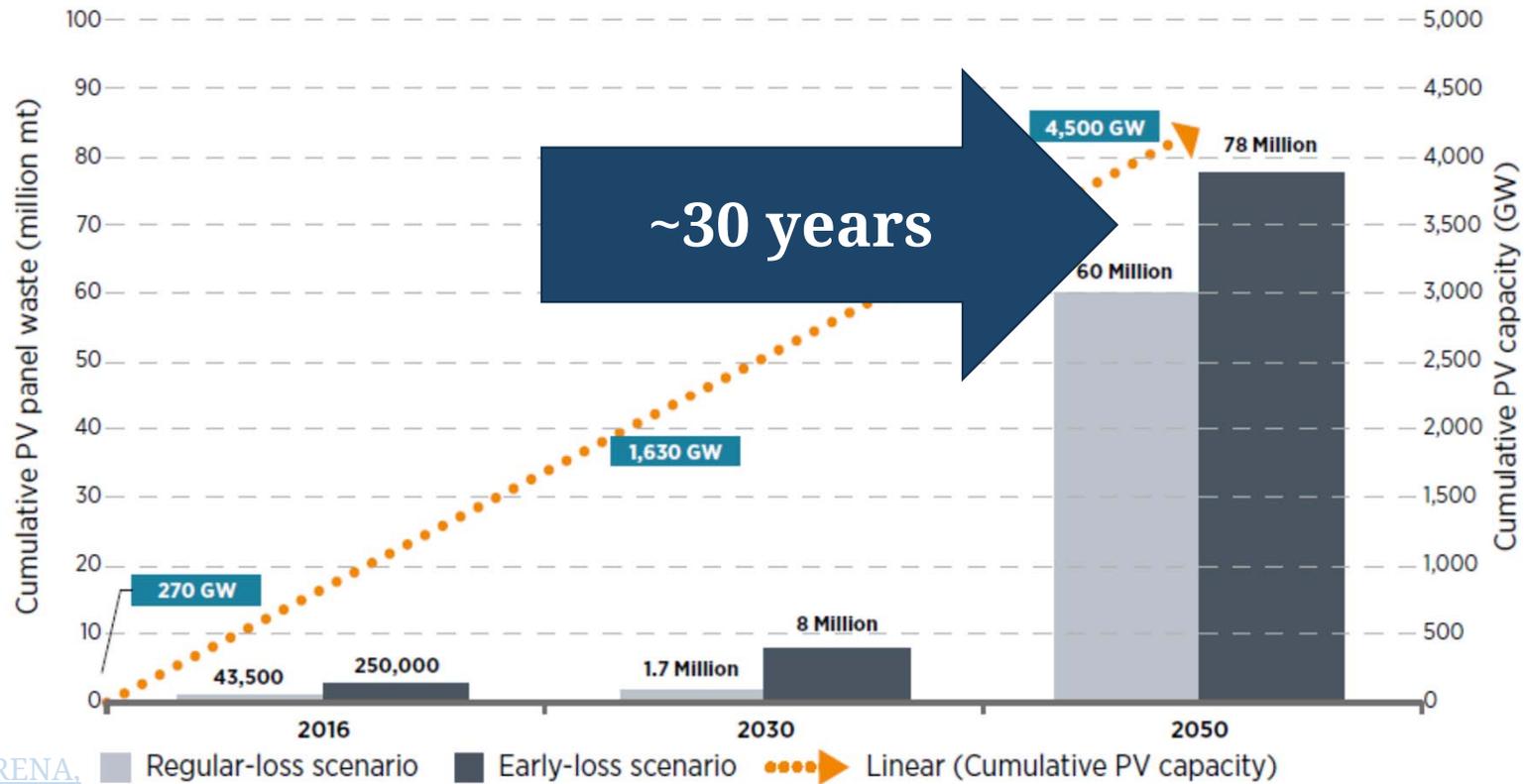
Work
proactivel
y to
develop
end-of-life
solutions

