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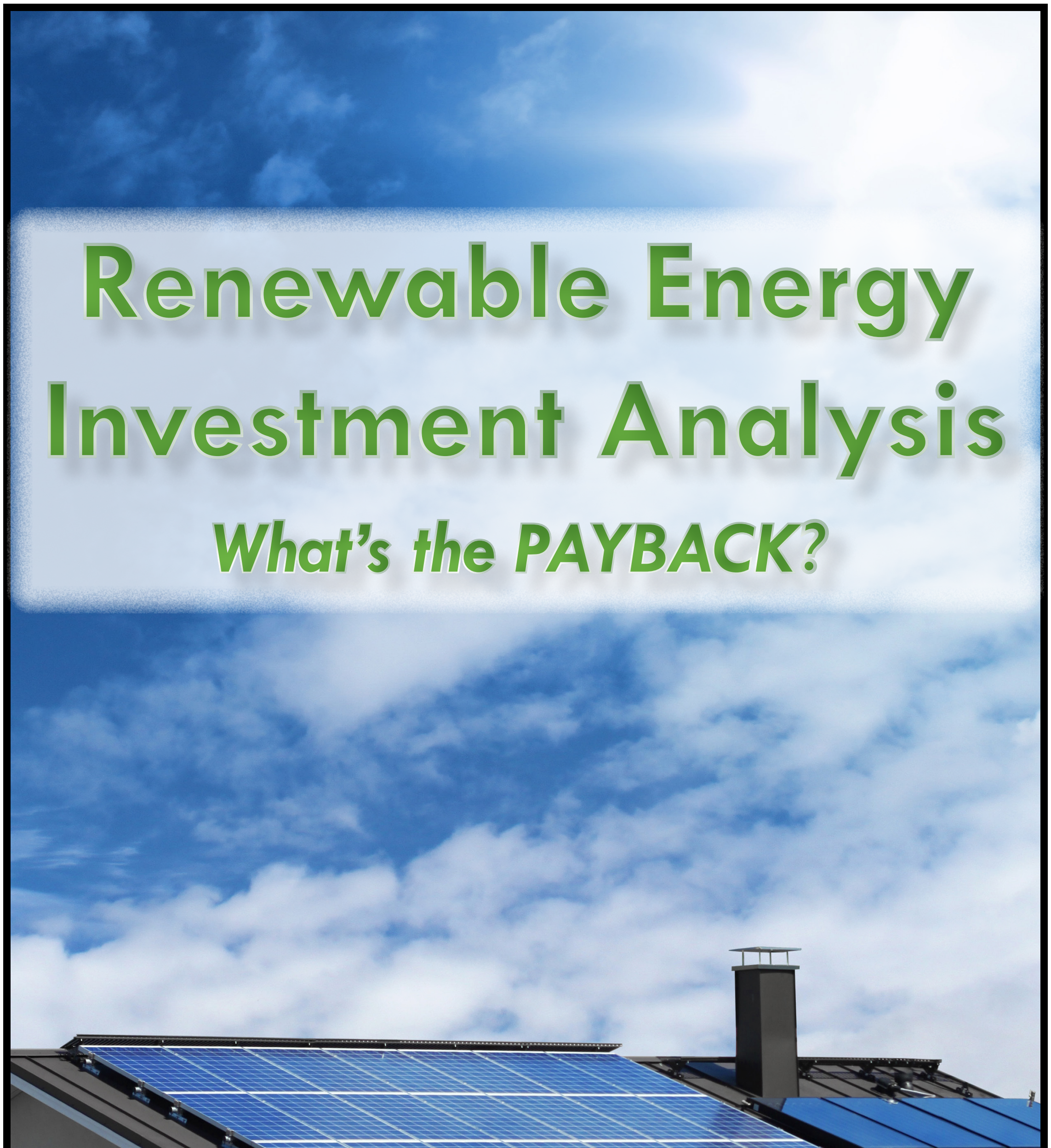
What's the PAYBACK?



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Renewable Energy Investment Analysis:

What's the PAYBACK?

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Renewable Energy Investment Analysis — What's the Payback?

Renewable energy (RE) technologies, such as solar, geothermal, and wind, are potential cost-saving investment opportunities for Wyoming homeowners and businesses. While the decision to purchase an RE system is seldom based on costs alone – social and environmental criteria also matter (e.g., how much do you value energy independence?) – purchasing an RE system is a significant financial investment. Sound investment decisions require a thorough economic analysis of expected costs and benefits.

One of the most requested measures of an RE system's economic feasibility is simple payback. Simple payback determines the number of years for the energy savings from an RE system to offset the initial cost of the investment:

Simple Payback Formula

$$\text{Payback (years)} = \frac{\text{Initial cost (\$)}}{\text{Annual production (kWh/year)*Value (\$/kWh)} - \text{O\&M (\$/year)}}$$

Initial cost: Total price paid for RE installation

Annual production: Amount of energy produced per year (kilowatt-hours per year for electricity generating systems)

Value: Price paid for energy from utility (i.e., market price)

O&M: Operations and maintenance, including repairs and updates over the life of the system

Simple payback is an attractive calculation because it is straightforward and easy to understand. Simple payback assesses how quickly an investment might pay back (the smaller the simple payback the better the investment) and whether the investment is likely to pay back within the expected lifetime of the project. However, the simplicity of the simple payback calculation has limitations when assessing the economic feasibility of a renewable energy project. The simple payback calculation ignores several critical investment characteristics, including: the time value of money, energy price escalation, variable rate electricity pricing, alternative investment options, and what happens after payback.

