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Wasting Away in Wind-and-Solarville

Wind turbines are silhouetted against the rising sun near Spearville, Kansas, on Jan. 13, 2021. Charlie Riedel/AP Photo

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6/3/2025 Updated: 6/3/2025

News Analysis

While green advocates commonly use the terms renewable, sustainable, and net zero to describe their efforts, the dirty little secret is that much of the waste from solar panels and wind turbines is ending up in landfills.

The current amounts of fiberglass, resins, aluminum and other chemicals—not to mention propeller blades from giant wind turbines

—pose no threat current to local town dumps, but this largely ignored problem will become more of a challenge in the years ahead as the 500 million solar panels and the 73,000 wind turbines now operating in the U.S. are decommissioned and replaced.

Greens insist that reductions in carbon emissions will more than compensate for increased levels of potentially toxic garbage; others fret that renewable energy advocates have not been forthright about their lack of eco-friendly plans and the technology to handle the waste.

“Nobody planned on this, nobody had a plan to get rid of them, nobody planned for closure,” said Dwight Clark, whose company, Solar E Waste Solutions, recycles solar panels. “Nobody thought this through.”

The discussion about what to do with worn-out solar and wind equipment is another topic usually elided in Net Zero blueprints, which often focus on the claimed benefits of projects while discounting or ignoring the costs. As RealClearInvestigations previously reported regarding the lack of plans for acquiring the massive amounts of land for solar and wind farms needed to achieve net zero, the math can get fuzzy, and the numbers cited most frequently are those rosiest for renewables.

“They’ve been either silent, or incoherent—or just hand-wave that we should recycle all this stuff without telling us how,” said Mark Mills, executive director of the National Center on Energy Analytics. In the headlong effort to make solar and wind seem as inexpensive as possible, they have not included fees that address the eventual cost of disposal, which could leave taxpayers holding the bag.

Some renewable supporters acknowledge Mills’ point. The Alliance for Affordable Energy, which supports government-funded research on recycling panels and turbines, said the “circular economy” Mills referred to has yet to materialize.

“With the existing energy infrastructure, a lot of end-of-life questions have never been addressed,” the Alliance’s executive director, Logan Burke, told RCI. “It may be that those costs have to be embedded in the front-end, but somehow we need to make the market circular. How do we find that market at the end of their useful life?”

Just how many panels the U.S. will dispose of or retire each year is also unclear. No clearing house keeps track of national figures, according to Meng Tao, an energy engineering professor at Arizona State University and a consultant on renewable waste issues.

The estimates can vary widely. Solar panels generally have a life expectancy of 25 years, but factors like damage and system upgrades

make the number of panels coming out of circulation each year impossible to ascertain. In 2021, the National Renewable Energy Laboratory, which did not respond to a request for comment, estimated that between 3,000 and 6,000 panels would be retired annually through 2026.

Critics say even the high end of those numbers seems suspiciously low given the hundreds of millions of panels now in use and tens of millions yet to come.

The problem will not be confined to the U.S. Several European countries are further down the NetZero road than America, and in March, the European Union estimated it "will cumulatively amass 6-13 and 21-35 million tons of (solar) waste by 2040 and 2050, respectively." The waste coming from wind turbines will be even greater, the EU said, sounding a hopeful note that recycling renewables will become more prominent.

"Both PV [photovoltaic] and wind power infrastructure waste streams require special handling and recycling methods that are not widespread in Europe today," the EU wrote.

The U.S. accounts for roughly 10 percent of the waste, according to several experts, and Tao estimated the U.S. would be producing roughly 2 million metric tons of solar waste a year by 2043, but other studies have a much higher figure. A 2019 study in renewable energy predicted roughly 10 million metric tons of solar waste between 2030 and 2060.

"Solar waste will grow exponentially in the next 20 years," Tao said. "Globally, we produced 20-25 million tons of solar panels in 2023. They will come offline in roughly 20 years. That is 20-25 million tons of solar waste a year in 2045."