Collaborat
e early
with
stakeholde
rs

Build
reuse and
recycling
resources



Global volume forecast (cumulative)



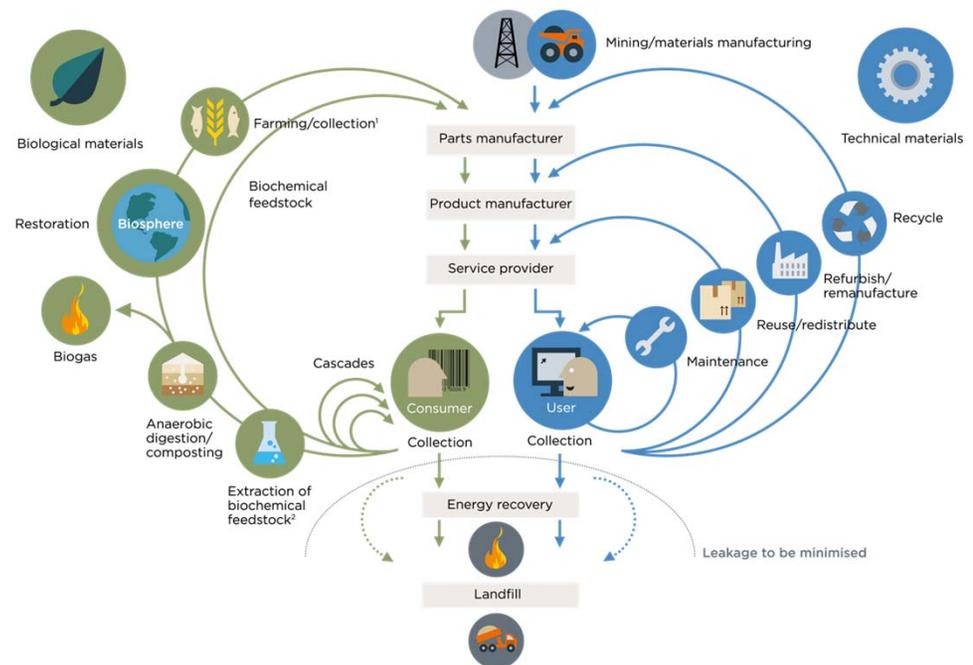
Source: [IEA/IRENA, 2016](#)

■ Regular-loss scenario ■ Early-loss scenario▶ Linear (Cumulative PV capacity)

Circular Economy

- Corporate Social Responsibility: *The Solar Commitment*
- Workforce Development
- Safety & Performance, Solar Codes & Standards
- Quality Assurance & Best Practices
- Operations & Maintenance
- Reuse / Resale
- Refurbish / remanufacture
- Recycling
- Materials

The circular economy—an industrial system that is restorative by design



1. Harvesting and fishing
2. Can take both post-harvest and post-consumer waste as an input
SOURCE: Ellen MacArthur Foundation - Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

Challenges and Opportunities

Design & Manufacture

Solutions for manufacturing scrap

Design innovation for ease of reuse, refurbishment or recycling

Work with suppliers
Improve purity of recovered minerals

Reuse

Create and prioritize reuse above other channels to ensure viable product is utilized

