DISTRIBUTED WIND FINANCE CASE STUDY: 10 KW FOR 40+ YEARS

A lifelong financial asset for an Oklahoma family

RADWIND Project

This is the second in a series of case studies on financing distributed wind projects at electric cooperatives and other rural utilities for NRECA Research's *Rural Area Distributed Wind Integration Network Development* (RADWIND) project. RADWIND's goal is to understand, address, and reduce the technical risks and market barriers to the adoption of distributed wind technologies by rural utilities. Distributed wind projects can use any scale of turbine from small kilowatt-scale units up to large multi-megawatt units, as long as they are connected on the distribution side of the electric grid. Turbines may be connected on the customer side of the meter to serve a local load, directly to the distribution grid as a utility generating asset, or directly powering an off-grid load. For more information on the project and additional resources, please visit the project landing page at www.cooperative.com/radwind.

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Project Snapshot

Cooperative	Project Ownership	Project Size	Turbine Size	Other System Equipment	Connection	Energy End Use
Oklahoma Electric Cooperative (OEC)	Residential member	10 kW	10 kW	Inverter	Behind-the-meter, distribution grid	Residential, net-metered

Project Background

In 1983, Donna and Ron Hames, members of Oklahoma Electric Cooperative (OEC), installed a 10-kW Bergey Windpower wind turbine next to their A-frame home in Norman, Oklahoma. Ron passed away in 2016 and Donna sold the home in 2019, but the wind turbine is still operating. Mike Bergey, co-founder and president of Bergey Windpower Co., recalls that Ron was motivated to purchase the turbine by the project economics, which were helped by federal and state tax credits available at the time. He also recalled that Ron liked the idea of using wind to make power, turning an annoyance into a source of income.

Bergey Windpower's advertising campaign in the early 1980s was "How to Make Money with Wind." State and federal tax credits at that time coupled with the generation potential made wind energy financially appealing for residential applications in many areas of the U.S., including Oklahoma. Unlike today, member interest in clean energy was not common or driving the market. A central selling point for the Hameses and likely other distributed wind customers at the time was the positive investment opportunity, especially given that it was not as common as it is today for middle class families to invest in the stock market. The proximity to Bergey Windpower's headquarters was another likely motivation for the Hameses specifically. "We had fairly good visibility in the community because we had several newspaper articles about us—this was newfangled technology and we were a growing local business," said Bergey.

Often when a story starts with "newfangled technology" and "investment opportunity," the ending is not good. This story is different. Donna and Ron Hames ended up with a piece of equipment that would pay for itself in 12 years through reliable energy generation. It would then continue steady operation for an additional 27 years and counting, outlasting most cars, furnaces, and roofs, while saving the homeowners from $600 up to more than $1,200 every year since it was paid off in 1995.

Neither NRECA nor its RADWIND project endorse products or manufacturers. For a list of small wind turbines that are certified to current U.S. industry standards as of August 2022, see Pacific Northwest National Laboratory's *Distributed Wind Market Report: 2022 Edition*.[1] The purpose of profiling the Hameses' system in a RADWIND finance case study is to share information about a reliable, small distributed wind system from early adopters. Their story is noteworthy because of its long-running performance. As of 1985, Bergey Windpower had installed about 800 10-kW wind turbines like the ones the Hameses bought. The goal of this case study is to profile a system with a known history to help co-ops and their members assess risks and benefits of investing in small distributed wind turbines today.

[1] Available from: https://www.energy.gov/eere/wind/articles/distributed-wind-market-report-2022-edition

Technical Details

The 10-kW wind turbine is installed on an 80-foot guyed tilt-up tower approximately 40 feet from a shed that houses the inverter and 140 feet away from the two-story home. The property is a 17-acre parcel about 8 miles east of Norman. Trees have grown taller on the property since the wind turbine was installed, but they do not appear to be impeding performance.

Interconnection and Metering

The system is connected behind-the-meter to OEC's distribution network. When the system was installed in 1983, Oklahoma did not have a state net-metering policy and OEC had only about 20 other residential members with grid-tied distributed generation, mostly Bergey 1-kW turbines. Working with Bergey

Windpower and the Hameses, the co-op installed a separate meter for the wind turbine that spun backwards only. The original home's meter spun forwards only. Generation from the wind turbine was used instantaneously on site, and any excess was sold back to OEC. "It was really pretty informal," said Bergey. In 1988, the Oklahoma Corporation Commission enacted net-metering rules for small power producers like the Hameses, after which, net-metering for this system complied with state regulations. As of June 2022, Oklahoma's net-metering policy allows net-metering of systems up to 25 kW with utility compensation for monthly net excess generation at their avoided cost rate.[2]

Figure 1. 10-kW wind turbine at Hames residence. Courtesy of Bergey Windpower.