The Institute for Energy Research puts the potential mountain even higher, pointing to studies that put the 2050 figure at 78 million tons.

For now, 90 percent of this detritus goes to landfills. And the panel fields and towering turbines must be dismantled, trucked away, usually by diesel-powered vehicles, and then sent to landfills or ports, where they are shipped to poor, developing countries. Fossil fuels may foul the air, but renewables may pollute the ground.

There has been promising research, most of it government-funded, on making components like turbine blades more recyclable, but the Trump administration appears unlikely to continue such funding. Such a shift under Trump would put the onus for developing more recyclable, renewable equipment on the private sector.

But the recycling industry as a whole has never been dynamic. Indeed, the last few years have seen widespread admissions that the recycling revolution that has led Americans to separate their trash into various categories has been a bust.

The push to make renewable waste renewable has smacked up against basic questions of profitability, according to Jesse Ausubel of Rockefeller University.

“The recycling industry overall is not one that has blossomed in the last 50 years; it’s just not a booming industry,” he said. “You’re going to need enormous amounts of installations and this stuff is made to last, made tough, which is the enemy of recycling. So it’s all still a big challenge and I think there are a lot of unanswered questions or we’ll be left with a lot of stranded assets.”

Tao agreed that, absent more profit, the recyclable future for renewable equipment is dim.

“We still don’t have a perfected technology for recycling them, we’re not there yet,” he said. “We’re trying to see how the industry will move forward, but there are multiple challenges, including the fact it is not profitable.”

Renewable energy champions insist all this will mean big business, perhaps as much as $2.7 billion in solar recycling in 2030, according to one estimate. But for now, it isn’t. Clark said his company clears about $5 from each panel.

It isn’t only the lagging technology and market pressures. At root, there isn’t much in the panel worth recycling. There are tiny amounts of silver and copper, along with some silicon, but those wafers are deep within a compressed sandwich of glass and other elements. Crushed glass has some limited value in construction, but extracting the small amounts of valuable components is an intensive, high-tech process, Clark said.

Ausubel said he thinks the smaller residential solar market can probably handle itself and that the real work will be disposing of millions of panels in the sprawling fields. Because unraveling the panel’s crunched knot is difficult and expensive, it only makes sense to recycle panels in the thousands, and the residential solar market is of less interest, Clark said.

“It’s like mining that way,” he said of the process. “The way they are assembled, stacked, with the cells intertwined and wired together amid sheets of plastic, resins, glue and the like.”

And all leaching cannot be prevented. While the hazardous materials contained in each solar panel, like its valuable elements, are slight, they could present a long-term problem. Even if a landfill strictly adheres to EPA regulations, the leaching from potentially millions of panels poses health risks that Tao compared to mercury poisoning.

Laws mandating recycling have proved difficult to enforce.

“To date, no single regulatory framework has been developed to serve as a North Star for renewable energy project end-of-life planning, leaving a patchwork of federal, state, and local policies and regulations to sift through—and leaving project owners and developers, as well as landowners and other interested parties, to fend for themselves,” a 2024 report concluded.

For example, Washington passed a law mandating solar panel recycling in 2017, but it has yet to be enforced. Currently, the law is set to take effect on July 1, but the Department of Ecology opposes that date in part because manufacturers and consumers have proved reluctant to pay the recycling costs, crimping the solar market there.

“The state’s clean energy transition is facing a setback if the law goes into effect on July 1, 2025,” the department said. “If the law is unchanged, it would disrupt the supply and cost of panels available for sale in Washington.”

The question of who will pay to dismantle the panels, transport them to landfills or recycling centers, or even, in some cases, ship them abroad has been left unanswered in most states. Lobbyists for wind and solar projects, eager to keep costs low, along with lawmakers captivated by the concept of a NetZero future, have left the market too lightly regulated, said Jason Isaac, founder and chief executive of the American Energy Institute, which supports “abundant, affordable and reliable energy.”