Expand beyond off-grid or charitable / second-market solutions

Potential conflicts with state waste regulations

Refurbishment & Resale

Identify treatments that don't affect module certification

Minimize / eliminate expensive retesting

Training, staffing

Codes and standards

Recycle

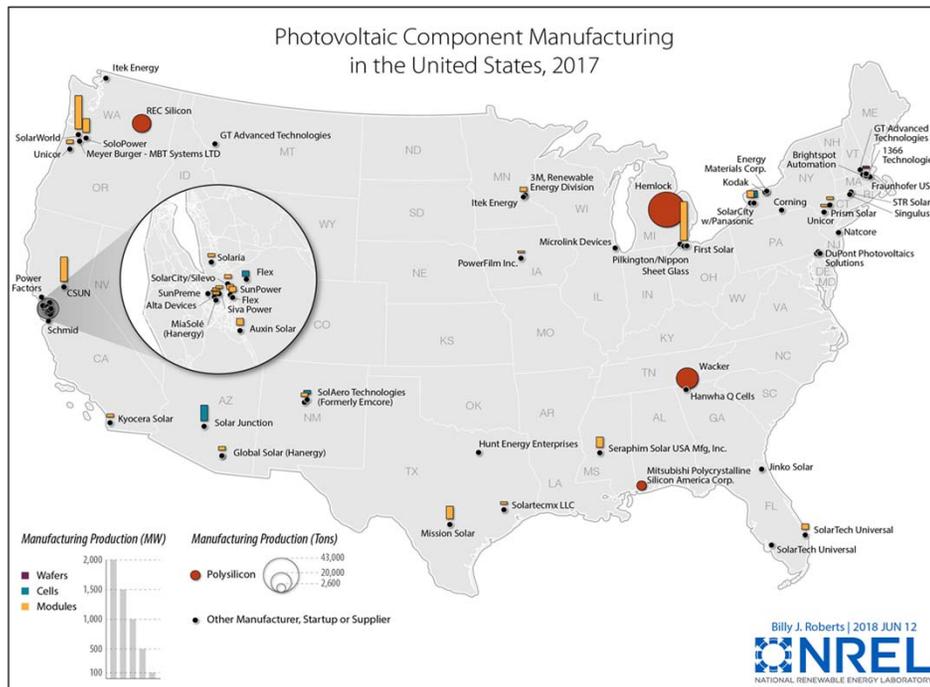
Develop collection in key markets

Minimize costs to encourage recycling

