How to determine if that RENEWABLE ENERGY project makes economic sense

By Ben Rashford

Thinking about diversifying your home or farm energy portfolio?

In addition to the big three – coal, oil, and natural gas – Wyoming also has abundant renewable energy resources, such as wind and solar power. When does investing in renewable energy (RE) make sense, and when will it break the bank? This is not easy to answer, but there are several financial calculations that can help.

This article describes three calculations: simple payback, net present value, and levelized cost of energy. Each provides a different way of determining whether RE makes economic sense.

Simple Payback

Simple payback, or payback period, is the number of years it takes for the energy savings to offset the initial investment – payback can also account for operation and maintenance costs (O&M). The common assumption is the shorter the payback period, the more economical the investment.

Simple payback is attractive because it is easy to calculate and understand. In reality, simple payback can be simply misleading. Payback ignores several important investment characteristics, including: 1) time value of money (see "Financial and renewable energy terms" at right), 2) cost and savings after payback, 3) increases in energy prices and 4) gains on alternative investment options you might have pursued

Financial and renewable energy terms

Annual energy output (or production) – Total energy generated by a renewable energy (RE) system in one year (typically measured in kilowatt hours).

Annual energy savings – The amount of money you save with a RE system – what would have been spent buying electricity minus operating costs.

Time value of money – Money today is worth more than the same amount of money in the future because of inflation, the lost opportunity to earn interest, and risk.

Present value – Dollar amounts from different years cannot be added together without accounting for the time value of money. The present value is an estimate of today's dollar value of future dollar amounts.

Discount rate – The interest rate a person uses to discount money in the future to money in the present period. For RE investments, use the interest rate on a similarly risky investment (e.g., government bonds [2-4 percent] for low risk investments), or, if you borrow money to finance the project, use the interest rate the bank is charging.

Present Value Annuity Factor (PVAF) – A number used to calculate the present value of a series of equally sized payments spread over future time periods.

instead of the RE project. Without these characteristics, simple payback generally underestimates the payback period making RE investments appear to be better deals than they really are.

Net Present Value

A more flexible – and meaningful – calculation for evaluating RE projects is net present value (NPV). NPV provides today's dollar value of a potential investment by taking all costs and savings for the lifetime of the project and converting them to present value and accounting for the time value of money. NPV can also accommodate energy price increases over time and can be used to directly compare alternative projects.

NPV includes more information than simple payback and is harder to calculate. For example, use a computer program (e.g., Excel) or online calculator to account for energy price calculation. Alternatively, a simplified NPV can be calculated by assuming no price escalation. In this case, the future stream of energy savings is called an annuity – a series of equal cash flows. Then, the present value annuity factor (PVAF; see table) can be used to calculate the NPV of any project using only a calculator (see example next page).

Present Value Annuity Discount Factors

Discount Rate (sidebar 1)	Useful Life (years)				
	10	15	20	25	30
2%	8.98	12.85	16.35	19.52	22.40
3%	8.53	11.94	14.88	17.41	19.60
4%	8.11	11.12	13.59	15.62	17.29
5%	7.72	10.38	12.46	14.09	15.37
6%	7.36	9.71	11.47	12.78	13.76
7%	7.02	9.11	10.59	11.65	12.41

How big should the NPV be? That depends on the other alternatives available for producing energy or investing your money. As a general rule, a project makes economic sense if the NPV is positive and greater than the NPV of other alternatives. When comparing two alternatives, such as a wind turbine vs. solar panels, the one with the larger NPV makes the most economic sense.

Levelized Cost of Energy

For RE projects that directly generate electricity, such as wind turbines and solar panels, levelized cost of energy (LCOE) is another useful calculation. LCOE is the implied price ($/kilowatt hour) of energy generated by the RE system. Put differently, it is the minimum price needed to break-even.

LCOE can be directly compared to the price the local utility charges. If the RE system generates electricity for less than the utility price, then the project is economically feasible. LCOE, however, does not account for energy price escalation. So, even if a RE project cannot beat the current electricity price, it may be cost competitive if and when utility rates rise.

