

Fact Sheet:

Decommissioning Wind and Solar Energy Systems

A growing demand for sustainable energy generation combined with decreasing equipment costs has created more opportunities for the development of wind and solar energy projects. Wind and solar projects are often located in rural areas and can provide numerous benefits to nearby communities, including lease payments to landowners, tax revenue to fund infrastructure and services, and the creation of both permanent and temporary jobs.

To take advantage of the potential benefits of wind and solar energy, county officials are responsible for enacting siting or zoning standards that help capture the benefits of new development while ensuring projects are built in a way that works best for local communities. One way this can be done is by planning for decommissioning, the process of removing energy infrastructure at the end of its operational life.

Reaching end of operation: What options are available for wind and solar projects?

As projects reach the end of their operational lifespans—estimates range between 25 and 40 years for wind energy, and 25 to 35 years for solar energy—owners may seek to cease generation at a facility and decommission the system, but various alternatives to decommissioning are also available.

- *Extending the performance period* means continuing the operation past the original planned performance period. Cost savings and revenue opportunities come along with this, as well as the benefits of leveraging existing land use, infrastructure, and interconnections. However, challenges arise when working with older equipment, including lack of expertise and difficulty finding parts.
- *Full decommissioning* indicates removal of a project at the end of its operational lifespan. This can involve recycling, disposal, or repurposing of project infrastructure. While repurposing and recycling offer financial and environmental benefits, infrastructure is often disposed of in landfills, which has environmental drawbacks.



Wind decommissioning options



Extending the performance period

Repowering can extend the operational life of a project by updating or replacing equipment and may also increase the efficiency and capacity of a project. A repowered wind system can leverage existing grid connections and infrastructure, providing cost-saving advantages.^{1,2} Full repowering and partial repowering options are available.³



Full decommissioning

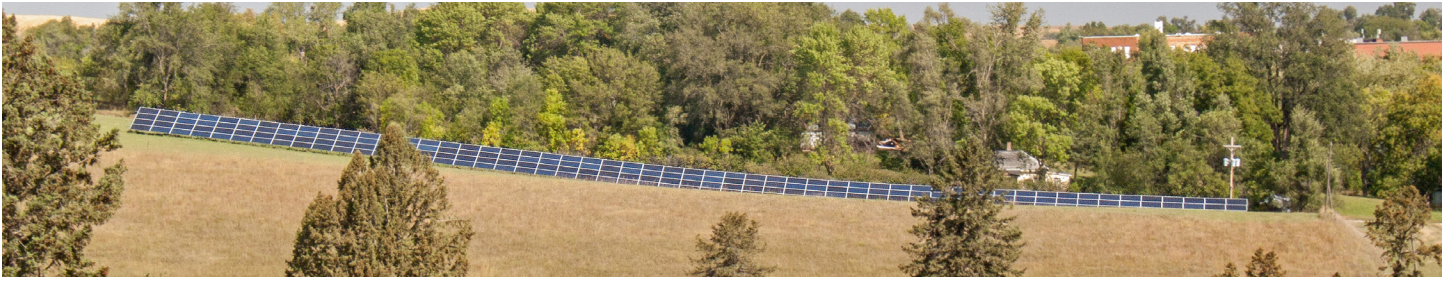
Recycling the metal components of a wind turbine is easy, but it is difficult to recycle composite components.⁴ Composition varies by manufacturer; typically 85% to 95% of a wind turbine is made from recyclable materials.⁵ Mechanical, chemical, and thermal recycling options are available.^{6,7}

Disposal of wind turbine parts usually involves depositing them into landfills. Landfill disposal is generally the most accessible and least expensive method, but it has environmental drawbacks and may not be allowed or available in certain places.

Repurposing opportunities for end-of-life are becoming more widely available and offer financial and environmental benefits.⁸ Several innovative processes allow wind turbine materials to be used in other building materials or repurposed into new structures.^{9,10,11}

Sources

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- 2 Kitzing, Lena, et al. "Multifaceted Drivers for Onshore Wind Energy Repowering and Their Implications for Energy Transition." *Nature Energy*, Nov. 2, 2020, nature.com/articles/s41560-020-00717-1. Accessed November 2024.
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- 4 "Decommissioned Wind Turbine Blade Management Strategies." American Clean Power, January 2023, cleanpower.org/wp-content/uploads/2023/01/ACP_BladeRecycling_WhitePaper_230130.pdf. Accessed November 2024.
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- 7 "Concrete Benefits: Recycling Old Wind Turbine Blades Could Help Cement Industry Cut CO2 Emissions." General Electric, Dec. 23, 2020, ge.com/news/reports/concrete-benefits-recycling-old-wind-turbine-bladescould-help-cement-industry-cut-co2-0. Accessed November 2024.
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- 9 Martini, Ryan, and George Xydis. "Repurposing and Recycling Wind Turbine Blades in the United States." *Environmental Progress and Sustainable Energy*, American Institute of Chemical Engineers, June 12, 2022, onlinelibrary.wiley.com/doi/10.1002/ep.13932. Accessed November 2024.
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Solar decommissioning options



