PART 6:

PV Solar Example

SOLAR ELECTRIC INVESTMENT ANALYSIS

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PART 6: PV SOLAR EXAMPLE

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Introduction

Photovoltaic (PV) panels are an increasingly common sight on urban rooftops and rural properties across the U.S. The declining cost of equipment and installation makes installing a behind-the-electric-meter (net metered) solar electric system enticing for many homeowners, businesses, non-profits, and agricultural producers. Evaluating the financial prudence of an investment in solar requires careful consideration of installation costs, the value of production, and operation and maintenance costs.

Unfortunately, some installers are not forthcoming with information necessary to make fully informed investment decisions. Third-party ownership structures, such as leases, further increase the challenge of understanding the viability of an investment. This six-part series distills the information collection and decision process into six parts:

- Part 1: Estimating System Production – Site-specific factors can influence the amount of electricity produced by a PV installation.
- Part 2: Assessing System Cost – From initial costs to incentives to ongoing insurance expense, the present and expected costs dominate the decision to install a PV system.
- Part 3: Forecasting the Value of Electricity – Utility and governmental policies affect how much electricity is worth. Not all electrons are created equal.
- Part 4: Understanding Incentives – Federal, state, and local incentives can greatly affect the financial viability of a PV installation.
- Part 5: Conducting a Financial Analysis – Accurately evaluating the viability of a PV system requires understanding financial concepts, such as simple payback, net present value, and the levelized cost of energy. Preferences for risk, environmental attributes, and independence also inform these measures of viability.
- Part 6: PV Solar Example – The importance of accurate evaluation is clear when applied to a hypothetical project.

What about small wind, solar thermal, ground source heat pumps, and other renewable energy sources?

Solar electric is now the dominant type of distributed renewable energy system, but other renewable energy technologies, such as small wind, solar thermal, micro-hydropower, ground source heat pumps, and efficiency upgrades, require similar scrutiny. Systems that provide thermal energy, as opposed to electricity, have less regulatory and policy considerations, but the analysis framework is the same.

We highlight in each part critical questions you must ask yourself and your installer. You will be empowered in the ultimate goal of making an informed decision about whether PV is right for you.

PV Solar Example

Installing a PV solar system is a significant investment that often involves lengthy and complex agreements. Selecting the right installer is a critical step in developing a PV solar system. Consumers should evaluate several proposal options to compare and contrast the assumptions used. A detailed financial analysis is essential to making informed decisions on whether or not to invest in a PV solar system; however, the financial analysis is only as good as the assumptions and data used in the calculations. A proposal that incorporates false assumptions that are not comprehensive, or are overly aggressive or too conservative will result in an inaccurate assessment.

This bulletin will help separate, analyze, and understand the core components of a typical PV solar proposal, including the system production, system cost, incentives, and electricity rates. A better understanding of the components and assumptions used to develop a proposal will allow a more accurate financial analysis, fostering informed investment decisions on solar projects.

USING THE SAM MODEL

The National Renewable Energy Laboratory, which is funded by the U.S. Department of Energy, developed the System Advisory Model (SAM) to help developers, installers, and potential system owners estimate the system production and financial impacts of renewable energy projects. This comprehensive financial model evaluates critical variables including system design and production, system cost, operation and maintenance, financial factors, project incentives, tax implications, and the value of electricity generated by the system, to simulate a detailed cash flow over the system's lifetime. The SAM model examines the details of a project and simulates a detailed cash flow analysis providing numerous metrics, including the payback period, net present value, levelized cost of energy, electricity savings, and electricity cost with and without a renewable energy system. SAM is available for download at no cost from https://sam.nrel.gov.

