

The future of renewable energy waste:

Addressing the recycling and disposal crisis



Introduction



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As the world is turning from oil and gas to renewable energy sources like solar panels, wind turbines and lithium batteries to combat climate change and reduce our reliance on fossil fuels, a new challenge is emerging: the ethical disposal of these products at the end of their lifecycle.

While renewable energy technologies promise a cleaner future, their global adoption also brings about significant environmental and logistical concerns regarding their disposal and recycling. While the world is trying to work towards sustainability, referring to the ability to maintain a process continuously over time and meeting the needs of the present without compromising the ability of future generations to meet their own needs, the disposal of these renewable energy products are causing environmental harm globally and pose potential risks to the rights of workers involved in their disposal or communities in proximity to waste.

The current recycling rates for these renewable energy products are alarmingly low. MIT Technology review states that only 10% of solar panels are recycled globally, with the majority ending up in landfills. Similarly, the recycling rates for lithium batteries in the US is only 12% even though they are largely recyclable, the lack of established infrastructure and processes cause them to end up in landfills globally. Furthermore, despite up to 90% of a wind turbine's mass being recyclable, there is no current data available on how much is actually being recycled versus being exported to landfill.

The urgency of addressing this issue cannot be overstated. The International Renewable Energy Agency stated that by 2030, it is estimated that more than 78 million metric tons of solar panels and 11 million tons of wind turbine blades will reach end-of-life. The global volume of end-of-life batteries from electric vehicles is expected to reach 21 million tons annually by the same year. These staggering numbers highlight the pressing need for a comprehensive and sustainable approach to managing the disposal and recycling of renewable energy products.

Beyond environmental concerns, the issue also carries significant economic and social implications, meaning it remains critical that we develop and implement energy transition strategies that are truly sustainable across Environmental, Social and Governance (ESG) principles. This involves investing in recycling infrastructure, driving innovation in recycling technologies, and establishing transparent regulations and reporting to mandate ethical disposal practices. By doing so, we can create a circular economy that not only maximises the lifespan of renewable energy products but also minimises their wider ESG footprint and support a 'just transition'.

Defining the problem

Despite the environmental benefits of renewable energy, the lack of awareness and responsibility regarding disposal and recycling is posing significant challenges for future generations.

Inefficient disposal does not just squander valuable resources that could be repurposed, but also poses additional environmental risks. As just one example, chemical leaching (a process to dissolve and extract precious metals) from batteries and solar panels can contaminate soil and groundwater, often causing fires in landfills that release harmful gases into the atmosphere, contributing to further air pollution.

Digging deeper into solar panels, only about 10% of solar panels are currently being recycled in the European Union and United States, according to a Yale Environment 360 report (2021). This low rate persists despite the current regulations in place in these regions, due to the complexity and high cost of recycling.

While solar panels contain amounts of valuable materials like silver, they are mostly made of glass, an extremely low value material. Meaning the cost to extract the small amount of valuable material is 10 to 30 times more than sending the panels to a landfill. This cost disparity, coupled with a lack of recycling infrastructure and detailed regulations, is leading to the vast majority of decommissioned panels ending up in landfills or exported to developing countries with little to no environmental regulations.

To further add to the issue, these end of life renewable energy products are often sent to third party countries for disposal. The countries that receive the renewable energy waste often face significant health and environmental risks. There are often inadequate safety measures during the dismantling processes and handling of these products that result in direct exposure for the workers and scavengers around the landfills. The workers and communities in these countries are often exposed to hazardous materials like lead, cadmium and other heavy metals, this exposure can lead to serious health issues like respiratory problems, neurological damage and cancer.

The failure to recycle and responsibly dispose of renewable energy products benefits those who prioritise short-term cost savings over long-term sustainability. By avoiding the costs associated with recycling, organisations contribute to health and environmental harm as well as resource depletion.

Addressing this issue requires a concerted effort from all stakeholders in the energy industry, government, and regulatory bodies to raise awareness, implement robust recycling infrastructure, and enforce regulations that ensure the ethical disposal of renewable energy products. Global collaboration is needed to establish comprehensive regulatory frameworks that promote sustainable practices and facilitate the development of recycling technologies to manage the growing volume of renewable energy waste effectively.



The path to sustainable renewable energy

Emerging recycling technologies

As global awareness around the future of renewable energy waste is growing, new recycling processes are emerging to tackle the growing waste stream. Researchers at the National Renewable Energy Laboratory in the United States are developing a chemical recycling process that can effectively recover 95% of all valuable materials from end-of-life panels. Some private companies are leading the way in developing recycling technologies. Röhm, for example, in collaboration with partners like Pekutherm and NEXTCHEM, is establishing a Europe-wide recycling system for PMMA (polymethyl methacrylate) plastics. This initiative aims to reduce waste from various sources, including wind turbine blades, and promote a circular economy. The alliance involves Pekutherm collecting PMMA from customers, consumers, and recycling centers through a Europe-wide network. NEXTCHEM, through its subsidiary MyRemono, uses its proprietary NXRe™ chemical recycling technology to process non-mechanically recyclable PMMA. Röhm then processes the mechanically recycled PMMA into proTerra products and chemically recycles MMA (methyl methacrylate) from MyRemono into virgin-quality MMA. This closed-loop system significantly reduces waste and supports the production of high-quality recycled materials.

