E3A: Small Wind Energy Applications for the Home, Farm or Ranch

Steps in the Small Wind Series

Economic considerations

Many incentives are available to make installing a small wind system more affordable, but there are still significant costs. You should consider several factors before investing in a small wind system.

Objective for purchasing a system — Acceptable return on investment in a small wind system is different for each consumer and largely depends on your objectives. If your objective is to build a demonstration, financial return may not be as important if your objective were to lower your utility bills.

Energy efficiency — Whether you're trying to reduce your carbon footprint or your total energy bill, energy efficiency measures are generally more effective than installing a renewable energy system.

Total cost — Many factors influence total cost, and system costs range from $4,000 to $8,000 per kilowatt of installed capacity. The estimated cost for a 10-kilowatt system, which would offset most of the electrical consumption of the average Missouri home, is $40,000 to $80,000.

Access to capital — Though it may be possible to offset 30 to 75 percent of the system cost with subsidies, depending on the state, you need to be able to pay cash for or finance the full cost of the system because of the timing of these incentives. Many price quotes list the price of the system after rebates, but many rebates will not be available until after the system is installed. Pay attention to when incentives become available.

Terms of available incentives — Pay attention to the terms of incentives.

- Tax rebate incentives: Many incentives are tax credits so consult a tax adviser about the benefits of potential tax credits. You might have sufficient tax liability to use the full value of the tax credit in the first year. Some credits can be carried over into future years if you do not use the entire amount in the first year. However, you will continue to make payments on the system while waiting for the tax incentive. Cash flow assumptions need to reflect the time lag.
- Reimbursement incentives: Some programs require you to submit receipts for reimbursement. Reimbursement programs may be able to process your incentive payment quickly, but delays are possible.
- Manufacturer or dealer financing: Some installers carry the financing for the amount of benefit a consumer is to receive. For example, if a consumer appears to qualify for a 30 percent rebate, the installer may agree to carry that 30 percent until the rebate is received. Some installers offer financing if you appear to qualify for tax rebate incentives, so ask about these incentives and understand the terms offered by the installer. Consult a tax accountant about your tax liability to ensure you will receive the benefit and be able to make payments to the installer.

Detailed information regarding various incentive programs is available on the E^{3}A website at *extension.missouri.edu/e3a*.

Common means of evaluating wind turbine economics

First cost

A first-cost, or initial-cost, analysis compares alternatives of the total upfront investment you can make in a system. A first-cost estimate typically includes estimates for the tower, turbine, site work, wiring and installation costs. Systems typically range from $4,000 to $8,000 per rated kilowatt (kW) based on the type of equipment used. For example, shorter towers and guyed towers are often less expensive than taller freestanding towers. The first-cost method paints an incomplete picture because it only provides information on the total upfront cost and does not look at long-term factors such as energy production and maintenance costs.

Simple payback

Calculate an investment's simple payback by dividing the total cost of the system by the annual net savings. In some cases, the total cost is the cost of the system after incentives, such as grants and tax credits. Net savings are calculated by subtracting the value of the energy generated from operation and maintenance (O&M) expenses. O&M costs are sometimes estimated in terms of cost per kilowatt-hour (kWh) of electricity production. Some estimates use \$0.001 to \$0.02 per kWh. Other methods estimate the cost of O&M based on the initial turbine cost at 1 to 3 percent of the initial purchase cost. O&M costs vary with the type of equipment; the more complex the system, the higher the estimate of O&M expenses. For example, if the turbine includes a gearbox, estimates for O&M should increase to account for wear and replacement gearbox components. When calculating economic return, assume higher O&M costs for a more conservative estimate. The following is an example of calculating economic return.

Simple payback is an easy calculation but does not always account for important factors such as increases in energy prices or alternative uses for the project capital.