PV SOLAR OHIO EXAMPLE

To illustrate the implications of aggressive assumptions and the drawbacks of basing a decision on the simple payback calculation, let's consider the example of a 10 kW photovoltaic solar project. We examine a PV solar project for a small swine and goat operation near Columbus, Ohio, with a farrowing house, nursery, and kidding facility. The operation has heaters in each barn, runs ventilation fans throughout the year, and uses several heat lamps in fall and winter. The average monthly electric usage is 2,729 kWh peaking at 5,200 kWh during the winter months. According to estimates from the model, the 10 kW solar system will provide approximately 37 percent of the agricultural operation's annual electricity needs. We constructed two scenarios in the SAM model. The first scenario assumes aggressive assumptions while the second scenario implements conservative assumptions (Table 1). Both assume the agricultural operation will provide 100 percent equity toward the project and require 0 percent debt financing.

This bulletin will use this PV solar example to evaluate how different assumptions influence project performance. Using information from this example, we will use the SAM to simulate various scenarios for the system's electric production, system cost, electricity value, and incentives. A financial analysis will then compare the two scenarios to illustrate how small changes in the inputs of a model significantly influence estimated payback period, net present value, and real levelized cost of energy.

Table 1: PV Solar Example Details

Variables	Scenario 1: Aggressive Proposal	Scenario 2: Conservative Proposal
System Cost	$31,000	$31,000
30% Investment Tax Credit	$9,300	$9,300
SREC Payment (10 years)	$2,500 (income tax not applied)	$2,500 (income tax applied)
Grant	25% USDA REAP Grant (income tax not applied)	$0
System Performance: Degradation	0.25% annually	0.50% annually
Operations and Maintenance Costs	$0/year	$20 per KW annually plus 2% annual inflation and 1% escalation
Insurance Costs	$0/year	0.5% of system cost plus 2% annual inflation
Energy Rate	.11¢ per kWh flat	Actual rate structure that includes a fixed monthly charge, time of use charges, and demand charges.
Energy Price Escalation Rate (real)	6% annually	1% annually
Inflation Rate	2% annually	2% annually
Discount Rate	4% annually	4% annually
Depreciation	5-year Modified Accelerated Cost Recovery System	5-year Modified Accelerated Cost Recovery System

SYSTEM PRODUCTION

To develop a proposal, PV installers must provide an estimate of production, typically separated into average monthly production. Site-specific factors most critical to determining the system's production include the geographic location, tilt of the solar panels, orientation of the system, shading, and degradation. The SAM allows uploading a site's shading data from a sun eye or solar pathfinder. In addition, you can apply production loss using snow coverage data from local weather stations.

We used the SAM to simulate the difference in production between scenario 1 and scenario 2 from the 10kW example system. Both scenarios assume a system orientation of 180° south with a 40° tilt, no shading. In this simulation, we compare the difference in system production based on the assumed annual degradation. As shown in Figure 1, scenario 1 assumed an annual degradation of 0.25 percent, yielding an average production of 12,287 kWh annually and 307,170 kWh over the 25-year project lifecycle. In comparison, scenario 2 used an annual system degradation of 0.50 percent, generating an average production of 11,928 kWh annually and 298,205 kWh over the 25-year project lifecycle. There is a fundamental connection between the production of a PV solar system and the return on the investment. Identifying the assumptions and considering the variables during the decision-making process is essential.

SYSTEM ORIENTATION AND TILT INFLUENCE PRODUCTION

Some system owners prefer rooftop systems on the top of existing agricultural buildings. However, consider the difference in system production before making a decision. For example, a 10 kW system on a barn oriented to the east (90˚) with a 4:12 pitch roof would produce an 18˚ panel tilt. This rooftop system would produce roughly 13% less than a ground mount system facing south (180˚) with panels tilted at 40˚.