An important concept in investment analysis is the **time value of money.** The time value of money is usually positive – a dollar today is worth more than the same dollar in the future. Positive time value occurs for three reasons:

- Inflation – rises in the overall price of goods and services implies that every dollar in the future will purchase less than it could today – $1 may buy a candy bar today, but because of inflation, it will not 20 years from now;
- Opportunity cost – every time you wait to receive a dollar, you give up the opportunity to do something else with it, such as investing that dollar and earning interest. For example, if you invest $10,000 in a solar hot water system, you forgo the chance to earn interest from keeping your money in a bond, stock, or savings account;
- Risk – there is always a chance you won't receive the money in the future.

Ignoring the time value of money leads to an under-estimation of a project's real payback time. Just as interest rates are used between lenders and borrowers to capture money's positive time value, thereby compensating the lender for foregoing alternative investment opportunities and risk, a discount rate is used to equate a future dollar amount to its present value. Benefits and costs of RE investments that occur in the future should be discounted to properly analyze the investment decision. There is no single discount rate that makes sense for everyone (personal discount rate is based on an individual's risk and time preferences), but in general it is the minimum rate of return required from an investment. As an example, a low discount rate (0-4 percent) would indicate a tolerance of risk and a high willingness to accept benefits in the future. A high discount rate (4-12 percent) would indicate the opposite.

So what does this mean for energy investments? Energy savings 10 years from now are worth less than the same savings today because of inflation, the lost opportunity to earn interest, and risk. In simple payback, the energy savings in the future are valued the same as energy savings in the present. For low discount rates (e.g., 4 percent), the error in the payback calculation may be small (i.e., because energy savings today are valued similarly to savings in the future); however, for higher discount rates (e.g., 10 percent) simple payback can severely underestimate the true payback period.

Simple payback also does not account for **electricity price escalation** (i.e., an increase in the real – inflation adjusted – price of electricity). This is an important economic consideration as expected electricity price increases are one of the most common reasons people consider renewable energy. If energy prices increase over the life of an RE investment, then the true payback period will be shorter than predicted by the common simple payback formula.

Simple payback also **cannot easily accommodate variable rate electricity prices**. The value of electricity generated (i.e., energy savings), used in the denominator of simple payback, is typically calculated by assuming the same price for each unit of electricity produced. Many utilities, in contrast, have variable rates (e.g., tiered or block pricing). The price per kilowatt-hour (kWh) therefore depends on the number of kWh consumed – in many cases the price per kWh increases with greater consumption. A grid-connected RE system could therefore offset the highest-priced electricity by bringing a household down to a lower pricing tier. This added benefit of RE systems is not easily captured in the simple payback calculation. Therefore, ignoring variable pricing will tend to overestimate the actual payback period.

Consumers should evaluate several RE and energy efficiency options to make the most financially sound investment decision (e.g., compare an RE system to the savings from energy efficiency improvements). Simple payback is **not well-suited to comparing alternative investments**. For instance, simple payback cannot meaningfully compare alternative investments that have different expected useful lives – it would treat a wind turbine with an expected life of 15 years and solar PV system with a life of 25 years would be treated as equal. The economic worth of an investment, however, is really determined by the net benefits after payback. You invest in stocks hoping to make a return above and beyond your initial investment, right? Simple payback **does not factor in the energy savings (benefits) and costs that occur after the payback period**. As a result, two investments that have identical payback periods but vastly different useful lives (i.e., one will continue to produce benefits much longer than the other) will be incorrectly judged the same by the simple payback criterion.

Small Wind Turbine Example

To illustrate the implications of these drawbacks of simple payback calculation, consider the following small wind turbine example:

Initial investment (less 30 percent tax credit)[1]:	$11,200
Energy production (at 12.3mph):	440 kWh/month
Operation & Maintenance Cost[2]:	$160/year
Electricity price (per kWh)[3]:	$0.0877
Discount rate:	4%
Electricity price escalation:	3 percent/year
Annual Energy Savings[4]:	$303.06/ year

With an $11,200 initial investment and energy savings of $303.06 per year, simple payback is 23.29 years. Thus, according to simple payback, the electricity savings generated will offset the installation costs in about 23 years (Figure 1). However, this simple payback does not account for the time value of money (i.e., does not use the discount rate of 4 percent), or price escalation (i.e., does not use the electricity price escalation of 3 percent/year). When we account for just these two drawbacks of the standard simple payback calculation, we get widely different payback estimates. For instance, incorporating the time value of money extends the payback time by almost nine years (from 23 to 32 years). If, alternatively, we only include energy price escalation, suddenly the payback is shortened to just over 16.5 years. Finally, including both the time value of money and price escalation provides the most realistic payback period of around 19 years, assuming that the 30 percent tax credit is used. Unfortunately, even the most realistic payback calculation cannot be used as the sole indicator of a sound investment because it does not account for other important economic considerations, such as the benefits and costs occurring after payback or the alternative investments you could make.