> Capital cost: \$50,000
>
> Value of energy: 16,500 kWh (estimated electricity generation) × \$0.09/kWh (cost of electricity) = \$1,485
>
> O&M: \$50,000 (capital cost) × 0.015 = \$750 (per year)
>
> Payback: \$50,000 ÷ (\$1,485 – \$750) = 68.02 years
>
> With incentives to offset 45 percent of capital cost: (\$50,000 × 0.055) ÷ \$735 = 37.41 years

Cost of energy (COE)

The cost of energy method combines the capital cost and the total expected O&M for the life of the project divided by the total lifetime energy production of the turbine. The following example uses a 20-year lifespan for the system.

COE provides a quick evaluation of economic return but is still considered a simple method because it does not include interest payments incurred from the purchase of the system, which increases the COE. This model also neglects increases in O&M expenses and the time value of money.

> Capital Cost: \$50,000
>
> O&M: (50,000 × 0.015) × 20 years = \$15,000
>
> Lifetime production: 16,500 kWh × 20 years = 330,000 kWh
>
> COE: (\$50,000 + \$15,000) ÷ 330,000 kWh = \$0.197/kWh
>
> Assuming a 30-year lifetime, the COE drops to \$0.146/kWh. If incentives offset 45 percent of the capital costs, then the COE over 20 years is \$0.128/kWh.

Net present value (NPV) and internal rate of return (IRR)

Most companies considering investing in a project evaluate its profitability based on its net present value or its internal rate of return. Both methods estimate cash flow generated by a project for each year of its operation. This cash flow includes purchase prices, tax incentives, value of electricity, insurance costs, maintenance costs and any other related income or expenses.

For net present value calculations, net cash flow for each period is discounted at a rate, often the expected inflation rate, back to the time of the system's purchase and added together. If the value is positive, the project is often accepted.

For internal rate of return calculations, a discount rate is selected that makes the NPV calculation equal to zero. A higher rate means a better financial return from the proposed project. These methods provide a more accurate analysis of a project, but they are only as accurate as the data used to generate them.

An NPV analysis first estimates a project's revenue and expenses for each year of its operation. In the example below, the project's initial costs are \$2,500. At the end of each of the next four years, the project will generate revenue of \$1,200 and incur expenses of \$200. Subtract expenses from revenue each year to calculate the net annual cash flow. Calculate each net annual cash flow using this formula:

$$(1 + \text{Discount rate})^{\text{Number of years}} = \text{Discounted value}$$

NPV is calculated by adding all discounted cash flows. A positive NPV indicates the lifetime cash flow of the project is expected to provide a greater return than the discount rate. A negative NPV indicates the project is expected to provide less return than the discount rate, which is generally a sign to avoid going ahead with a project.

Table 1. Net present value example.

	Project revenue	Project expenses	Net annual cash flow	Years to discount	Discounted value
Initial costs	$0	$2,500	–$2,500	0	–$2,500
Year 1	$1,200	$200	$1,000	1	$952
Year 2	$1,200	$200	$1,000	2	$907
Year 3	$1,200	$200	$1,000	3	$864
Year 4	$1,200	$200	$1,000	4	$823
				Net present value	$1,046

Assume discount rate of 5 percent

Electronic calculators or manufacturer-provided calculations

There are economic calculators available online, many of which are downloadable spreadsheets. These tools are often far more robust than the simple models discussed above. They include calculations of the net present value and rate of return for a project. Some models account for the time value of money and show the effects of tax incentives can have on a project. Many models account for rises in O&M and per-kWh electricity costs at rates other than the expected general inflation rate. These tools allow you to run a variety of scenarios with different assumptions to evaluate a proposed project.

Manufacturers or dealers typically provide calculations for economic return as part of their proposal package. These figures are tailored to your situation and may reflect specific details about your financing package or product that cannot be easily included in generic calculations.

However, online calculators and manufacturer-provided calculations are only as accurate as the assumptions they're based on. Companies may select assumptions that favor their product rather than those that most accurately reflect your situation. Check their assumptions used to determine if the economic return indicators provided are accurate for your situation.