Another breakthrough in the renewable energy sector could come from the modular design of solar panels, which makes disassembly and recycling easier. RexTag is at the forefront of this innovation, developing standardized, detachable components for solar panels. This design ensures that panels do not have to be shredded at the end of their lifecycle, allowing for higher-value recycling of intact materials. By enabling the recovery of valuable components without extensive processing, RexTag's approach not only reduces waste but also enhances the economic viability of recycling solar panels. This modular design aligns with the principles of a circular economy, ensuring that materials are reused and repurposed efficiently.

Design with recycling in mind

As we see in many other industries, there is an opportunity to design future renewable energy products with recycling in mind from the very beginning. By carefully selecting materials and implementing modular designs, the recycling process can be made much easier. Although implementing modular designs might lead to higher fabrication costs of these products, this approach will lower the recycling costs and have great environmental benefits. Also, eliminating expensive, rare and harmful materials in construction will simplify the recycling process.

Responsibility of the manufacturer

As the solar and battery industries continue to grow rapidly, they have a notable responsibility to address the issue of waste waste and identify key risks to people and environment downstream in the value chain. Rather than shifting the cost and burden of recycling to the public sector, these companies should take greater responsibility for the full life cycle of their products. By investing in research, designing with recycling in mind and investing in infrastructure and initiatives for the recycling of their products these industries can demonstrate their commitment to sustainability and environmental stewardship.

Policymaking driving sustainability in the renewable energy sector

Governments must play a pivotal role in accelerating recycling renewable energy waste through a combination of incentives, regulations and industry standards. Prohibiting the export and dumping of waste in landfills will create demand for recycling services and encourages investment in recycling infrastructure. Financial incentives will be crucial to make the recycling economically viable.

Extended producer responsibility (EPR) laws can further stimulate investment in recycling infrastructure by holding the manufacturers accountable for the end-of-life management of their products. Under EPR frameworks, solar companies are required to finance and oversee the collection and decommissioning of their products, incentivising them to design products with the recyclability in mind.

Finally, setting clear standards and targets can provide a regulatory framework within the renewable energy industry. Those standards could specify acceptable recycling rates, mandate minimum recycling rates and establish guidelines that would facilitate material recovery recovery but could also focus on for instance occupational health and safety in the recycling process and material recovery. Doing this, governments and policymakers globally can level the playing field and set clear expectations, driving innovation and investment in sustainable renewable energy lifecycles.

Conclusion: Leading the charge for sustainable disposal practices

The transition to renewable energy sources has brought about remarkable progress in combating climate change and reducing our reliance on fossil fuels. However, as the lifecycle of these products comes to an end, the challenge of responsible disposal emerges as a critical environmental issue. Improper handling of decommissioned wind turbines, solar panels and batteries risks negating some of the environmental benefits they were designed to achieve.

At LRQA, we understand that the journey toward a truly sustainable future doesn't stop at clean energy generation—it extends to the responsible end-of-life management of these products.

With our **LRQA Environmental Claim Verification Zero Waste to Landfill Standard**, we provide organisations with the framework and assurance they need to demonstrate their commitment to sustainable waste practices.

Zero Waste to Landfill involves diverting all generated waste from landfill, aiming to reduce waste and utilise the reuse and recycling of materials or opting for alternative end of life waste solutions such as Energy from Waste (EfW). It is a more achievable ambition for businesses, compared

to the philosophy of 'Zero Waste' (total waste elimination), which is extremely challenging.

By adhering to this standard, companies can minimise their environmental impact, strengthen stakeholder trust and position themselves as leaders in environmental stewardship.

The path to zero waste is both a challenge and an opportunity for companies to align with global sustainability goals. At LRQA, we are proud to support organisations in achieving meaningful progress through credible solutions and verification. Together, we can ensure that the renewable energy industry not only drives the clean energy revolution but also sets the benchmark for environmental responsibility.

If your organisation is ready to make a difference and embrace sustainable waste practices, we invite you to **reach out to our team**. Together, we can build a solution that supports your goals and contributes to a greener, more sustainable future.

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LRQA is the leading global assurance partner, bringing together decades of unrivalled expertise in assessment, advisory, inspection and cybersecurity services.

Our solutions-based partnerships are supported by data-driven insights that help our clients solve their biggest business challenges. Operating in more than 150 countries with a team of more than 5,000 people, LRQA's award-winning compliance, supply chain, cybersecurity and ESG specialists help more than 61,000 clients across almost every sector to anticipate, mitigate and manage risk wherever they operate.

In everything we do, we are committed to shaping a better future for our people, our clients, our communities and our planet.

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