R&D PV recycling equipment to maximize material recovery

Maximize communication to minimize environmental impacts

Today's PV recycled products



Manufacturing scrap



Warranty-related returns



Broken during logistics or handling

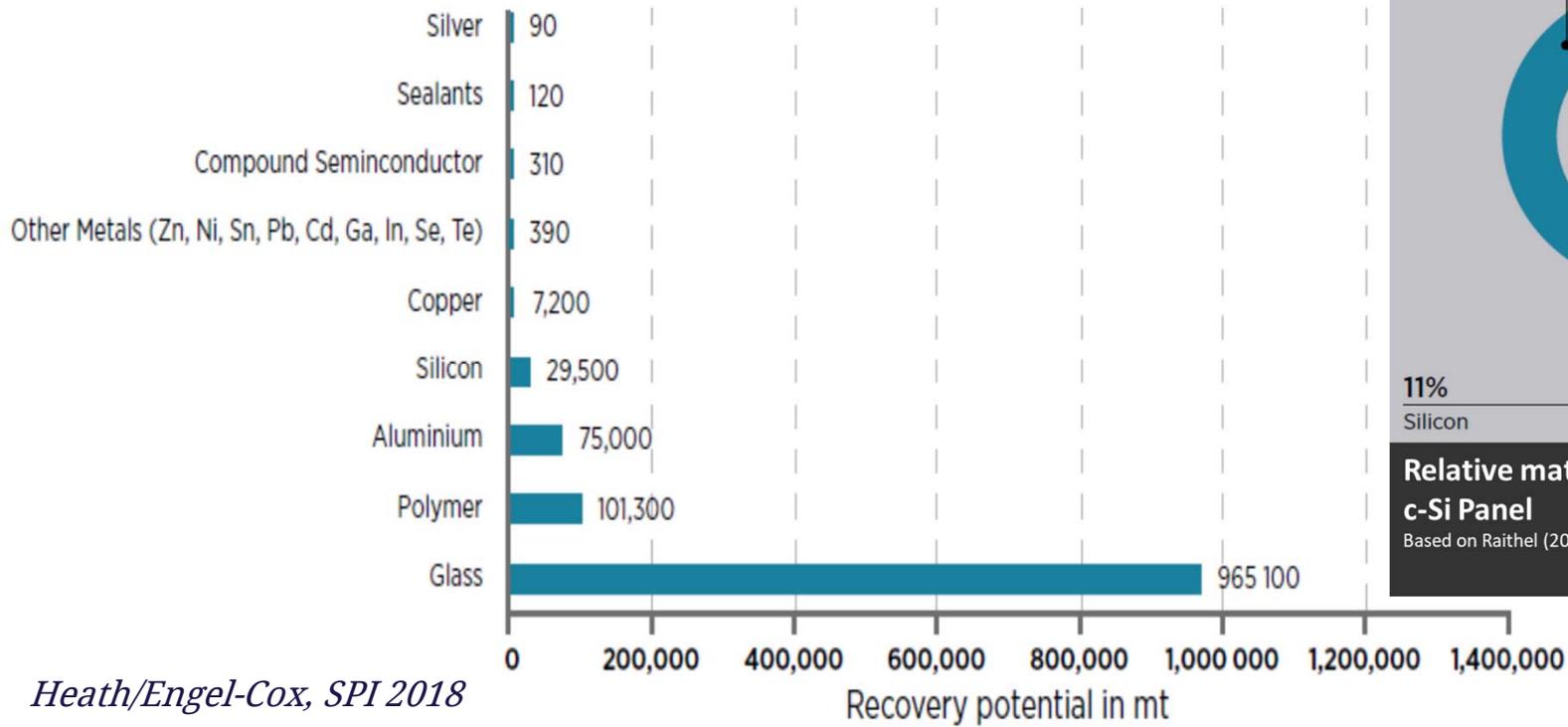


Extreme weather events

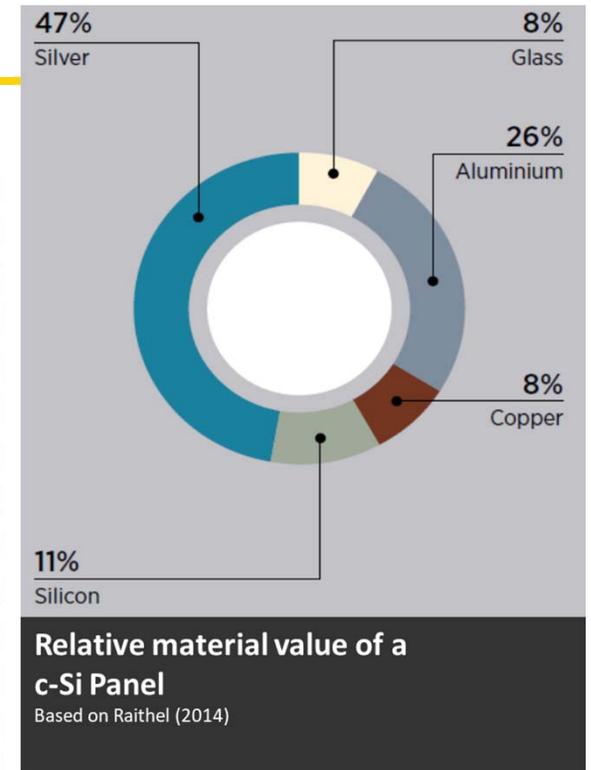


Technology upgrades

Why recycle PV modules?