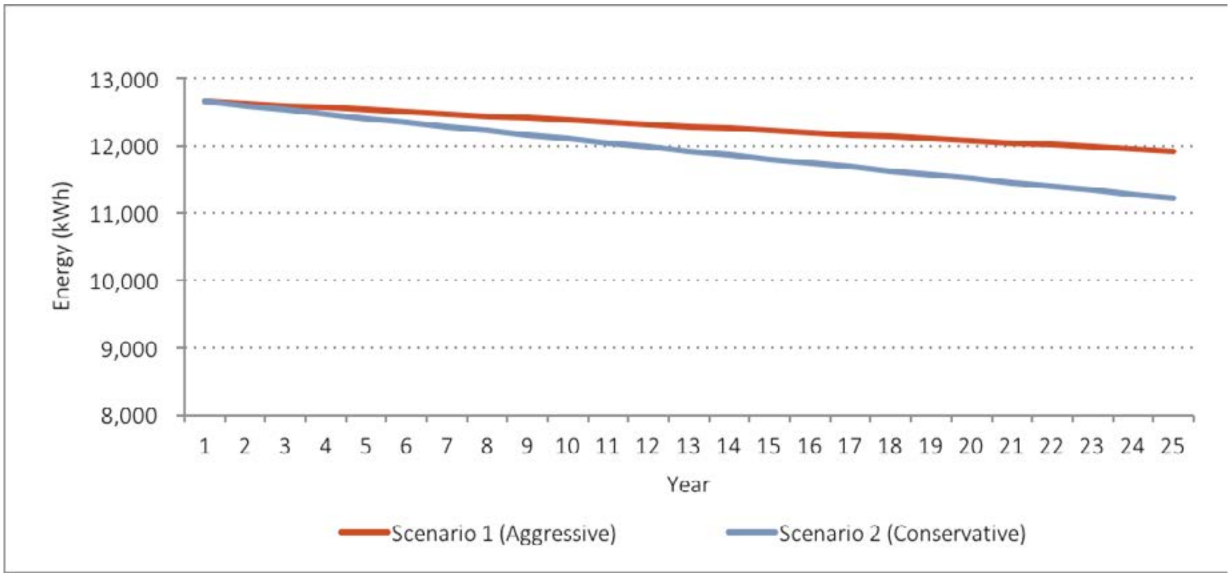

Figure 1: Annual System Production: Baseline vs. Simulation Variables

SYSTEM COST

When evaluating multiple quotes or project proposals, identify the total upfront system costs and the ongoing system costs. In the example, scenario 1 did not include any cost for operation and maintenance or insurance in the simple payback calculation. Conversely, scenario 2 includes ½ percent of the total system costs annually plus 2 percent annual inflation to account for the insurance costs of the system. Also, scenario 2 applies $20 per kW annually plus 2 percent annual inflation and an additional 1 percent escalation rate to calculate the operation and maintenance costs. As illustrated in Figure 2, on average scenario 2 will include additional costs of $465 per year or $12,144 over the 25-year project lifespan. Considering operating expenses such as insurance and maintenance is essential to the financial analysis because they represent real ongoing costs. This example demonstrates how excluding small costs can still significantly influence the cash flow analysis of a system.