[1] Initial investment assumes a non-discounted (instantaneous) use of either the Business Investment Tax Credit (30 percent) or the Residential Renewable Energy Tax Credit (30%).
[2] Based upon assumption that 1 percent of total installed cost is used for annual maintenance: 0.01 x $16,000 = $160/yr.
[3] Average residential electric price in Wyoming, according to the Energy information Administration (2010).
[4] Annual energy savings is calculated as: (440 kWh/mo × 12 mo × $0.0.0877/kWh) - $60/yr

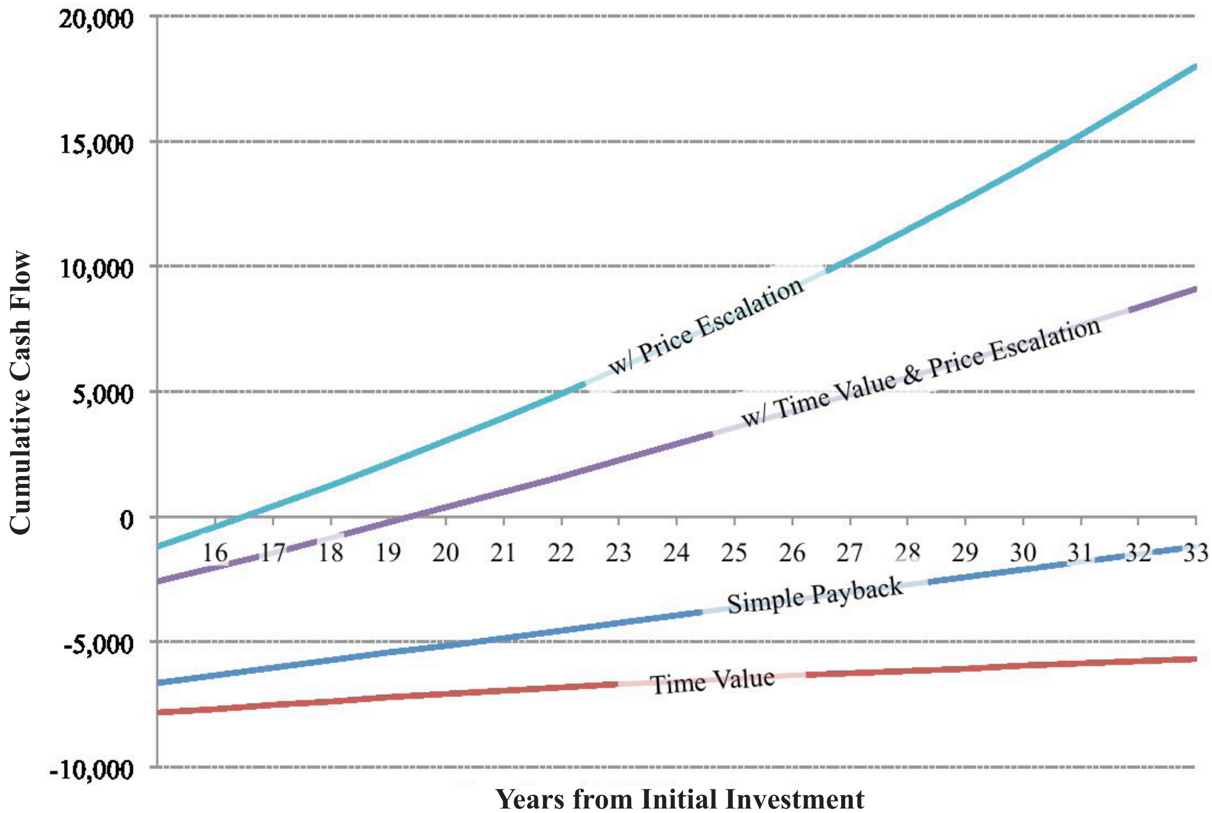

Figure 1. Cumulative cash flow for a small wind turbine with different assumptions about the time value of money and electricity price escalation. Payback occurs when the cumulative cash flow equals zero.

Despite simple payback's several drawbacks, the simple formula can be used to effectively screen clearly undesirable investments that have outrageous payback periods compared to the life of the RE system. For instance, a system with an expected life of 15 years but a simple payback of 30 years is unlikely to be a sound investment decision regardless of whether you account for the drawbacks to simple payback. The take-home message is that while simple payback can provide an initial indication of economic viability, it does not provide enough information to make a sound decision on such a large investment. If purchasing an RE system based on the simple payback alone, you may be very disappointed in the return on your investment. Fortunately, investment analysis has several alternative metrics that, while requiring more effort, solve most of the drawbacks of simple payback. These metrics, including net present value or discounted cash flow analysis, are discussed at UW Extension's "Renewable and Efficient Energy – Solutions for Wyoming" website at http://renewables.uwyo.edu/.

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