Sustainability for Solar Powered Batteries

By Juwairia Shoaib
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Benefits of Using Solar Energy

Solar energy is an increasingly important energy source. It harnesses clean, renewable power from the sun, which positively impacts the environment. As an alternative to fossil fuels such as coal and natural gas, solar energy has the potential to mitigate the negative effects of climate change! Solar energy can dramatically reduce the production of harmful pollutants and greenhouse gases, particularly carbon dioxide. By decreasing emissions, solar energy can prevent $167 billion in annual health and environmental damage and can save more than 25,000 lives every year!

Solar power is also an inexhaustible resource. Energy from the sun is free and readily abundant. If we could capture all of the sun's energy shining on our planet for just one hour, we could power the entire world for one whole year!

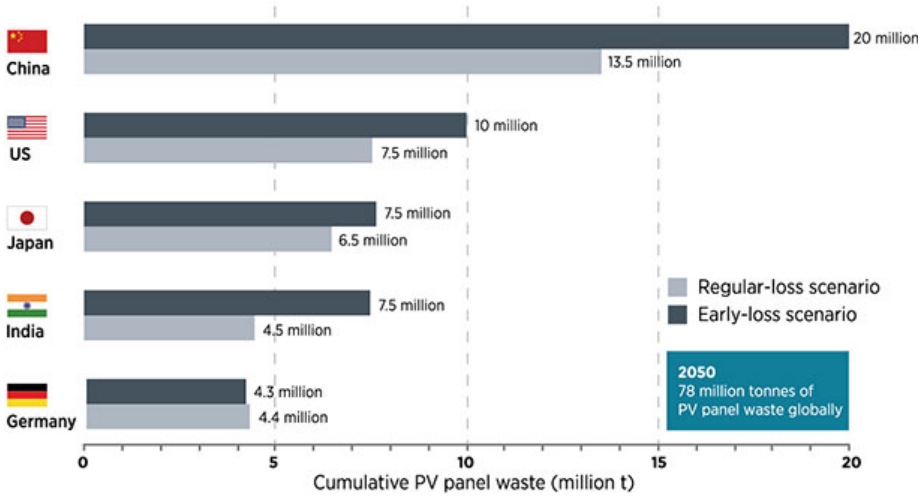
Photovoltaic (PV) panels are the most common technology for harnessing solar power. These panels use the photovoltaic effect to convert solar radiation to energy, which can supply homes and businesses with electricity. In the last decade, PV solar energy has become much less expensive, making it the technology with the sunniest future!

Challenges

Solar technology isn't new, but solar panels are a relatively recent invention. Physicist Edmond Becquerel first discovered the photovoltaic effect in 1893, but it wasn't until 1954 that Bell Laboratories invented the first practical panel, which was made from silicon solar cells. By the 2000s, solar power was readily available to the public, and the solar technology market has grown exponentially all over the world!

Despite the essential role that solar panels play in fighting climate change, the technology has flaws. PV panels are complex pieces of technology that become big, bulky sheets of electronic waste at the end of their lives. By 2050, the International Renewable Energy Agency projects that worldwide PV waste will reach 78 million metric tons as more and more panels reach the end of their usefulness. Right now, most of the world doesn't have a plan to deal with all that waste.

While the projected amount of annual solar waste is significantly less than the total e-waste the world currently produces each year, regular electronic recycling methods simply don't suffice for solar panels.



Source: IRENA

Solar panel materials like silicon and silver require specialized recycling methods. Failing to create solutions and implement policies will drastically increase the number of solar modules in landfills.

Read more about the predicted solar trash wave here!

Solar panels consist of many small PV cells that contain toxic materials that can seep into the soil while breaking down. These toxic chemicals include lead, cadmium telluride, copper indium selenide, cadmium gallium (di)selenide, hexafluoroethane, and many others.

Read more about PV panels' end-of-life recycling issues here and here!

Solutions

While solar energy is one of the cleanest energy options available, the projected 78 million metric tons of discarded solar panels will have a long-term negative impact on the plants and animals of our planet. Additionally, solar panels may contribute to the climate change crisis.

