PANEL DISCUSSION

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Over the last two decades, large solar arrays have become an increasingly common sight in landscapes across North America and around the world.

While solar equipment can stay in circulation for over 30 years, end-of-life management of this material has become a larger talking point, and one organization has predicted that more than

10 million metric tons worth of solar panels will be hitting the waste stream annually across the globe by 2050.

What are the details on this potential market for material recovery? And how can the recycling industry prepare itself for the growing solar stream?

The materials and the market

First, let's make sure we understand the basics of the equipment in question. In the world of solar energy, photovoltaic (PV) cells are the most common technology utilized. Panels made of PV cells transform sunlight into electricity.

Most materials used in the construction of these modules are non-toxic. Some are precious metals, such as silver and tellurium.

There are two types of PV panels that account for most of the market today: crystalline silicon (c-Si) and thin film. The c-Si modules are the most prevalent, accounting for 90-95% of global production. This popularity can be attributed to higher efficiency rates delivered by c-Si panels.

In terms of the materials used, a typical c-Si panel is 76% glass by weight, 10% polymer, 8% aluminum, 5% silicon and 1% copper. Trace amounts of silver, tin and lead are also used in the products.

In thin film modules, meanwhile, the panel is made of thin films of semiconductors deposited on glass, plastic or metal, providing flexibility for functional applications.

There are three versions of thin film chemical makeup – amorphous silicon (a-Si), cadmium telluride (CdTe), and copper indium gallium selenide (CIGS). A variant on this last category is gallium-free CIS. CdTe is the most common thin film offering, and these products contain a mix of glass (97%) and polymer (3%).

It's worth noting that even if solar panels end up in landfills, they are unlikely to negatively affect human health directly. In a recent report, the International Energy Agency (IEA) concluded that lead in c-Si panels amounts to one-tenth of the risk-level threshold set by the U.S. Environmental Protection Agency. The risk is even lower for cadmium and selenium in thin-film panels.

But that report does not take into account the economic potential of equipment resale and secondary raw materials. It's in this realm that opportunity is building.

Presently, less than 1% of all PV units out in the market need to be disposed of annually, according to the Solar Energy Industries Association. Solar panels tend to produce energy at manufacturers' guaranteed peak performance levels for an average of 20 to 25 years. Following that time period, they will still produce power but below the industry standard of 80%, losing about 6-8% annually. Depending on the owner's energy consumption needs, it is possible for a solar system to last 30 to 40 years.

SHINING A LIGHT ON THE MARKET

As the solar sector continues to mature, those interested in the recycling side will want to keep tabs on the evolution of the business. Here are some key resources that provide solar panel recycling information and updates:

International Renewable Energy Agency (IRENA):
irena.org

National Renewable Energy Laboratory (NREL):
nrel.gov

Solar Energy Industries Association (SEIA):
seia.org

Solar Waste / European WEEE Directive:
solarwaste.eu

Nonetheless, analysts expect to see disposal volume increase exponentially in the coming decades due to the rapid growth of solar installed since 2010.

The National Renewable Energy Laboratory (NREL) states that PV modules could make up more than 10% of global electronic waste tonnage by 2050. NREL forecasts cumulative global PV panel waste between now and 2050 to be between 60 million to 78 million metric tons, with the annual global total reaching nearly 10 million metric tons by 2050.

China, the United States, India, Japan, and Germany are on track to produce the largest amount of PV waste. Combined, these countries will yield just under 50 million metric tons over the next three decades, according to NREL.

Looking into the secondary market

There are instances when system owners may choose to replace panels sooner than the point at which they hit end of life (EOL). Two primary reasons for non-EOL decommissions are technology upgrades and policy changes.

Used panels may have resale value, especially if they are less than 20 years old. Resold equipment often moves to do-it-yourself homeowners, companies looking for replacement parts, off-grid consumers and bargain shoppers. Other repurposed panels are used to provide free solar systems to marginalized communities in developing countries.

Buyers tend to search online for used panels, and buyers and sellers can connect to one another via online marketplaces.

A reputable reseller, who specializes in equipment testing, has the capability to appraise equipment. The reseller conducts quality control tests, measures amp and voltage performance, inspects safety levels, and reports results in writing. If a panel fails testing, it is forwarded onto a recycling center for raw materials extraction. In general, used panels with broken glass should be recycled rather than offered for resale.

And what are the realities of that recycling ecosystem today?

According to the International Renewable Energy Agency (IRENA), at least 85-90% of a solar panel's weight (specifically aluminum and glass) can easily be recycled by a traditional recycling facility.

NREL expects the United States to be one of the world's top benefactors as more solar material reaches EOL. Anticipated PV waste in 2030 would generate $60 million in raw material recovery. By 2050, U.S. operators in the market could profit $2 billion.

