EXTENSION

EC3008

SOLAR ELECTRIC INVESTMENT ANALYSIS

F. John Hay

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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 throughout.

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.

Other Small Scale Renewable Systems.

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.

1. Estimating System Production

Producing renewable energy is much like gardening or farming – the quantity produced and the net value of the product determine profitability. If you grow more tomatoes, more tomatoes can be sold at the farmers market. Similarly, if you have tomatoes for sale when others do not, then the tomatoes can be sold at a higher price. The profit earned on tomatoes must consider the capital put into growing them (e.g., a high tunnel) and the ongoing inputs (e.g., labor and fertilizer) during the growing season.

Two similar components drive the return from a PV system – total amount of electricity produced and net value of that production. Since electricity is measured in kilowatt-hours (kWh), the value of a solar installation is dictated by the number of kWh produced and how much they are worth after expenses. The more kWh generated from an installation and the higher the net value, the better the rate of return.

YOUR SITE-SPECIFIC SOLAR RESOURCE

PV installers should provide an estimate of production, typically separated into average monthly production. On a flat landscape, the climate, elevation, and temperature determine the amount of energy produced by a PV solar system. Generally, the resource decreases as one moves from the equator to the poles, but local factors can significantly influence production. For example, Lincoln, Nebraska, is at approximately the same latitude as Columbus, Ohio, but Lincoln is sunnier, the same PV array produces 15 percent more electricity in Lincoln than in Columbus.

Site-specific factors are most critical to determine production, and the ultimate value, of a solar investment. Shading has the most visible negative impact on production. Shading effects will vary by season, often increasing as the sun angle becomes lower in winter months. Departure from true south also affects production, as panels facing east or west will generally produce less than the same installation facing due south. The tilt, often roof slope, of the panels also influences production, as flatter angles will increase production in summer but decrease production in winter. Temperature can also affect production as increased temperatures increase electrical resistance and reduces PV efficiency. Figure 1 shows a solar array on a barn roof in Ohio.

Figure 1. – Photo by: F. John Hay

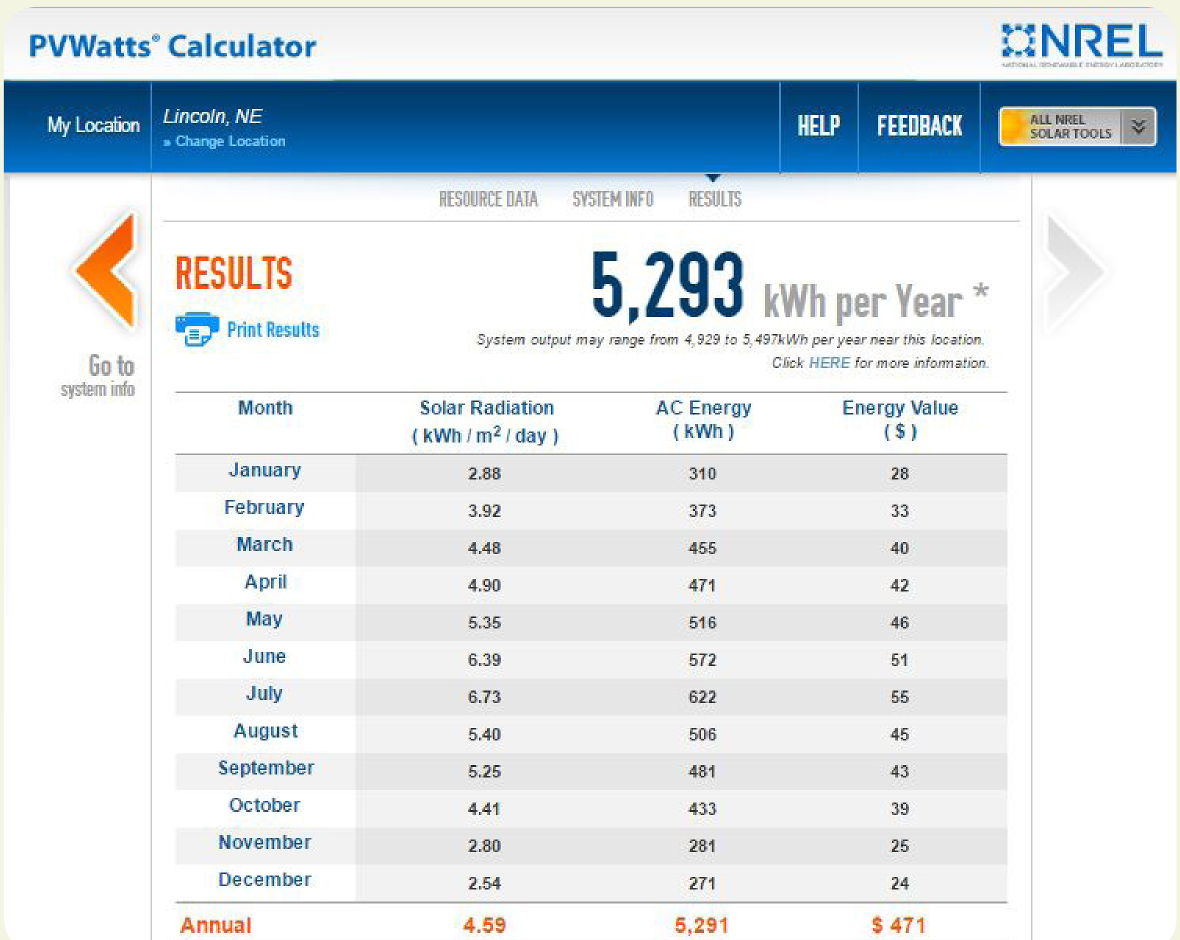
Most PV panels carry at least a 25-year warranty, but like most man-made objects, the sun will degrade PV panels over time. A typical warranty guarantees that production declines will be less than 0.5 percent a year. A 25-year old panel will produce at least 87.5 percent of original rated capacity of the system – a 10 kW system would be 8.75 kW in year 25. These calculations are considered in the National Renewable Energy Lab's PVWatts and System Advisory Model (SAM), but an installer should also account for these losses. The National