Heath/Engel-Cox, SPI 2018



SEIA's PV Recycling Program



Member-based program

- Evaluate service capabilities
- Downstream capabilities
- **Anyone** can use these recyclers

Evaluate and develop recyclers

- Members help develop process
- Members help with technology
- Site visit, samples

Collect data

- Weight and volume (est. annually)
- Recovered materials (modeled)

SEIA Recommended Recyclers / Collectors



Partner Qualifications

- Collect and process in the U.S.
 - no exporting of whole products or components
- Accredited by R2, e-Stewards, etc.
- Strive for maximum material recovery / second-life usage
- Specific benefits for SEIA members
- Work sustainably and promote sustainability



EOL Factsheet and Preparation Checklist

- SEIA Website: <https://www.seia.org/initiatives/recycling-end-of-life-considerations-photovoltaics>
- End-of-Life Considerations for PV
- PV End of Life Management: Prepare for recycling PV equipment

PV End-of-Life Management

Prepare for recycling PV equipment

Gather information

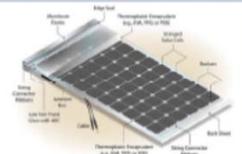
End-of-Life Considerations for Solar Photovoltaics

Engaging the circular economy approach

Photovoltaic equipment and options for first end-of-life stages

The falling cost of solar has made renewable energy accessible to more people than ever before and has resulted in an exponential increase in solar adoption. With more than 400 gigawatts (GWdc) of photovoltaic (PV) modules installed globally (including 62 GWdc in the U.S. through 2018), end-of-life management is important for all PV technologies to ensure clean energy solutions are a sustainable component of the energy economy for future generations.

Like many other durable products and construction materials, solar equipment can last for decades, particularly with proper maintenance. In some cases, PV modules can be reused or refurbished to have a 'second life' of generating electricity. The other components of solar systems can also be handled responsibly. Inverters can be recycled as e-Waste and racking equipment can be re-utilized with newer technology or recycled like other metals.



Reuse

PV systems may be decommissioned for several reasons. Repowering a solar system with newer technology that is more efficient or has a higher nameplate capacity can provide even more electricity from the same amount of space.

The replaced PV modules can be reused in other projects as they may still have plenty of useful life left. Often these modules can find new opportunities in charitable, off-grid or even grid-connected projects, provided they continue to meet the appropriate building codes and safety standards.

(this film, string type, etc.)

ers of each product to be recycled (such as inverters, racking, etc.) will be processed (dismantled, packaged, banded, on pallets, etc.)

ills and other equipment (separate by type of equipment) is required for the shipment

ts (inside, outside, how protected, etc.)

have been stored while awaiting disposition?

lift truck or stacker?

in site or does one need to be brought on-site?

of modules/other equipment the equipment is helpful for advanced preparation of recycling

in storage?

in any way?

mounting rails or pilings?

Have you noted the damage on the modules by serial number?

-similar information

her benefits from our [partners](#)

other entities

a recycler may accept PV modules using

table processing techniques

If it is of concern

t or Stewards accreditation in addition to complying with EPA

struction/recycling for the products sent (COD/COR)

nce (or check if credit is to be owed back to your business for the

lines, check if the recycler complies.