These estimates don't include any regulations or consumer incentives that could be passed into law. But recycling challenges also lie ahead.

First, the cost to recycle this material tends to be prohibitive. Today, there is simply not enough volume to achieve economies of scale.

However, a number of entities are investing resources with the belief that innovation can lead to efficiency. First Solar, for instance, is a U.S.-based manufacturer of thin-film modules with an on-site recycling facility. The company has a take-back program in which customers pay to have material recycled.

Determining who is responsible for the cost is often debated. Some believe manufacturers should foot the bill, and others hold the notion that consumers should pay. Contentious debate around this has been seen in jurisdictions where solar panel recycling legislation is being considered.

Notable legislation passed in recent years includes SB 489 in California, SB 5839 in Washington, and changes to the Waste Electrical and Electronic Directive (WEEE) in the European Union.

California's bill, passed in 2015, categorizes EOL modules as universal waste, a move that should help streamline material handling requirements and promote recycling.

Meanwhile, Chapter 70.355 RCW of Washington's bill requires manufacturers to fund recycling programs for their modules sold in the state after July 2017. Washington's bill has recently been challenged through HB 2645, which moved through the state legislature this year and grants each manufacturer a new deadline of July 1, 2022 to submit a stewardship plan to the Washington Department of Ecology.

Europe's WEEE legislation was amended to include PV modules in 2012, which mandates PV companies collect and recycle their EOL products as well as guarantee the financial future of PV waste management.

How can recycling system leaders help?

Still, more action needs to happen to ensure processes are in place to reap the economic advantages of future PV recycling. Local and state recycling system leaders can play a role in advancing solar panel recycling opportunities. Here are three ways you can get involved today.

1. Craft and implement a plan to address solar panel recycling.

Having a plan will help to create a seamless process for solar panel recycling today and in the future. Recycling facilities need to determine what role makes best sense for their operations. For instance, an operator may decide to add a PV recycling division to an existing facility, or the operator may determine that partnering with another facility that specializes in solar panel recycling is the better option.

There is a growing network of e-scrap and solar panel recyclers that are forming strategic partnerships to address PV recycling needs. My company, EnergyBin, is an online business community that can help stakeholders locate partners in a given geographic area. EnergyBin

and its sister site, BrokerBin, have members who specialize in secondary market services throughout 60 countries.

Forming a strategic partnership allows each partner to contribute what they do best. Perhaps one partner focuses on logistics and the other on processing. The logistics plan could entail a stationary collection site, mobile collection points, or a combination of the two.

Consider engaging solar installers in your area to transport decommissioned panels back to their business locations. The consumer benefits from ease of recycling as the installer packs out the old after installing the new. Recycling companies, meanwhile, benefit from fewer pick-up locations to manage.

Whatever direction you choose to pursue, the plan should be developed with the customer in mind. Ask, “How can we make it easier for solar system owners to recycle?” Keep in mind that consumers tend to choose recycling over waste only when they perceive the ease of recycling over the difficulty of disposal.

2. Stay up-to-date on recycling developments and get involved in policy-making.

A plan for solar panel recovery should allow for flexibility as the political and economic landscapes shift. Keep an eye on legislation and new entrants as well as consumer behavior and technological advances. These factors will shape and change the playing field. You may also want to follow what other industries are doing to advance recycling.

Aside from staying informed, consider how you can lead the way in developing a circular economy. Perhaps you can be an instrumental player in proposing new legislation or crafting state-wide protocol.

In addition to proper handling standards, any stakeholder involved with new legislation should consider the benefits of incentives. When consumers have an economic motivation to recycle, they are more likely to participate. Incentives can be strategically deployed to boost volume.

There are a number of incentives that tend to have a positive effect on consumers, including financial programs (cash-back and discount coupons), environmental enticements (for instance, for every panel returned, a tree will be planted), and societal charity incentives (donations). Consider how your company could motivate consumers with incentives as well as how collaborative efforts among stakeholders could lead to an appealing incentives package.

3. Educate your customers and the general public.

Another way recycling system leaders can take part in solar panel recycling efforts is via education. Providing education to the general public on the environmental and economic advantages of recycling is quite similar to what the renewable energy industry does on the front end to convince consumers to switch from fossil fuels to solar.

If you run a community program, include information on your website with links to solar recyclers in your area. You could insert a message in your newsletter or attached to customer billing statements.

You may also want to consider hosting webinars or events for consumers with solar systems, and you can invite guest speakers from the solar industry to present. Publish a recording of the presentation on your website as a resource.

Education today can help a community adopt the practice of EOL solar panel recycling for the long term. It also has the power to shape consumer behavior by making the act of recycling feel like an everyday routine.

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