Renewable Energy Lab's tools and resources can quickly verify an installer's estimates. Figure 2 shows the result of a PV Watts model for a 3.6 kW array in Lincoln, NE.

KEY QUESTIONS:

- Is shading, orientation, angle, and temperature included in production estimates?
- Does the lifetime production include annual declines from degradation?

NATIONAL RENEWABLE ENERGY LAB'S PVWatts



Month	Solar Radiation (kWh / m2 / day)	AC Energy (kWh)	Energy Value ($)
January	2.88	310	28
February	3.92	373	33
March	4.48	455	40
April	4.90	471	42
May	5.35	516	46
June	6.39	572	51
July	6.73	622	55
August	5.40	506	45
September	5.25	481	43
October	4.41	433	39
November	2.80	281	25
December	2.54	271	24
Annual	4.59	5,291	$ 471

PVWatts is the most commonly used tool for evaluating solar resource. Novices and experts can use the easy-to-use platform. PVWatts even allows customized sizing of a solar array and variations based upon slope and orientation. The tool also offers rudimentary financial analysis. http://pvwatts.nrel.gov

Figure 2.

2. Asessing System Cost

Investing in a photovoltaic solar energy system is a major investment that will influence the future profitability of a farm or ranch. In many ways, investing in a solar system is similar to purchasing new farm machinery. When investing in a new tractor, investors start by reassessing their needs for the tractor before researching various models, options, and costs to determine the best option. Whether considering a new tractor or PV solar system, the goal is to get the most return on the investment by maximizing the ratio between performance and cost.

Investors should carefully evaluate multiple quotes or project proposals when considering a PV solar system. Due to different variables and assumptions used to develop a PV solar proposal, evaluating proposals may seem like trying to compare apples to oranges. Combining the total system cost with various savings, rebates, tax credits, grants, and subsidies will further distort the actual investment. If necessary, do not hesitate to ask the installer to put the information in an easier-to-understand format. This section will help readers understand the core components of the cost of a PV solar system, including direct capital costs, indirect capital costs, and operations and maintenance. A better understanding of system costs and standard assumptions allows a more accurate financial analysis, fostering informed investment decisions.