Although the future of solar e-waste seems far away, we must develop plans now to deal with the waste. Those plans must include PV panel recycling and repurposing. Lawmakers must also establish enforcement mechanisms.

Policies

Most solar panels have a lifespan of 25 years. Because those solar panels weren't installed widely until the 2000s, not many are being dismantled today. But some have been taken offline early due to damage or manufacturing defects, and they have been replaced with newer models.

The United States can look abroad for solutions to the problem of decommissioned solar panels. In the EU, manufacturers are required to ensure that their panels are recycled correctly. Other countries like Australia, China, and Japan are currently working on solar waste management policies as well. Here in the US, only California and Washington have enacted state laws to address the issue. Nationally, Congress has no laws or regulations in place.

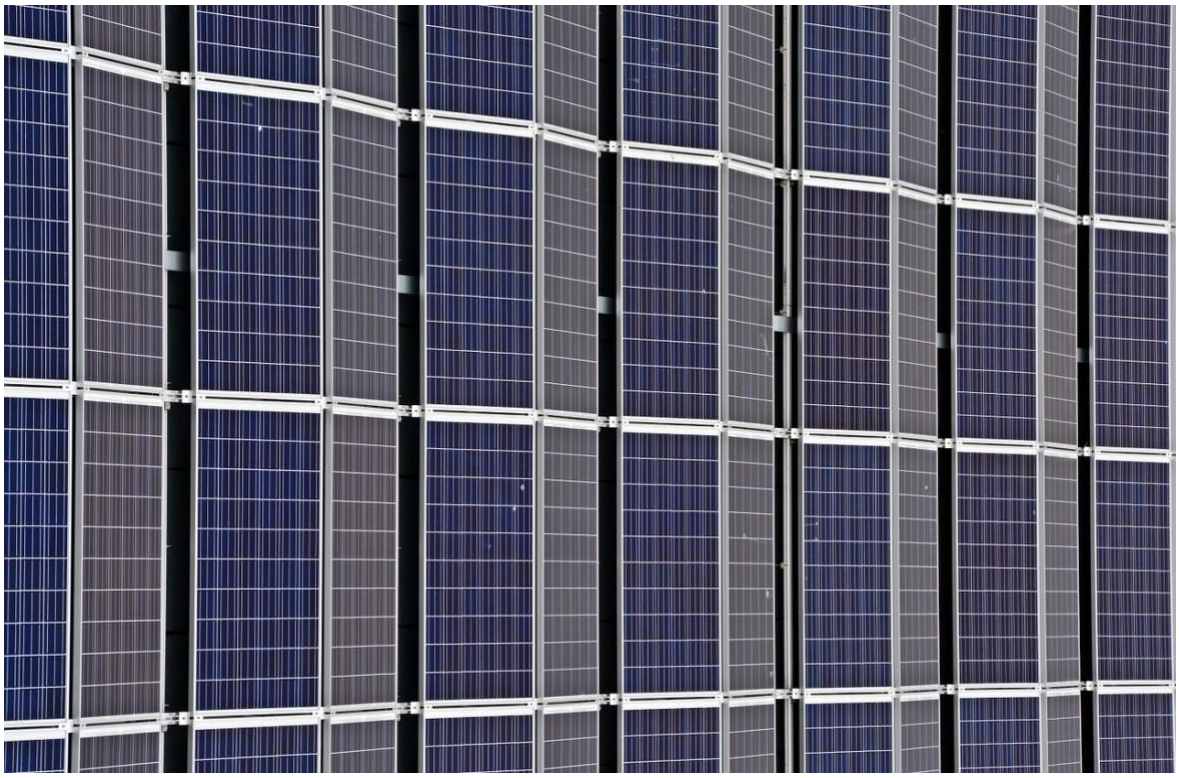
To address the issue, local governments must advocate for solar waste management. Clearly defined federal and state regulations can also help to implement successful PV recycling and recovery programs.

On a smaller scale, individuals can push for better policies by educating ourselves and our community, advocating for e-waste management organizations, and supporting future policy implementation.

Here are some organizations advocating for change: SEIA, ISTC, PV CYCLE, and Recycle PV Solar.