Refurbishment

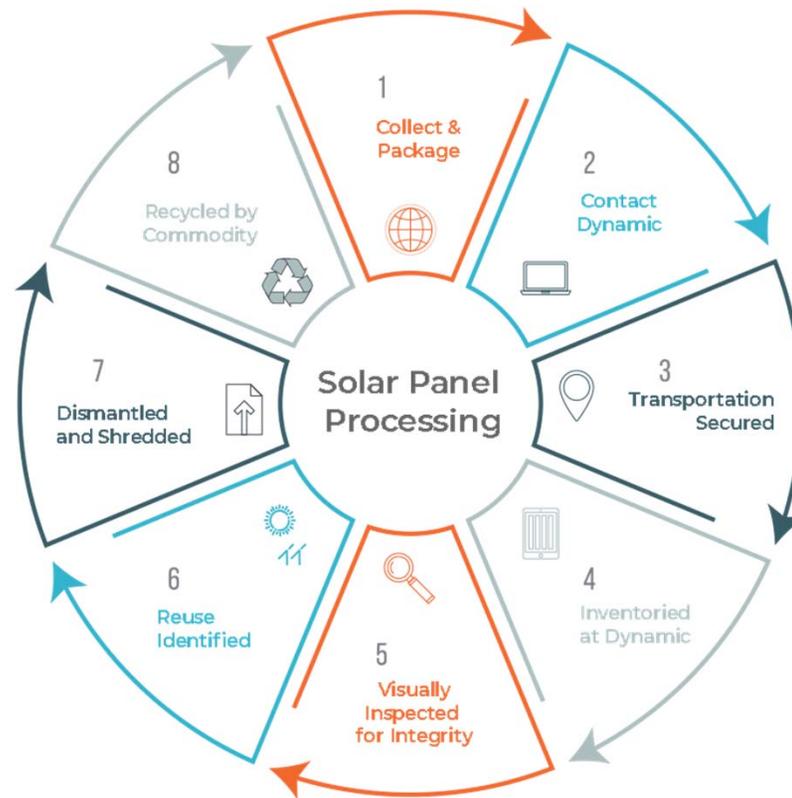
PV modules can be damaged during transit, installation or moving. Some of these modules can be repaired for minor issues and there are several new organizations pursuing this option. If the product is still under warranty, the installer or manufacturer should be contacted to determine if repair is an option. Many modules that are repaired today are often reused in off-grid or non-grid connected applications. While this channel is not as developed as other end-of-life options, SEIA is actively exploring the related options with our members and other stakeholders