Production

Given the tower height and the wind conditions in this area, the Hameses' wind turbine has consistently produced about 10,000 kWh or more each year since 1983. Specific data on how this amount of production compared to the home's annual energy consumption is not available; however, if the home electricity usage were in alignment with state averages during that time period, the wind turbine's generation would have offset about 80% of their usage.[3] Based on other small wind customer energy data at that time, Bergey expects the wind turbine's generation met 100% of the Hameses' usage for nine months a year, with additional electricity needed from the co-op during the summer when wind speeds slow and the demand for air conditioning is high.

Operations & Maintenance

Over the system's 39-year life to date, the wind turbine itself has required very little maintenance. According to Bergey, from 1983 to 2014, the wind turbine operated with all original equipment and almost no maintenance. Bergey attributes this to his late father and Bergey Windpower co-founder, Karl Bergey. "One of his greatest contributions was really forcing us to focus on simplicity of design," said (Mike) Bergey. The wind turbine has only three moving parts—combined rotor and generator, tower pivot, and hinged tail.

Bergey Windpower has performed repairs and maintenance over the years on the first-generation inverter, which was damaged at times by line surges on the local distribution network, local brownouts, and component deterioration. The original inverter was installed before the Underwriters Laboratories (UL) standard 1741, *Inverters, Converters, Controllers and Interconnection System Equipment for Use With*

[2] https://programs.dsireusa.org/system/program/detail/286, accessed on August 22, 2022
[3] https://www.eia.gov/electricity/state/oklahoma/

Distributed Energy Resources,[4] was developed, but it did have safety shutdowns in the event of grid failure. The turbine's electrical system has never caused a safety issue or line disturbance even though, as Bergey noted, the old silicon-controlled rectifier (SCR) and analog circuitry systems had high harmonic distortion levels and could never meet the UL 1741's requirements of today.

Besides repairs to the inverter, the only other notable maintenance before 2014 was two rounds of leading-edge tape replacement on the blades. In 2014, the Hameses upgraded the system with newer blades and a new inverter to improve performance, increasing output by about 25%.

Today, Bergey Windpower advises their customers to budget $300 per year for maintenance. This amount won't be needed every year; however, if saved over time, it will be available to cover infrequent maintenance needs (e.g., in 10-year intervals), such as worn electronic circuitry in inverters. Note that the manufacturer recommends regular inspections of their turbines to determine if any maintenance is needed.

Economic Details

The total installed cost for this system in 1983 was about $22,000, and the Hameses' recouped $7,500 of that through federal and state tax credits available at that time.[5]

Figure 2. 10-kW wind turbine at Hames residence. Courtesy of Bergey Windpower.

[4] https://www.shopulstandards.com/ProductDetail.aspx?UniqueKey=20941

[5] $22,000 in 1983 dollars is worth about $65,000 in 2022 dollars. See: https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=22%2C000.00&year1=198301&year2=202205

Through savings from offset electricity usage and net-metering, the owners recouped their total investment of $14,500 ($22,000 installation cost less the $7,500 in tax credits) in 12 years, by 1995. Since that time, the system has continued to produce about 10,000 kWh or more per year. Average retail electricity rates in Oklahoma have increased from $0.068 in 1995 to $0.101 in 2020, so the retail value of the system's annual generation has increased from about $660 per year in 1995 dollars to more than $1,000 in 2020 dollars. The cumulative retail value from 1995 to 2020 is worth more than $30,000 when adjusted for inflation to 2022 dollars.[6]

The Hameses timed their purchase well for tax credits. State and federal tax credits for small wind turbines have started and stopped multiple times over the past four decades. The Energy Tax Act of 1978 first created tax credits for residential wind and other renewable sources. These credits were extended through 1985 and then discontinued. After that, temporary extensions were made for solar, geothermal, and a few other technologies. Small wind, however, was not addressed again until The Emergency Economic Stabilization Act of 2008, which included a 30% tax credit for small wind that was extended through 2019.[7]

Under the Inflation Reduction Act of 2022 (IRA),[8] there is a 30% investment tax credit (ITC) available for residential small wind energy systems placed in service before 2025, with additional technology neutral "Clean Electricity" ITC provisions for non-greenhouse gas emitting technologies placed into service in 2025 or later. These new credits extend into the 2030s.[9] State credits vary widely. Oklahoma's tax credit expired in 1985 and was never reinstated. The Database of State Incentives for Renewables & Efficiency (DSIRE) (https://www.dsireusa.org/) is an excellent resource with current information on state-by-state and federal incentives.