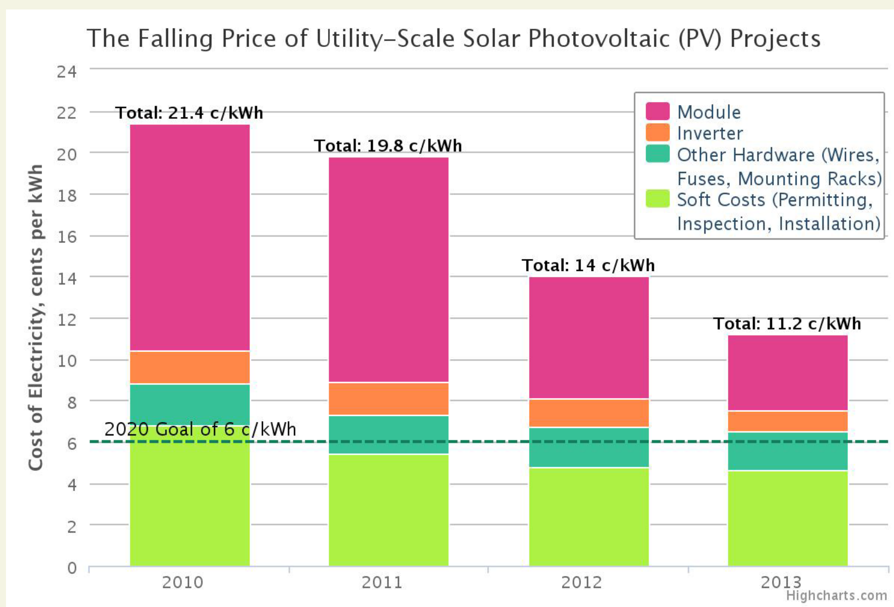


Figure 3.

DIRECT CAPITAL COSTS

Direct capital costs are those directly associated with the PV solar system and can be clearly assigned to a specific piece of equipment or components related to the project. Direct capital costs are included in the total system cost, which is an upfront cost incurred in year zero of the cash flow analysis. Common examples of direct capital costs for a PV solar system include the solar panels, inverters, and the balance of system components that typically includes racking, wiring, fuses, breakers, and monitoring equipment. As illustrated in Figure 3, the national average cost for utility scale PV solar projects in 2013 was 11.2 cents per kilowatt-hour. Direct capital cost accounted for 59 percent of the total costs including panels/modules (33 percent), inverters (9 percent), and the balance of systems hardware (17 percent).

INDIRECT CAPITAL COSTS

Indirect capital cost represents the soft costs associated with a project. Indirect capital costs are also included in the total system cost, which is an upfront cost incurred in year zero of the cash flow analysis. Common examples of indirect capital costs for a PV solar system include the installation costs (labor), grid interconnection, engineering, permitting, environmental studies, and sales tax. As illustrated in Figure 3, indirect capital cost accounted for 41 percent of the total installation cost in 2013. In most instances, the installation costs represent the largest indirect costs for small and midsized systems.

OPERATION AND MAINTENANCE

Unlike direct and indirect capital costs that occur upfront, operation and maintenance cost represent the ongoing annual expenses required to maintain, service, and/or replace critical components of a PV solar system. Common examples of operations and maintenance costs for a PV solar system include re-torqueing electrical connections, replacing fuses, repairing broken/crushed wiring conduit and fittings, locating ground faults, resealing leaking junction boxes, and repairing or replacing inverters and modules. Proposals use various assumptions and can report operation and maintenance costs in many ways, including as a simple fixed annual cost, fixed annual cost proportionate to the system size (nameplate capacity), fixed cost as a percentage of the overall capital investment, and a variable annual cost proportionate to the projected annual electrical production of the system. The National Renewable Energy Laboratory suggests a fixed operations and maintenance costs of $19 per kW/year for midsized (10 – 100 kW) PV solar systems. As an example, a 20 kW PV solar system would allocate $380 per year ($19 x 20kW = $380) for operations and maintenance costs. Some proposals will apply an annual inflation rate and annual escalation rate to the operation and maintenance costs. An escalation rate represents the estimated increase in operations and maintenance costs above the annual inflation rate due to the aging of system components. Because there are no moving parts, low operation and maintenance costs are a benefit of PV solar compared to other renewable energy technologies; however, a comprehensive PV solar proposal will account for the operation and maintenance costs because they represent a real cost and are essential to maximizing a system's production throughout its useful life.

SUMMARY - COMPARING MULTIPLE PROPOSALS

Separating the actual system cost from financial incentives, such as tax credits and grants, is important when evaluating multiple proposals. Typically, renewable energy incentives provided through state and federal government programs and utility providers are not unique to any one installer. The first question when comparing proposals is an important yet simple one: What is the total system cost?

While the question is simple, careful consideration of multiple PV proposals is challenging due to various configurations, assumptions, and system sizes. Establishing consistent metrics is critical to fairly compare system cost from multiple installers. An easy way to conduct an apples to apples comparison of multiple system costs is to calculate the installed cost per watt (Table 1). Divide the total installed system cost by the systems nameplate capacity in watts (tip: 1 kilowatt = 1,000 watts). Calculating the installed cost per watt is a valuable metric to compare system cost from multiple installers whose proposals may vary slightly in size and configuration.

