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DISTRIBUTED WIND CASE STUDY: FOX ISLANDS ELECTRIC COOPERATIVE

Generating local wind energy and resiliency for two Maine island communities

Fox Islands Electric Cooperative
Member-Owned Since 1975

RADWIND Project

This is the sixth in a series of case studies on 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.

The distributed wind project profiled in this case study is part of a front-of-meter community wind farm connected to the co-op's distribution grid.

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Project Snapshot

Cooperative	Project Ownership	Project Size	Turbine Size	Other System Equip.	Connection	Energy End Use
Fox Islands Electric Cooperative (FIEC)	Fox Islands Wind, LLC (FIW), a subsidiary of FIEC	4.5 MW	1.5 MW	Submarine power cable	Front-of-meter, distribution grid	Offsets wholesale power purchases

Cooperative Profile

Fox Islands Electric Cooperative (Fox Islands Electric/FIEC)[1] is an eight-employee electric cooperative that serves Vinalhaven and North Haven Islands, rural lobster fishing communities located off the southern coast of Maine. See Figure 1. The co-op has about 1,200 year-round members and 500 seasonal members, and during the summer tourist season the islands' population more than doubles.[2]

Figure 1. Fox Islands Electric Cooperative's Territory

Unlike many electric co-ops, which were formed in the 1930s and 1940s as a result of the Rural Electrification Act and other efforts by the federal government,[3] Fox Islands Electric is relatively new. Established in 1975, the co-op took over from the previous power provider, Vinalhaven Light & Power Company, that had been operating there since 1915. Until the co-op was formed, the community's electricity came from a 400-kW coal plant which was converted to diesel generators in the 1920s. In the 1960s and 1970s, the plant could no longer keep up with the islanders' electricity needs. To address this, Vinalhaven Light & Power implemented a time-share arrangement. Residents were divided into two groups, and power was switched from one to the other several times a day. At any given time, half the residents had power while the other half were in the dark.[4]

When the cooperative was formed, one of their first actions was to run an 11-mile-long submarine power cable to the mainland. This enabled FIEC to purchase wholesale power from New England's independent system operator, ISO New England (ISO-NE),[5] through the Vermont Public Power Supply Authority[6] and provide enough electricity for all members at the same time. In 2005, the co-op replaced the 30-year-old cable with a new submarine transmission cable buried beneath the ocean floor. Today, while the co-op continues to purchase some power from the mainland, the community gets more than 65% of their electricity from a 4.5 MW community-owned wind farm on Vinalhaven Island.[7]

Although Fox Islands Electric Cooperative is tiny, it is a leader in distributed wind energy. The co-op's wind farm was Maine's first wind project on an island and is still one of the East Coast's largest community-owned wind projects.[8] Furthermore, it puts FIEC into the lead among co-ops, with one of the highest shares of wind energy of any co-op nationwide.

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[1] https://www.foxislands.net/
[2] https://cleantechnica.com/2009/11/17/100-percent-wind-powered-island-wind-plant-goes-online/
[3] https://www.electric.coop/our-organization/history
[4] https://www.foxislands.net/energy.html
[5] https://www.iso-ne.com/
[6] https://vppsa.com/
[7] https://www.foxislands.net/energy.html
[8] https://cleantechnica.com/2009/11/17/100-percent-wind-powered-island-wind-plant-goes-online/

Project Background

In 2001, co-op staff and board members began discussions about generating wind energy locally to reduce the cost of energy.[9] At that time, electricity prices on the island were more than double the prices on the mainland and could be volatile due to the energy market in Maine.