Financing

Whether the Hameses used any type of personal financing to pay the upfront cost of their wind turbine is unknown, but Mike Bergey expects they did not. In the early 1980's, personal loans and mortgages carried interest rates of 15% to 20%, much higher than what is common today. Given that, and the favorable policies available at the time, it is likely the couple decided they could finance the balance of the cost themselves. Today, homeowners interested in financing small wind projects may choose to work with banks, credit unions, community development financial institutions, or other lenders. The DSIRE website mentioned earlier includes financing-related information on available grants, loans, and local net-metering rules.

In addition, some electric co-ops help members finance related projects. As of July 2022, 90 co-ops[10] offer on-bill programs to help members acquire and utilize energy efficient, solar PV, and battery storage equipment. Several of these programs include residential solar systems, a few are piloting programs that include whole-home battery storage, and some may find small wind to be a viable program measure,

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[6] https://www.eia.gov/electricity/state/oklahoma/ adjusted annually to 2022 dollars via the U.S. Bureau of Labor Statistics CPI Inflation Calculator available from: https://www.bls.gov/data/inflation_calculator.htm
[7] See: https://crsreports.congress.gov/product/pdf/IF/IF10479 and Appendix B: https://www.everycrsreport.com/reports/R42089.html#_Ref308424243
[8] https://www.congress.gov/bill/117th-congress/house-bill/5376/text
[9] https://www.natlawreview.com/article/relief-arrives-renewable-energy-industry-inflation-reduction-act-2022
[10] According to 2022 data from the Energy and Environmental Study Institute (EESI), https://www.eesi.org/obf/map

although none include small wind now. For more information, see the RADWIND Finance Case Study, *Opportunities for Including Distributed Wind in On-Bill Programs*.[11]

Benefits to Members

A straightforward, easily quantifiable benefit of this project is a 10,000 to 12,500 kWh/year offset to the home's power bill. Beyond that, other benefits from this kind of project vary based on individual needs and desires. Some community members may value being able to generate clean, local, energy, or the option to add a home battery energy storage system (BESS) that could be charged with renewable energy. As consumers witness increasing occurrences of extreme weather, power outages, and supply chain disruptions, home resiliency is becoming increasingly important to many. For example, market research sources estimate a compound annual growth rate of around 4.5% per year from 2021 to 2030 for the U.S. residential fuel-based generator market, which is projected to reach $1.5 billion by 2030.[12]

From a financial perspective, some consumers may view the ability to lock in a fixed price of energy for years to come as a way to build wealth over time. Regardless of a person's interest in energy, a distributed wind turbine with a payback at a quarter of the equipment lifetime (or less) and zero fuel cost may be an appealing investment. In this case, by 2023, the Hameses' system will have yielded a 300% return on their initial investment of $14,500 (after tax credits).

Considerations for Cooperatives

Some may wonder how such a project could be good for a co-op. It results in lost sales for the co-op, and depending on how rates are structured, it may mean that the member pays less than others in the area for things like line maintenance. However, projects like this one also have value streams for co-ops related to member interest, peak shaving, deferral of line upgrades, power quality, resiliency, and potential future grid services.

Co-ops have a long-standing mission and history of cultivating member satisfaction. As with many other measures, supporting members who wish to install distributed generation, including small wind turbines, creates goodwill. It also helps ensure better outcomes for both parties. By having a role in project planning, a co-op can advise and educate members on quality manufacturers, equipment, and other aspects of system design. This has a dual benefit. Members are informed on reliable systems and expectations, and co-ops avoid connecting potentially troublesome equipment to their networks.[13]

In addition to helping any member, some co-ops may want to consider reaching out to members in strategic locations about small distributed projects that could help the co-op. For example, if a remote line is reaching capacity, one or more small wind turbines, PV systems, and/or BESS could help defer line upgrades by reducing peaks.