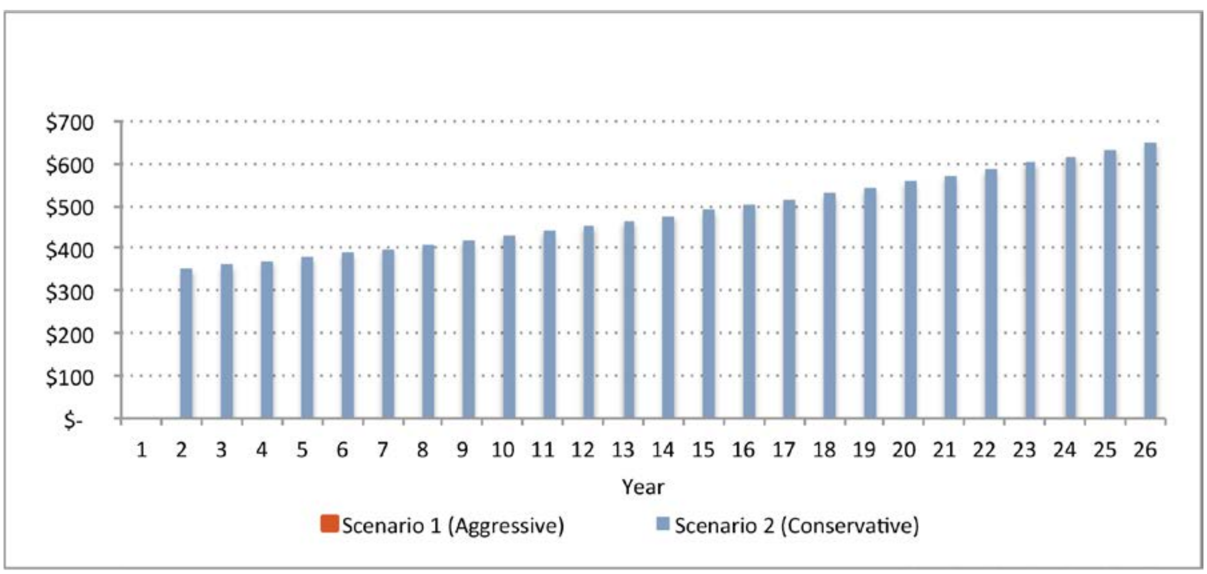

Figure 2: Annual Insurance, Operations, and Maintenance Costs [Note: Scenario 1 assumes no ongoing costs.]

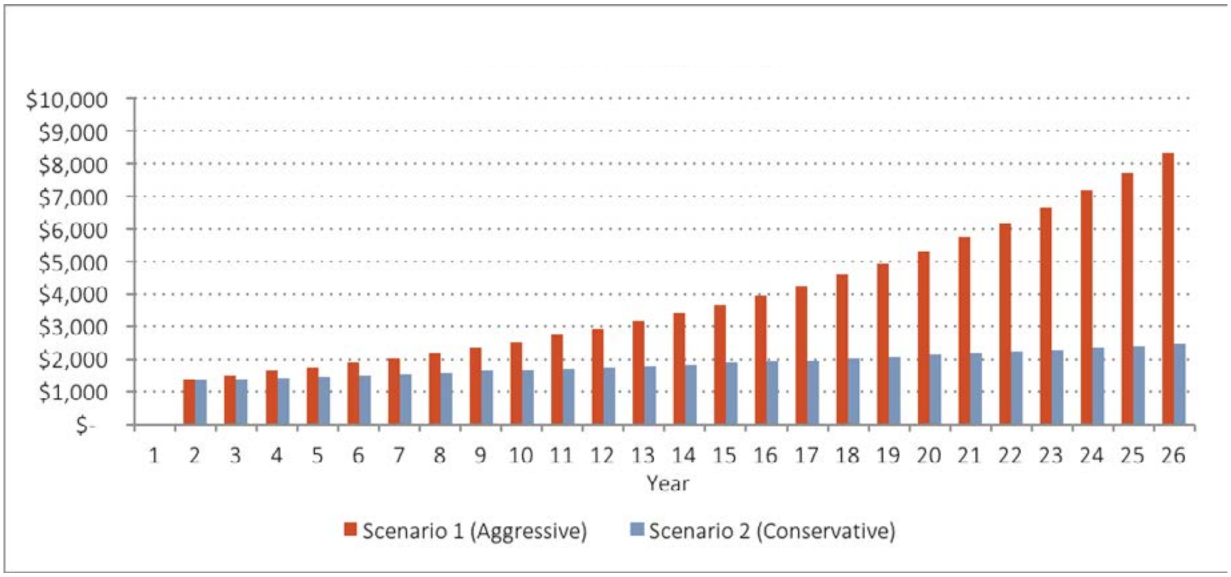

Figure 3: Value of Electricity (Annual)