Spurred by community member interest in lowering costs with local renewable energy generation, Fox Islands Electric applied for and received a Rural Utility Service (RUS) grant for a three-year wind feasibility study. The findings indicated that a wind farm sized to meet community needs could save members between $0.02 and $0.04/kWh.[10] While the co-op continued to evaluate developing a wind farm, Hurricane Katrina hit the Gulf Coast in 2005, disrupting natural gas supply. Prior to the wind farm coming online, members were paying up to $0.30/kWh, which included costs incurred from replacing the original submarine transmission line.[11] The temporary price spikes resulted in extremely high electricity bills for some members and re-energized the discussion about local wind energy.[12]

In 2006, the decision about whether or not to pursue wind farm ownership was put to a member vote, which resulted in 383 yeses and only 5 noes.[13] With that strong directive, the co-op proceeded to build a wind farm, forming a for-profit subsidiary called Fox Islands Wind, LLC (FIW) and naming George Baker, a Harvard Business School professor with a second home on Fox Islands, as CEO. The wind farm broke ground in 2008 and by November of 2009, it was producing local, renewable energy.

Figure 2. Fox Islands Wind Turbines.

Credit: Cianbro, https://www.cianbro.com/Projects-Markets/ProjectDetails/pid/495

[9] https://www.islandinstitute.org/ii-solution/fox-islands-wind/

[10] https://maineinsights.com/fox-islands-electric-cooperative-a-model-for-community-wind/

[11] https://cleantechnica.com/2009/11/17/100-percent-wind-powered-island-wind-plant-goes-online/

[12] https://bangordailynews.com/2009/06/29/news/islanders-celebrate-wind-power/

[13] https://maineinsights.com/fox-islands-electric-cooperative-a-model-for-community-wind/

Technical Details

The 4.5 MW wind farm consists of three 1.5 MW General Electric (GE) wind turbines, model: GE Energy 1.5sle. Turbine towers are 250 feet tall (76 meters), and rotors are 253 feet in diameter (77 meters).

The wind farm's capacity factor is 25.5%, but this is lower than its technical potential, which is estimated to be a 30% capacity factor. Over the life of the project, FIW has made operational and equipment adjustments to the turbines to address some community members' concerns about sound. Prior to these adjustments, the project met all state requirements for sound as verified by Acentech,[14] an independent third-party acoustical engineering firm. The firm found that all wind turbine sound was within the range of pre-project decibel levels from noises such as wind blowing through trees. The wind farm is continually monitored to ensure it does not exceed permitted sound levels. Except for a short period in 2016 when a noise was produced by a failed bearing, the wind farm sound level has been in compliance with all applicable regulations. Nonetheless, some nearby members feel disturbed by sounds from the wind turbines.[15]

To address these concerns, in 2011, FIW worked with GE to design and implement a new noise reduction curtailment protocol. Currently, FIW curtails all three turbines for 12 hours every day — 7:00 p.m. to 7:00 a.m. — by derating them from 1.5 MW to 1.3 MW during this time. FIW will follow this curtailment protocol until the turbines can be retrofitted with automated technology. In addition, FIW and GE installed serrated, low-noise trailing edge (LNTE) technology on the blade tips to further reduce sound.[16] The current curtailment protocol results in a 10% loss in generation each year.

Siting and Interconnection

The project is located on land leased from a long-time Vinalhaven resident and cooperative member. The turbines are two miles from a 10 MVA substation owned by FIEC. The project is connected to the substation at 3-phase 12.47 kV line voltage.

Metering

The wind farm's total generation is first metered on-site before being distributed to Fox Islands Electric's local distribution grid for use by members. Any wind energy not used on Fox Islands is transmitted via the co-op's 11-mile submarine cable to the mainland. It is metered there at a switching substation near Rockland, Maine before being sold into the regional grid.

According to Amy Watson Turner, Fox Islands Electric's CEO, line losses associated with transmitting energy over the 11-mile submarine cable are around 6% in each direction. This loss, over and above standard transmission line losses, results in only 94% of FIW's excess wind energy being metered, and ultimately purchased, on the mainland. Turner calculated the submarine transmission line loss from the wind farm alone in 2020 to be 700 MWh.