Is the energy consumption calculation for your site consistent with the information you obtained from your utility company? Collect at least one year's worth of energy statements to get an accurate estimate of your annual electricity use for the purposes of calculating appropriate turbine size.

What is the actual cost of energy from your utility? Contact your utility to obtain actual costs of energy for your site.

What assumptions are being made about energy price increases? Without major policy changes, such as the regulation of greenhouse gas emissions, the U.S. Energy Information Administration projects energy prices will increase at approximately 2.5 percent per year from 2010 to 2035.

What assumptions are being made about turbine electricity generation? This question requires additional research on your part to make certain the energy output calculations are accurate. Many estimates and calculators assume maximum energy output from the turbine, which overestimates the economic return calculation.

What is the assumed life expectancy of the turbine? Many calculations assume an operational span of 20 to 30 years. Some small wind turbines have been in operation for this amount of time, but many new turbines and companies do not yet have a 20- to 30-year product history. Ask the manufacturer or dealer for further information from testing or actual field performance of their turbines to determine whether life expectancy is suited to your project. Some parts of the system, such as the tower, may have value after the project is complete, so you may want to consider individual components' life expectancy in addition to the system as a whole.

What assumptions are made about O&M costs? Your O&M allocation should provide for replacement of parts over time. If the inverter fails, which is typically assumed to have a life expectancy of 10 to 15 years and can cost $1,000 to $3,000, the O&M allocation should be large enough to cover the cost of replacement. You may want to consider how the project analysis would change with a major component failure at some point during the project.

What assumptions are being made with regard to the cost of the system? Detailed costs on the following system components should be included in an estimate from the manufacturer or dealer:

- Wind turbine
- Inverter
- Controller
- Batteries (only for off-grid applications)
- Tower (prices vary by tower height and type)
- Tower erecting equipment
- Foundation materials
- Wiring and electrical supplies
- Labor for foundation, tower erecting, electrical wiring and turbine installation
- Turbine and tower shipping
- Siting and permitting

- Sales or property taxes, if applicable
- Insurance costs

Does the economic calculation assume that any excess energy is being purchased and paid for by the utility — sometimes referred to as a buyback rate? In Missouri, net-metered projects are compensated at a utility's avoided cost, which is typically $0.02 to $0.04 per kWh. Such low rates generally do not make it economical to sell large amounts of excess energy to your utility.

What assumptions are made about your purchase of the system? Does the model assume you will pay cash or obtain a loan? With debt financing, what is the interest rate and loan period? Check with your lender regarding appropriate interest rates. What are you assuming for down payment and collateral? You may be able to take advantage of some renewable energy loan programs with low interest rates. Before assuming you qualify for a nonconventional lending program, check with a program manager about loan availability and interest rates.

What does the calculator assume about state and federal incentives? Not all programs apply to your situation, so verify which programs are used in the calculator and review program qualifications to ensure you qualify for the incentives before including them in your analysis.

Are operations and maintenance costs assumed to increase at the same rate as inflation or at a different rate? Does the model account for increases in O&M costs, and if so, what rate is used? Discount rates are often included in electronic or manufacturer-provided calculations. The discount rate, typically 3 to 4 percent, is included in time value of money or net present value calculations.

Does the calculator make any assumptions about reducing demand charges? In general, small wind systems have little effect on demand charges. You can assume a monthly demand reduction of half of the capacity factor multiplied by the rated power of the turbine. In most residential applications, demand charges or service fee reductions should not be assumed.

What assumptions are being made with regard to the sale of renewable energy credits (RECs)? In some cases, wind turbine owners sell renewable aspects of their electrical production to utilities, companies or individuals who want or need to ensure a portion of their electric usage is produced from renewable sources. This is common for large projects but much more rare for small projects.

Economic returns may only be one consideration in your evaluation of a small wind system. Evaluate the assumptions in economic calculations to ensure the installed system meets your expectations and your fiscal objectives.

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Original work created by Montana State University Extension and the University of Wyoming.
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