Take Out the Guesswork

Determining the economic feasibility of RE projects may not be easy but running the numbers and considering several calculations will help ensure homeowners make an educated decision. Of course, economic feasibility is not all that matters. You may still want to invest in RE even if it doesn't pencil out because you value energy independence, you think energy prices will increase significantly, or you think the environmental benefits are worth the extra costs.

More Information

Milt Geiger is the University of Wyoming Cooperative Extension Service energy coordinator. He has a wealth of information about the economics of renewable energy to share. He can be reached at (307) 766-3002 or at mgeiger1@uwyo.edu. For more information, go to http://www.uwyo.edu/renew-energy

Ben Rashford is an assistant professor in the Department of Agricultural and Applied Economics in the College of Agriculture and Natural Resources at the University of Wyoming. He can be contacted at (307) 766-6474 or brashfor@uwyo.edu.

Calculating simple payback, net present value, and levelized cost of energy for a small wind turbine

To perform any financial calculation, first collect basic information about costs and expected production of the proposed project. All the items listed below are needed for a small wind turbine. Our example uses values consistent with a typical household wind turbine (rated at 2.4 kW) on a site with 12 mph average wind speeds.

Installed cost – $12,000
Rebates/incentives[1] – $4,000
Annual energy output– 5,280 kWh/year
Annual operation and maintenance– $120/yr

Useful life – 20 years
Retail electricity price – $0.11/kWh
Discount rate – 2%

Given the basic information, calculate the net annual energy savings for the wind turbine by multiplying the expected annual energy output (AEO) by the current electricity price then subtracting annual O&M:

$$\begin{aligned}\textit{Net Energy Savings (\$/year)} &= \textit{[AEO (kWh/year)} \times \textit{Price (\$/kWh)]} - \textit{O\&M (\$/year)}\\ &= [5{,}280 \times 0.11] - 120 = \$460.80\end{aligned}$$

A) Calculating simple payback

Calculate simple payback by plugging the necessary values into the following formula:

$$\textit{Payback (years)} = \frac{\textit{Installed Cost (\$)} - \textit{Rebates (\$)}}{\textit{Net Annual Energy Savings (\$/year)}}$$

$$\textit{Payback (years)} = \frac{\$12{,}000 - \$4{,}000}{\$460.80} = \mathbf{17.4\ years}$$

B) Calculating net present value (NPV)

First, calculate the present value of net annual energy savings by selecting the present value annuity factor (PVAF) that is consistent with your discount rate and the expected life of the project (see PVAF table page 8). For this example, the PVAF for a 2 percent discount rate over 20 years is 16.35. The discounted net annual energy savings is:

$$\textit{Discounted Net Annual Savings (\$)} = \textit{Net Annual Energy Savings} \times \textit{PVAF} = \$460.\ 80 \times 16.35 = \$7{,}534.74$$

This means that the $460.80 net benefit the wind turbine produces every year for the next 20 years is worth $7,534.74 today. Note that this is less than $9,216 because it accounts for the time value of money.

Next, subtract the total initial costs from the discounted net annual savings to get the NPV:

$$\textit{NPV (\$)} = \$7{,}534.74 - \$8{,}000 = -\$465.26$$

C) Calculating levelized cost of energy

Calculate levelized cost of energy by plugging the necessary values into the following formula:

$$\textit{LCOE (\$/kWh)} = \frac{\textit{Initial Cost (\$)} + \textit{[O\&M (\$/year)} \times \textit{PVAF]}}{\textit{Annual Energy Output (kWh/year)} \times \textit{PVAF}}$$

$$\textit{LCOE (\$/kWh)} = \frac{8{,}000 + [120 \times 16.35]}{5{,}280 \times 16.35} = \mathbf{\$0.115/kWh}$$

This example demonstrates the importance of using multiple calculations. The simple payback period is a little long (17.4 years) but shorter than the useful life (20 years). This suggests the wind turbine will pay for itself before it stops working. The NPV, however, is negative suggesting that, accounting for the time value of money, you will lose money on this project. On the other hand, the LCOE implies that the turbine will generate electricity over the next 20 years at a cost of 11.5 cents per kWh. This is more than the current utility rate of 11 cents, but, if energy prices rise in the near future, this wind turbine will be cost competitive.

[1] *Information on federal and state rebates/incentives for renewable energy is available on the Web at www.dsireusa.org*