VALUE OF ELECTRICITY

The value of electricity a solar system yields will depend on factual details, such as how the utility charges for electricity and assumptions such as the escalation rate, or the future cost of electricity. In the example, scenario 1 calculates the energy savings based on a flat rate energy value of 11¢ per kWh and applies 2 percent inflation and a 6 percent (real) energy escalation rate annually. In comparison, scenario 2 used the SAM to select and import a real utility rate structure intended for electric consumers with maximum demands greater than or equal to 10 kW but less than 8,000 kW. The rate structure used in scenario 2 includes a fixed monthly charge of $34.21 and time of use charges. In addition, we applied a more conservative approach and adjusted the energy escalation from 6% (scenario 1) to 1 percent annually. As shown in Figure 3, the aggressive assumptions used in scenario 1 exaggerate the value of energy from the project, estimating total energy savings of $97,875 over the 25-year project. In comparison, the simulation for scenario 2 is 52 percent less, estimating total energy savings of $47,089 over the 25-year project life.

INCENTIVES

Despite rapidly declining costs for PV solar, incentives are still critical to the cost-effectiveness of a project. There are numerous types of incentives, such as tax credits, deductions, net metering, grants, and rebates, available to offset the initial capital investment. When evaluating a project proposal, investors must identify and understand any incentives included in the calculations. In the example, scenario 1 applied the 30 percent federal Business Energy Investment Tax Credit (ITC), an upfront payment for energy credits, and the USDA REAP grant in the simple payback calculation. In a more conservative approach, scenario 2 only considered the 30 percent ITC and an upfront payment for energy credits in the payback calculation. Note that because the USDA REAP grant funding is not guaranteed, scenario 2 excluded the incentive program from the financial calculations. As seen in Figure 4, assuming grant funding can significantly decrease the balance or net system cost, implying an unrealistic payback period. Also note that, unlike a grant program, the 30 percent ITC offers a reduction in the system owner federal tax liability and does not provide upfront payments toward the initial system cost.

FINANCIAL ANALYSIS SUMMARY

The straightforward and easy-to-understand simple payback formula is a preferred evaluation metric for solar installers; however, as discussed in Part 5, the simple payback calculation has limitations because it ignores several real variables, such as time value of money, energy escalation rates, rate structure, and opportunity costs. When applying the aggressive assumptions from scenario 1, the SAM forecasts a simple payback of four years. According to simple payback, the electricity savings generated will offset the installation costs in about four years; however, this analysis does not account for critical factors such as system degradation, insurance costs, energy escalation rates, and taxable income. Furthermore, scenario 1 assumed funding from the USDA Rural Energy for America (REAP) grant, which is a non-guaranteed competitive grant.