[14] https://www.acentech.com/
[15] Acentech Report to Maine Department of Environmental Protection, 5 July 2016
[16] Acentech Report to Maine Department of Environmental Protection, 5 July 2016

Production

In 2020, the derated and curtailed turbines collectively generated just under 10,000 MWh. Although the co-op's annual sales are close to 12,000 MWh, Fox Islands Electric used only 6,745 MWh of its wind energy because of daily and seasonal usage variations. FIW sold the remainder — more than 3,000 MWh — at wholesale to ISO-NE.

During the first several years of the project, this arrangement saved the co-op and its members money, since FIW could generate wind energy for less than it cost to purchase wholesale electricity. Also, the wind farm had predictable prices, whereas wholesale market prices for electricity fluctuated widely. However, during the life of the project, the energy market in Maine was deregulated and the state eventually became a net energy exporter, both of which contributed to lower wholesale power prices. As a result, in recent years, wind energy from FIW has cost the co-op more than wholesale electricity from ISO-NE.

Planning & Engineering

The Renewable Energy Research Laboratory at the University of Massachusetts Amherst conducted the project's first feasibility studies to assess wind speeds on Vinalhaven.[17] Fox Islands Electric then hired the engineering firm Woodard & Curran[18] to model a wind project and draft a preliminary wind engineering report to include site development, generation capacity, acoustic analysis, visual impacts, and budgetary projections. When the project began in earnest, FIW (the sole owner of the wind farm) contracted with Cianbro,[19] a 100% employee-owned construction company, for engineering, procurement, and construction.

According to Cianbro, for this project, they:

- Provided support to the owner through permitting, engineering and procurement of the turbines,
- Cleared the site,
- Constructed the site road,
- Placed the concrete foundations,
- Erected the three wind turbines, including tower sections, nacelle, hub, and blades,
- Installed the collection and interconnect system, and
- Installed the SCADA and communications systems.[20]

Constructing a wind farm on the island necessitated some interesting logistics. All materials and equipment — including cranes, towers, blades, nacelles, and concrete — had to be delivered by barge without causing excessive disruption to the islands' tourism and fishing economies. In total, Cianbro had 75 different barge loads transported to the site.[21] See Figure 3.

[17] https://www.umass.edu/windenergy/sites/default/files/downloads/pdfs/Vinalhaven_2004_QuarterlyReport_Spring.pdf
[18] https://www.woodardcurran.com/
[19] https://www.cianbro.com/
[20] https://www.cianbro.com/Projects-Markets/ProjectDetails/pid/495
[21] https://www.cianbro.com/Projects-Markets/ProjectDetails/pid/495

Figure 3. Barge Delivering Wind Turbine Blades to Fox Islands.
Credit: Cianbro, https://www.cianbro.com/Projects-Markets/ProjectDetails/pid/495

Operations & Maintenance

FIEC staff, contracted by FIW, handle routine turbine maintenance like oil changes. FIW also has a maintenance agreement with GE for twice yearly inspections and major service. Other than some gearing adjustments needed to derate the turbines, FIW has experienced two major O&M issues to date — a bearing problem identified in 2016 in one of the turbines and gearbox failure in another turbine in 2019.

In both instances, the repairs were labor intensive and expensive processes that required cranes to be leased and delivered via barges from the mainland. Fortunately, the project's insurance covered most of the repair expenses and lost revenue from the lapse in generation; however, the co-op was responsible for $50,000 and $200,000 deductibles for the respective claims.[22]

The cost of operating the wind farm was estimated initially at $150,000 annually, which fell significantly short of the expenses incurred each year since the commercial operation date. The O&M costs, as well as insurance and litigation expenses, have contributed to a much higher kWh cost than projected.

[22] https://www.islandinstitute.org/ii-solution/fox-islands-wind/

Economic Details

Financing

Diversified Communications,[23] a global media company and project investor headquartered in nearby Portland, Maine, and Fox Islands Electric formed a for-profit subsidiary, Fox Islands Wind, LLC, to help with financing for the $14.5 million project. Baker, FIW's CEO, assisted in the process. Because FIW was a for-profit entity, it could take advantage of the 30% tax credit available at that time from the federal Investment Tax Credit (ITC).[24]

Diversified Communications invested $5 million in exchange for the tax credits from the ITC. FIW secured the remaining $9.5 million from a USDA RUS loan at 3.545% interest plus a 0.00125% adder on principal for a term of 19 years, reaching maturity on December 31, 2029.[25] Fox Islands Electric bought out Diversified Communications' interest in FIW in 2014, converting FIW into a wholly owned nonprofit subsidiary of Fox Islands Electric.