Table 1: Example of Comparing Multiple System Proposals

	Proposal 1	Proposal 2	Proposal 3
System Size (kW)	9.848	11.777	7.927
kilowatts to watts	9,848	11,777	7,927
Direct Capital Cost	$16,600	$18,300	$14,600
Indirect Capital Cost	$11,500	$10,900	$13,000
Total Installed Cost	$28,100	$29,200	$27,600
Installed Cost Per Watt (Pre-Incentive)	**2.85**	**2.48**	**3.488**

http://bit.ly/2bBpged – Photo by: Matt Montagne – Figure 4.

Figure 4 shows a meter configuration with two meters. Utilities will require a meter configuration which ensures a proper metering billing for the system.

KEY QUESTIONS

- Can I easily identify the direct and indirect cost of the system?
- What is the installed cost per watt?
- Are the operations and maintenance costs included and clearly defined in the proposal?

3. Forecasting the Value of Electricity

The average retail price of electricity (all sectors) in the U.S. increased from 7.29 cents per kilowatt-hour in 2001 to 10.45 cents per kilowatt-hour in 2014[1]. Investing in a PV solar system is essentially hedging against future energy prices. Electricity production from a system will displace electricity that would otherwise be purchased from a utility. Although seemingly simple to calculate the energy savings for a project, one must consider many important variables, including the details of your individual rate structure and the assumed energy escalation rate that influence the value of electricity your PV system produces.

This section will help readers identify their utility rate structure, understand how the rate structure affects the value of electricity, evaluate energy escalation rates, and assess how these factors affect the assumed value of energy savings for a project. A better understanding of how to calculate energy savings will allow a more accurate financial analysis, fostering informed investment decisions.

UNDERSTANDING YOUR RATE STRUCTURE

There are more than 3,300 electric utilities in the U.S. and no standardized rate structure. Most electric consumers never consider the factors that influence the calculation of their electric bills; before assuming energy savings from a PV solar system, the rate structure of your home, farm, or business must first be understood. Common charges often included in farm or business rate structures may include a fixed (basic) charge, energy charge, demand charge, and a monthly charge. To determine specific charges, look up your utility rate structure and identify any cost that will remain after a PV solar system installation. The OpenEI Utility Rate Database

HOW ARE YOU CHARGED FOR ELECTRICITY?

Although the components of a bill vary by utility, the following charges are generally included:

- **Fixed monthly (Basic) charge** – This fee is a fixed dollar amount typically associated with infrastructure costs. A PV system will not reduce this charge.
- **Energy charge** – This charge covers the cost of producing energy (kWh). A PV install will reduce this expense.
- **Demand charge** – Covering peak demand (both daily and seasonal) requires power plants be available to provide energy for relatively short durations. A PV system may reduce this fee, but often PV does not align with peak demand charges.

Figure 5.

(www.en.openei.org/wiki/Utility_Rate_Database) provides a comprehensive list of utility companies in the United States that can be filtered by ZIP code and utility name to research details of your rate structure. You can further assess how different charges influence the value of your energy after determining the rate structure.

[1] U.S. Energy Information Administration Electricity Data Browser

VALUING YOUR ELECTRONS

The value of all kilowatt-hours (kWh) produced from a solar array are not the same. When production occurs (time of day and season) and how a utility charges for electricity (fixed, demand, and energy fees) significantly influence how much solar-produced electricity is worth. Both factors can drastically alter the viability of a PV solar project.

Wholesale electricity prices (the price your utility pays for electricity before reselling it to you) vary throughout the day based on demand. For example, wholesale power produced at 10 a.m. is generally less valuable than electricity generated at 6 p.m., when people return home and residential loads surge. Similarly, production in the winter or summer, when heating or air conditioning loads are greatest, is often more valuable than production in autumn or spring. The day of the week also matters, as electric consumers typically use less electricity on weekends than weekdays.

The higher a utility's energy charge, the greater the value of PV-produced electrons. If your utility provider currently (or in the future) applies charges for services other than energy, such as demand, time-of-day rates or fixed charges, then the value of PV-produced electrons will be less, Figure 6.