www.seia.org

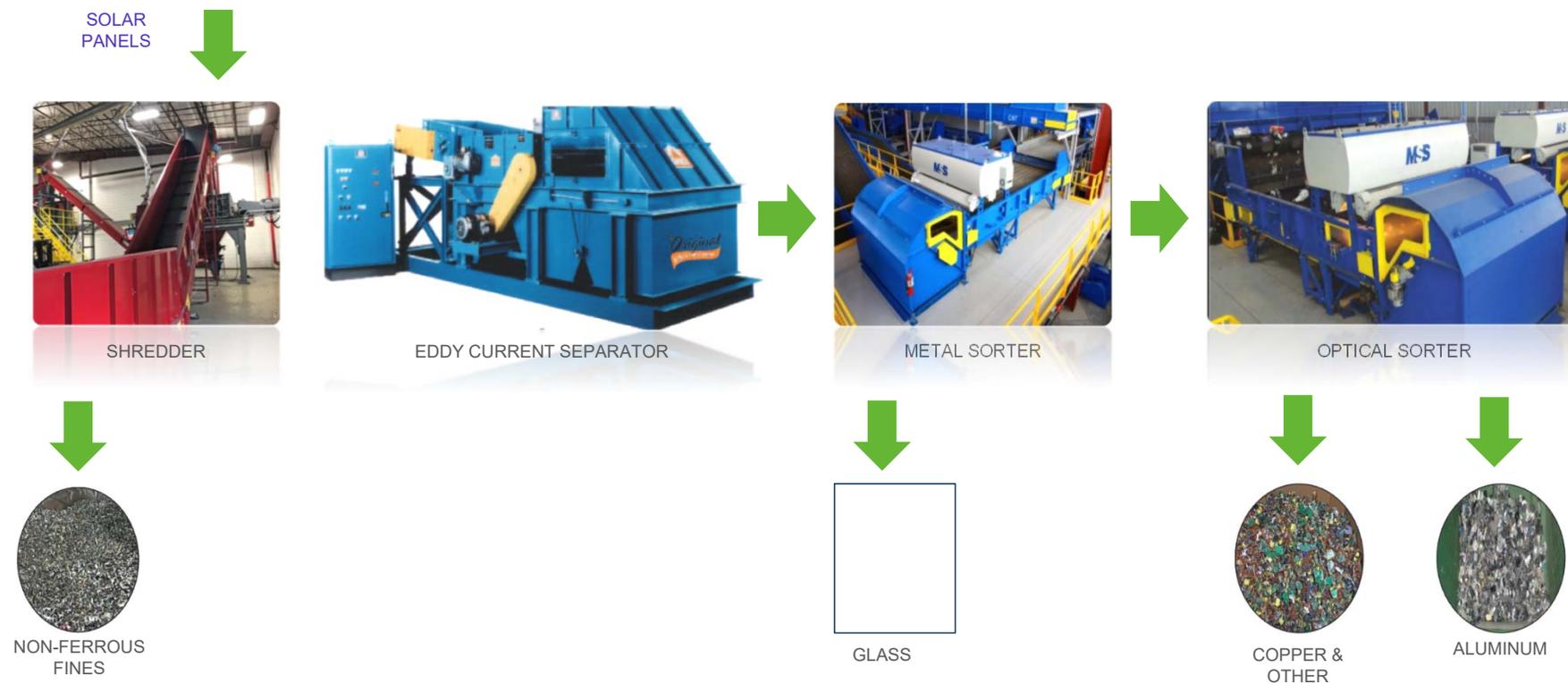
May 2019

Recycling Process (mechanical process)



Graphic courtesy of Dynamic Lifecycle Innovations

Example process



Graphic is courtesy of Dynamic Lifecycle Innovations

Policy Overview

State	General scope	Status
California SB 489 (2015)	Categorizes end-of-life PV as Universal Waste; authorizes Department of Toxic Substances Control (DTSC) to create regulations	DTSC regulations approved and effective Jan. 1, 2021. Many solar organizations have notified DTSC of their intent to collect, transport and / or treat/process. Currently DTSC dbase shows >70 organizations registered.
Washington HB 2645 (2020)	Delays RCW 70.355 implementation by 2 years to allow for a more in-depth study by WSU of all solar in state; plans submitted by July 1, 2024; only allows products w/plans in state on or after July 1, 2025; cover all PV modules connected to grid or utility service.	Due to COVID-19, Gov. Inslee partially vetoed the funding portion of the bill; delayed dates are still in effect and industry is exploring how to fund the study to make recommendations by 2022 legislative session.
North Carolina H329 (2019)	Conduct study w/stakeholders for the Environmental Management Commission to adopt rules and establish a regulatory program to govern the management of EoL Wind, PV and energy storage used in utility-scale projects, including decommissioning plan requirements	Final report delivered by DEQ to the EMC and will go to the Environmental Review Commission of the legislature. <ul style="list-style-type: none"> • Recommends a financial assurance method within 5 years • Recommends PV modules as UW

Policy Overview

State	General scope	Status
New Jersey A4011 (2019)	Establishes the New Jersey Solar Panel Recycling Commission to investigate options and provide recommendations for recycling PV modules and other EoL management methods within one year; authorizes Department of Environmental Protection to adopt rules and regulations based on Commission's final report	Commission is now meeting and working on their recommendations and report.
Illinois (since 2017)	Stakeholder group managed by Illinois Sustainable Technology Center and prompted by passing of 2016 Illinois Future Energy Jobs Act; would like to avoid landfills as a solution; proactive perspective on ensuring that solar is not discouraged while reasonable solutions and a recycling infrastructure is created. Draft language in review.	Developing policy approaches for consideration by local policy organization and IL solar association.
Minnesota (since 2017)	Stakeholder group managed by the state's Pollution Control Agency; similar scope and aims with IL stakeholder group, including SEIA, product stewardship organizations, manufacturers, recyclers, etc.; assessing development of potential draft language.	In progress discussions and development of approaches.

NASEW / SPI 2021: New Orleans, LA

- Annual renewable energy/ solar conference and tradeshow
- Research, white papers, articles
- PV Recycling / End-of-Life sessions at regional solar events, webinars, meetings



2021 and beyond



Expand network to additional recyclers in more states



Expand program scope to include batteries from energy storage systems



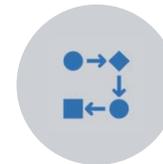
Continue advocacy work



Encourage, support additional research



Develop reuse market



Develop refurbishment protocol



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