Recycling

The inside of a solar panel is made up of crystalline silicon cells, which are protected by layers of polymers and glass and an aluminum frame. In the cells, electricity travels through a copper wire to the junction box. At a recycling facility, a PV panel must go through a complex process to strip the semi-precious metals from the module. The remainder is crushed into glass. While it currently costs $20 to $30 to create a panel, recycling a panel recovers about $3 of materials. The panel are often just dumped into solid-waste landfills because it costs almost nothing to dispose of them by conventional means.



If the module's more valuable metals (e.g., silicon, copper, and silver) were separated and refined efficiently, recycling costs would drop. Once purified, glass and silicon can also be reused where needed, aluminum frames can be sent to refineries, plastics can be reused as fuel for cement production, and cables and connectors can be recycled into copper shot. A few PV recyclers are already using this method, which can separate 95% or more of the recaptured materials!

Check out some recyclers who are already doing this: Veolia and PV Cycle.

Repurposing

Along with better regulations and new recycling policies, we should also think about repurposing solar modules. Not only would repurposing be more financially beneficial than recycling, but also it could also offset the energy required to recycle PV panels.

The EU is already implementing repurposing programs! Through their Circular Business Models for the Solar Power Industry (Circusol) program, the European Commission funds a variety of demonstration projects that show how solar panels from businesses and homes can be repurposed. For example, the European Commission's Daidalos program is using old panels to power housing complexes in Belgium and e-bike charging stations in Berlin.

Conclusions

Solar energy is rapidly growing, which is wonderful news for the health of our planet. Unfortunately, we don't have a plan to deal with used panels yet. In the next few decades, surplus solar e-waste will become a serious problem unless lawmakers take steps now to improve recycling and repurposing programs.

If too many panels end up in landfills, animal and plant habitats will be at risk because improperly discarded PV modules can leak toxic materials into the environment. Recycling and repurposing the modules used in PV panels can reduce that waste. Improving existing laws and creating new laws to manage e-waste can keep our environment safe!

Some companies and organizations are already working to solve this problem! Veolia in France, PY CYCLE, and the EU's Circusol programs have made significant strides in minimizing and managing solar waste. They have done this by reusing parts of PV panels for community projects, connecting manufacturers to e-waste facilities, and implementing new, improved recycling methods.

There are innumerable benefits to using PV panels, but we also need to ensure that the future of solar energy remains sustainable. Solar energy has already done so much to reduce our global carbon footprint. For example, a recent study shows that the implementation of renewable energy like solar panels has already reduced Turkey's carbon footprint by 20%!

While researching PV panels for this article, I was surprised to learn how much work the EU has done to foster solar energy and to address the waste created by decommissioned panels! Legislation and nonprofits have significantly reduced e-waste in the region. Going forward, I hope the US can follow their lead.

Research

California State Regulations on PV Waste Management (Department of Toxic Substances Control)

Circucol

The Dark Side of Solar Power (Harvard Business Review Article)

End-of-Life Management: Solar Photovoltaic Panels (IRENA Research)

Energy, Economic, and Environmental Benefits of the Solar America Initiative (NREL Research Paper)

The Environmental and Public Health Benefits of Achieving High Penetrations of Solar Energy in the United States (NREL Research Paper)

Global E-waste Monitor (United Nations)

The History of Solar (U.S. Department of Energy Timeline)

Major Challenges and Opportunities in Silicon Solar Module Recycling (Research Report)

NREL Solar Energy Basics (Article)

An Overview of Solar Photovoltaic Panels' End-of-life Material Recycling (Research Article)

PV Cycle

Research and Development Priorities for Silicon Photovoltaic Module Recycling to Support a Circular Economy (Nature Energy Research Report)

SEIA Research on the Industry's growth (Article)

Solar Photovoltaic Module Recycling: A Survey of U.S. Policies and Initiatives (NREL and EPRI Research Report)

This Month in Physics History (APS Physics Article about the Physics of Solar Cells)
Veolia

Washington State State Law on E-waste Management (Department of Ecology)
Waste from Electrical and Electronic Equipment (European Commission)

Acknowledgments

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