Power Purchase Agreements and Renewable Energy Credits

FIW's wind generation offsets the amount of energy that Fox Islands Electric purchases. Vermont Public Power Supply Authority transacts purchases of any excess generation from FIW to ISO-NE. Because FIEC is an independent (or unaffiliated) cooperative without an all requirements contract with a G&T or other wholesale electricity provider, it does not have contractual limits on the quantity of self-generation.

A significant source of income for FIW is the sale of renewable energy certificates (or credits) (RECs). FIW RECs are Class 1 Maine RECs[26] and are certified for sale in ISO-NE. State and regional renewable portfolio standards (RPS) create a healthy REC market in New England. According to Turner, in 2021, the price in the region for a Class 1 Maine REC is about $30/MWh.

Members and Community

Because it is member-owned, the wind project is deeply intertwined with the community's identity.[27] While the project unintentionally raised some difficult issues for the community regarding sound perceptions and the risks of locally-owned generation, Turner has observed that the community is "largely supportive" and that the wind project remains "a source of pride for a lot of our community." That sentiment was evident from the beginning. When the wind farm was built, the community showed interest and excitement with well-attended dedication ceremonies and positive news stories in national and

[23] https://www.divcom.com/

[24] https://windexchange.energy.gov/projects/tax-credits

[25] https://cleantechnica.com/2009/11/17/100-percent-wind-powered-island-wind-plant-goes-online/

[26] Class 1 indicates new renewables that have come online after 2005. https://programs.dsireusa.org/system/program/detail/452

[27] According to the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EERE), "The distinguishing feature of a community wind project is that one or more local community members receive the majority of the economic benefits of the project, beyond land lease payments." https://windexchange.energy.gov/markets/community

regional outlets.[28] As Baker was quoted in one article, "What could have been a disruptive summer [of construction] was instead a constant celebration."[29]

A more quantifiable outcome for members is the financial impact of the project to their electricity rates. Early estimates suggested that over the 25-year estimated project lifetime, the average Fox Islands Electric member would save $7,000 from locally-generated wind energy compared to the expensive wholesale energy available at the project's onset.[30] This calculation is no longer accurate due to market changes and operational adjustments after the project began. For the first several project years, members enjoyed lower rates, but wholesale prices went down after Maine's energy market was fully deregulated and are now lower than FIW's cost to generate.

However, it is also likely that market conditions will change again during the remaining ten or so project years and improve project financials. For example, in 2019, Maine adopted an RPS for 80% clean energy by 2030, working towards 100% by 2050.[31] As the Maine Public Utilities Commission and other affected entities work towards this goal, demand for and value of wind energy is expected to increase.

Looking ahead, Turner sees FIW as having an integral role in the islands' resiliency in the face of rising sea levels, warming oceans, and the increasing frequency and intensity of storms. The islands are also at risk from non-climate related threats like cyber-attacks on the national grid or energy supply. The premium that FIEC and its members are paying now for local wind energy can be seen as a kind of insurance against external forces like climate and energy supply uncertainty because it buys the community energy independence. "Having a resilient and strong energy system is really important to sustain our community," said Turner. In response, Fox Islands Electric is actively exploring options for adding battery storage to their wind farm.