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[11] https://www.cooperative.com/programs-services/bts/radwind/Pages/On-Bill-Financing-Opportunities-for-Distributed-Wind.aspx

[12] https://www.transparencymarketresearch.com/residential-generators-market.html

[13] For more information on relevant codes and standards, see the 2022 NRECA Business & Technology Advisories: *Applicable Standards for Small and Medium Wind Turbines for Electric Cooperatives* and *Improving Cost Competitiveness of Small and Medium Wind Turbines and the Competitiveness Improvement Project*, both available from: https://www.cooperative.com/programs-services/bts/radwind/Pages/default.aspx

Similarly, like large wind turbines, many of today's small wind turbines can provide frequency and voltage support to the grid. More research is needed on how many distributed wind turbines are required to offer this kind of support in different applications, or for which conditions they are most effective. However, having a handful or even just one reliable small wind turbine connected to the co-op's network may offer co-op staff a chance to get familiar with system performance and test possible ancillary benefits to the local grid. For example, could a <100 kW wind turbine at a member's farm offset power quality issues from large induction loads? New power electronics and storage technology are opening new opportunities for consumer-owned generation to provide grid services.

Small distributed wind systems can also be a part of a co-op's peak reduction and beneficial electrification strategies. Unlike solar, properly sited small wind turbines can generate electricity about 90% of the time,[14] meaning that they typically produce at least some power during evening peaks and overnight through the early morning when electric cars are charging at homes.

These attributes make small wind a good fit for many residential and small business applications, whether it is the only renewable energy source or paired with solar to take advantage of complementary daily and seasonal generation patterns. The addition of a BESS to a small wind system further increases the value to co-ops. In addition to dispatchable stored energy, the power quality correction features may also be available on demand. A wind-powered BESS could also offset the need for fuel by serving as a backup generator during power outages.

While few members have whole-home BESS to absorb excess distributed generation now, some co-ops and other utilities are exploring the shared benefits of battery storage located in consumers' homes. Colorado's Holy Cross Energy is piloting an on-bill tariff program whereby members can receive financial support to purchase a whole-home battery that the co-op can tap into if needed during peaks. Other utilities piloting shared-benefit home BESS programs include Arizona Public Service, Portland General Electric (Oregon), and Green Mountain Power (Vermont).[15] Small, distributed wind turbines could be a viable component of similar programs in many areas. Wind plus BESS hybrid programs could further reduce peak power purchases for distribution utilities above non-storage programs, increase local resiliency, and insulate individual members or neighborhoods from power outages.

Key Lessons and Insights

Over the past few years, interest in residential solar energy systems has skyrocketed, realizing 33% growth per year for the past ten years,[16] while the growth rate for residential wind systems has remained flat.[17] However, the Hames project, quietly operating for nearly 40 years, shows that small wind can be a reliable, low-maintenance option with a very long operating life. Distributed wind turbines may be a better choice than solar for some members and an effective complement in hybrid systems for others. For co-ops, having a consumer portfolio with a mix of strategically sited wind and solar may help grid

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[14] https://cleanpower.org/facts/wind-power/#:~:text=Over%20the%20course%20of%20a,increase%2C%20so%20does%20electricity%20productio n.

[15] https://www.eesi.org/articles/view/home-battery-storage-programs-provide-grid-flexibility-and-save-customers-money

[16] https://www.seia.org/solar-industry-research-data#:~:text=Residential%20Market%20Continues%20to%20Diversify,2020%20with%204.2%20GW%20installed

[17] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, *Distributed Wind Market Report: 2021 Edition*, available from: https://www.energy.gov/eere/wind/articles/distributed-wind-market-report-2021-edition-released

operations in localized areas and offer more opportunities for peak reduction and beneficial electrification. Members interested in distributed generation have a variety of motivations, but most have some goals in common—smart financial investment and reliable equipment. Co-ops can take leading roles in these projects as primary trusted advisors, helping members have successful projects that benefit the individual member, the cooperative as a whole, and the broader community.

Contact for Questions

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Additional Information on NRECA's RADWIND Project

For more information on the RADWIND project and additional resources, please visit the project landing page at www.cooperative.com/radwind.

Want to stay informed of our progress with the RADWIND project, and provide your input and feedback? We welcome all NRECA members to join the project as an advisor. Contact our team at: RadwindProject@nreca.coop.