Extending the performance period

Repowering involves redesigning the system and installing new arrays and inverters to rebuild or replace the power source, which can cost about 80% of the total plant value. A repowered solar system is new in most respects but can leverage existing land-use, permitting, and utility interconnections.¹²

Refurbishment involves making necessary repairs to extend the lifespan of the system's older equipment. Refurbishing older equipment can be challenging due to the difficulty of finding parts and lack of expertise in working with older technologies.¹³

Reuse of the system's photovoltaic modules is the most economically and environmentally beneficial option and can provide opportunities for revenue or tax savings.¹⁴



Full decommissioning

Recycling solar panels decreases waste and allows for the recovery of high-value and energy-intensive materials.¹⁵ Solar panels typically consist of materials that can be successfully recovered and easily recycled.

Disposal of solar energy system equipment by landfill is the least expensive and most accessible option, although it presents environmental drawbacks.¹⁶ Disposal of solar panels should be done with careful consideration of federal, state, and local solid waste requirements.¹⁷

Sources, continued

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Decommissioning costs

Costs for decommissioning wind and solar energy projects vary widely. Cost differences depend on numerous factors specific to the project, site, calculation methods, local government requirements, and whether salvage value is included as part of the total. Using local, independent professionals, such as third-party engineers, to develop a project-specific decommissioning cost estimate can assist with planning for decommissioning. Additionally, ordinances can require developers to submit financial assurance to guarantee funds will be available for the removal of projects, ensuring financial responsibility for decommissioning falls to the project owner, not the county or landowners.

Decommissioning cost estimates	
Wind ¹⁸	Solar ¹⁹
Data from a limited review of eight decommissioning estimates for wind energy projects proposed from 2019 to 2021 showed the average cost of decommissioning is between \$114,000 and \$195,000 per turbine. When salvage estimates were included, decommissioning costs were reduced to a net range of \$67,000 to \$150,000 per turbine.	Few solar projects have yet to be decommissioned, so cost estimates vary widely. One source estimated the decommissioning costs for a 2 MW solar installation and found that the total cost after 20 years, taking into account a 2.5% interest rate, is \$98,900.

Components of a decommissioning plan

Decommissioning plans for wind and solar energy systems often include:

- Decommissioning tasks and a timeframe for completion of decommissioning activities.
- A description of expected impacts on natural resources.
- An estimated lifespan of the project.
- Identification of the party responsible for decommissioning.
- Plans and schedule for updating the decommissioning plan over time. This may include updating the cost of decommissioning.
- Description of any agreement made with a landowner regarding decommissioning.
- A statement defining how notification will be made of intent to start the decommissioning process.
- A detailed cost estimate prepared by a knowledgeable independent party. This may or may not include the salvage value of wind equipment and infrastructure.
- Financial surety, which may be established through different financial instruments, such as trusts or escrow accounts, bonds, letters of credit, or other types of agreements.

Sources, continued

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Recommendations for decommissioning

As county officials look to enact siting or zoning standards for wind and solar energy ordinances, we recommend they:

- Include a requirement for decommissioning plans in their ordinances, outlining the obligations and methods developers will use to decommission projects, remove materials, and restore sites.
- Ensure that decommissioning plans include expected timelines for completion of tasks.
- Require the project developer to notify the county of its intent to stop using the facility once it has been determined the system will be fully retired.
- Work with a knowledgeable independent party to determine the real projected cost of decommissioning for a project and use that to set amounts for financial assurances.
- Include a provision that the project owner is responsible for the costs of decommissioning, ensuring the county and landowners do not bear these costs.
- Determine if there are existing standards for decommissioning at the state level prior to county officials drafting any requirements and address any additional decommissioning related issues through an ordinance.
- Consider how they want to regulate disposal into landfills and encourage recycling or repurposing of wind and solar components.



This fact sheet is based on the Center's wind and solar decommissioning guides:

- To learn more about decommissioning solar energy systems, visit cfra.org/decommissioning-solar-energy-systems
- To learn more about decommissioning wind energy systems, visit cfra.org/decommissioning-wind-energy-systems