In many cases, when highly regulated power companies look to build a new plant, laws require them to set aside money in bonds or escrow accounts to cover or defray decommissioning costs, Mills said. That is not always the case. A recently decommissioned coal mine in northern Louisiana may cost $300 million to break down, according to the Alliance for Affordable Energy, which says those costs will probably be borne by ratepayers. But Isaac and Mills believe financial decommissions requirements have been either ignored or insufficiently funded in the renewable market.

Some state legislatures, like Louisiana’s, are moving to address that vacuum and prevent taxpayers from being stuck with the cleanup bill.

“The goal is to not leave the state or a farmer with a field of broken solar panels by putting in cradle-to-grave assurances of bonding requirements,” said H. Sterling Burnett of the Heartland Institute, a group skeptical of apocalyptic global warming scenarios. “We need to treat these like any other energy source.”

In April, Burnett testified in Baton Rouge on just such a law, prompted in part by a solar field in Livingston Parish that has been damaged over the years by hurricanes. In 2022, the legislature passed a bill requiring a bond from renewable project builders, but the specifics of that have not been promulgated, leaving new projects in limbo, said Rep. Brett Geymann, a sponsor of the new bill.

“No existing projects here have required decommissioning, unless that’s part of a private contract with a landowner,” he said.

A small number of solar panels are even finding a secondary market in places like Haiti, Zimbabwe, and elsewhere, Clark said. Groups like Brighten Haiti, which did not respond to a request for comment, take replaced panels that still have some life in them to that impoverished island, although some said that amounts to misguided philanthropy.

“It’s sort of a ‘nice’ way of dumping, really,” Tao said. “Because those places have no clue what to do with it in the end.”

All of these issues are outweighed by the carbon emission reductions renewable energy represents, according to other experts. Paul Gipe, a California-based energy analyst and proponent of wind, said concerns about renewable waste are overblown and advanced by enemies of NetZero goals.

“Solar panels are mostly glass, so glass is easy to recycle,” he said. “Wind turbines are mostly metal; again, easy to recycle. Most of the concern about ‘recycling’ is fear, uncertainty and doubt from the usual suspects.”

It’s true that turbines, which have a lifespan of about two decades, are mostly metal, but they nonetheless present their own set of end-of-life problems. While most of it may be recyclable, breaking down and transporting the gigantic contraptions on land or offshore requires tremendous labor—and energy. The thousands of tons of concrete that make up their bases will likely remain in the ground or on the ocean floor in some form for decades, according to Mills and others.

Blades on offshore turbines today can be as long as a football field, and the structures are equal to 10-story buildings, with those offshore sitting on an ocean floor slab as big as a city block.

“These offshore things are not renewable and not clean—it takes boat loads of equipment out to the sites to build and maintain them, and it will take boat loads to bring it all back,” said Robin Shaffer of Protect Our Coasts, a grassroots group that began fighting a since-scuttled offshore project in New Jersey.

What’s more, bankruptcies among European companies have begun to mar the renewable wind landscape as surely as the towers, a trend that could continue or accelerate as the Trump administration stops the federal spigot.

“The government has let them off the hook by shaping their policies around climate activism,” Shaffer said. “They’re not putting down escrow money for decommissioning and someone’s going to have to come along and remove them, or we’ll be staring at these rotting towers in the ocean.”

The blades are so big that they are usually broken into three pieces when decommissioned, and the giant chunks of fiberglass, resin, and composite materials go to landfills or warehouses.

Already, horror stories exist of municipalities faced with decommissioning problems. Towns like Sweetwater, Texas, which for many years has been the leading state for wind power, have seen turbine recycling contracts ignored. Global Fiberglass Solutions, one of the companies handling such contracts, did not return requests for comment.

“You can’t reuse turbines, and there are now thousands upon thousands of blades just sitting there in warehouses already,” Isaac said. “It’s an environmental disaster we’re looking at.”

From RealClearInvestigations

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