Project Experience, Opportunities, and Challenges

FIW has experienced highs and lows that are typical of high-profile community efforts. Most members feel connected to and proud of the project. And annually, the wind farm generates almost as much electricity as the islands use, putting Vinalhaven and North Haven much farther along the path of energy independence than most communities in the country. But, the project also faces challenges. In a 2016 interview with Island Institute,[32] former Fox Islands Electric general manager Chip Farrington discussed his take on a few unexpected issues that arose during his tenure:

- **Increased administrative work for the co-op:** The co-op became responsible for new tasks such as maintaining accounting records, keeping insurance coverage current, keeping operational records, and selling RECs. "A wind project creates additional administrative and mechanical work, and a community-run project faces challenges that a commercial wind project may not. The nine employees of the Fox Islands Electric Co-op don't have the same training as employees of a

[28] For example: https://maineinsights.com/fox-islands-electric-cooperative-a-model-for-community-wind/ Many other articles from this era are no longer readily accessible online, but are referenced here: https://en.wikipedia.org/wiki/Fox_Islands_Electric_Cooperative#Fox_Islands_Wind_Project

[29] For example: https://maineinsights.com/fox-islands-electric-cooperative-a-model-for-community-wind/ Many other articles from this era are no longer readily accessible online, but are referenced here: https://en.wikipedia.org/wiki/Fox_Islands_Electric_Cooperative#Fox_Islands_Wind_Project

[30] https://cleantechnica.com/2009/11/17/100-percent-wind-powered-island-wind-plant-goes-online/

[31] https://www.maine.gov/energy/initiatives/renewable-energy/renewable-portfolio-standards

[32] https://www.islandinstitute.org/ii-solution/fox-islands-wind/

wind development company. Turbines don't operate on their own, and the manufacturer may not always be available for assistance."

- **Neighbor concern over sound:** Existing ambient sound and projected turbine sound were both assessed in the planning phase; however, once the wind farm was built and operational, some neighbors complained of disturbance despite the fact that the wind farm's sound was in compliance with regulations. An understanding of these concerns upfront, including legal limits, should be "rock solid," advised Farrington.

- **Actual production lower that predicted:** To address sound concerns, FIW turbines are curtailed 12 hours overnight, from 7:00 p.m. to 7:00 a.m. the following day, which reduces production, thereby increasing the cost per kWh.

Although Turner was not employed by FIEC until 2020, she noted that initial inaccuracies in the project's performance and expense forecasting may have contributed to unrealistic expectations among some members. While market and operating conditions will almost certainly change over the course of any 25-year project, having accurate data and setting realistic expectations upfront is integral to maintaining community trust.

Fortunately, the project is far from over. Adding battery storage to the wind farm could have a significant impact on the co-op and the community. If FIW stored excess generation for use when demand is greater than generation, the co-op could reduce its wholesale purchase to under 2,000 MWh in a typical year, which is less than half of their current annual wholesale power purchase need of about 5,000 MWh. Energy storage would insulate members from future wholesale price swings and allow the islands to operate almost entirely off of renewable energy, increasing resilience and energy independence. Furthermore, using the wind energy locally would avoid the 6% line loss associated with transmitting power to and from the mainland.

Key Lessons and Insights

An essential part of this project is the community involvement, and Turner is very supportive of a local decision-making process. "Energy decisions should be made locally, allowing customers to decide how to invest their dollars. They're the ones taking the financial risk from a rate perspective, and they're the ones that will experience the beneficial or negative consequences of such risk," she said. With FIW, the community benefited from lower electricity prices at one point, but currently faces higher prices. "But projecting out, it looks like the overall investment will be worth it from an economic standpoint."

Fox Islands Electric members will soon have another opportunity to voice their opinions about the project's direction. The turbines will be ready for repowering by 2030, and Turner expects the decision on how to proceed will be put to members, just as it was when members voted to develop the wind farm back in 2006. "We have a very active community, and we're very responsive to our members," she said.

Despite some of the project's hurdles, Turner highlights the immeasurable value of "taking control over our own energy future," which is particularly significant for island communities facing uncertainty. "Even though the economic projections were off, the energy market and utility landscape can and will change," she said. "The fact is that we're still very much in charge of our own energy system and our own energy

generation, and we have the option to add a battery and possibly add more generating capacity. That has not changed."

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