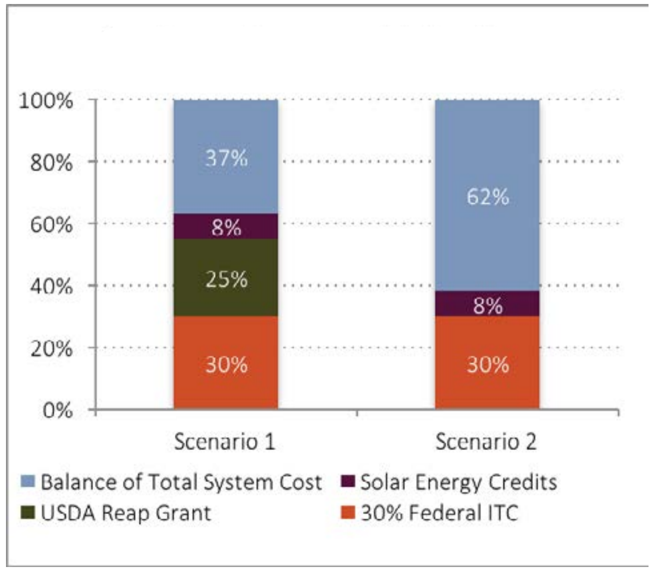

Figure 4: Incentives as a Percentage of the Total System Cost

In comparison, when we account for these variables in the simulation of scenario 2, we get widely different payback estimates. For instance, simply removing the REAP grant, which is not guaranteed funding, extends the project payback time by almost four years. Additionally, if we adjust the variable assumptions as outlined in Table 1, the payback increases from four years to 14 years, while the nominal levelized cost of electricity increases from 2.91¢/kWh in scenario 1 to 11.02¢/kWh in scenario 2. Similarly, scenario 1 suggests a net present value of $22,000, while the adjusted scenario 2 simulation yields a net present value of - $2,074. Figure 5 illustrates a comparison of the cash flow between the two scenarios.

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

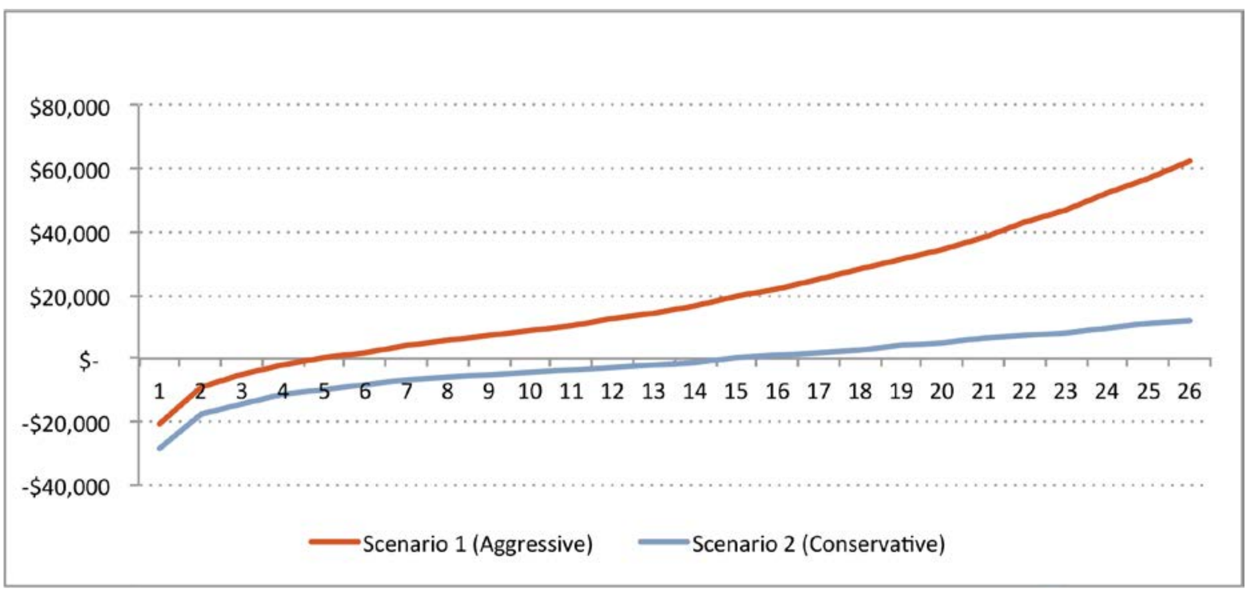

Figure 5: Comparison of System Cash Flow (cumulative)

benefits and costs occurring after payback or the alternative investments that could be made; however, using tools such as the System Advisory Model (SAM) to evaluate the viability of a PV solar proposal will provide multiple metrics to accurately evaluate a project, including simple payback, a detailed cash flow analysis, net present value, and the levelized cost of energy. As with any financial matter, consulting a qualified tax professional is encouraged to ensure eligibility for tax deductions, incentives, and grants programs.

If the System Advisory Model seems a bit overwhelming, please contact a local extension educator to work together to evaluate potential PV installations.

https://commons.wikimedia.org/wiki/File%3ASolar_panels_and_satellite_dish_and_chimney_-_Smaack_-_201206.jpg • S. Maack