An example helps illuminate the importance of understanding the value of PV-produced electricity. Consider a farm with average annual electric usage of 32,745 kWh. If a 10 kW solar system with an estimated annual output of 16,253 kWh is installed, the amount of electricity (kWh) purchased from the utility will be reduced by roughly 49 percent. However, the value of that electricity will vary depending on the utility's rate structure. Simulation models such as the System Advisory Model (SAM) help illustrate how different rate structures affect the value of electricity produced by a PV solar system. The SAM model is a computer model developed at the

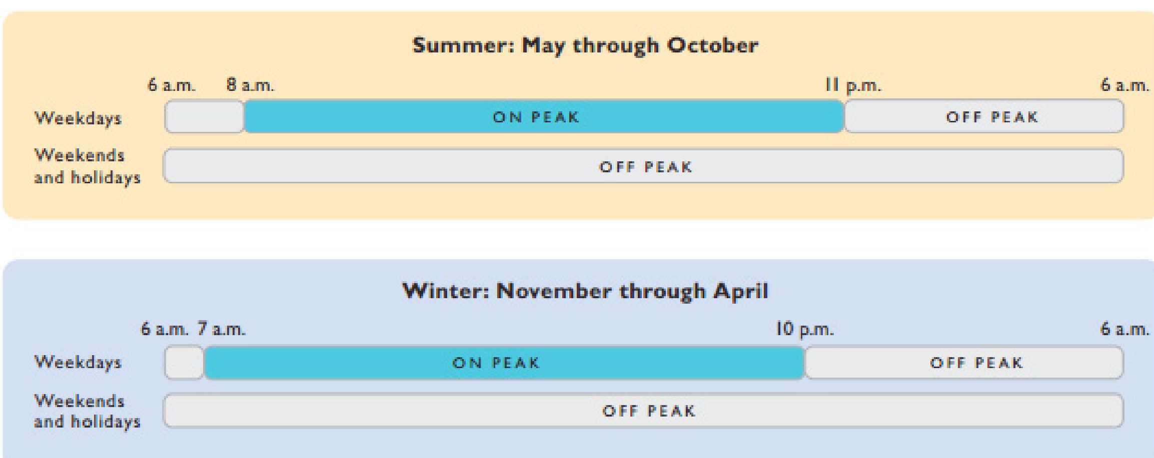
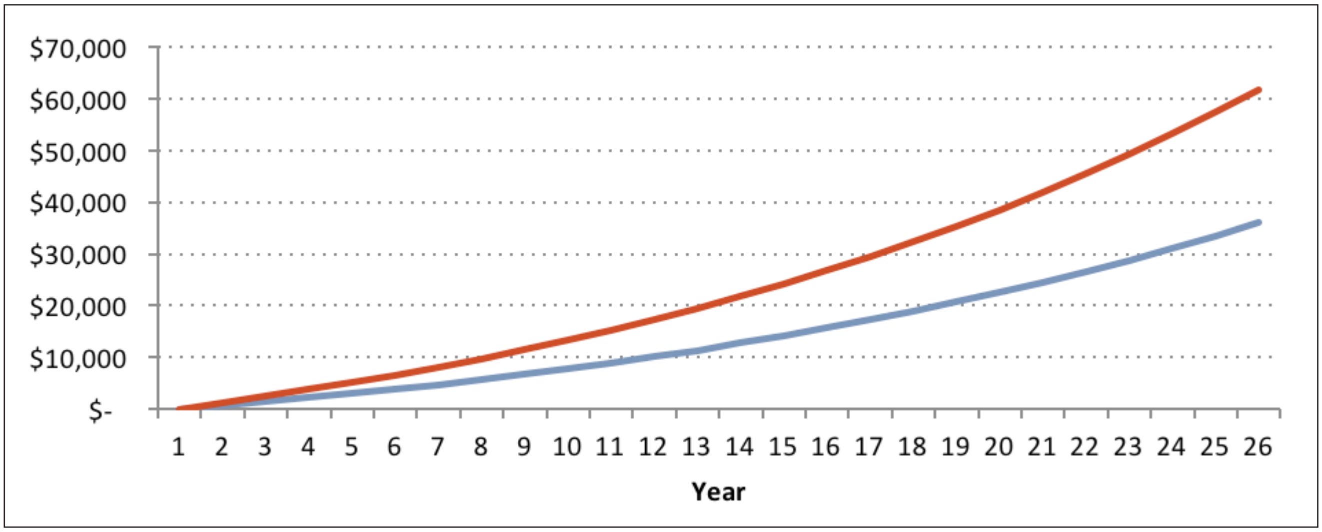


Figure 6: Example of daily, weekly, and season peak rates (Source: Rocky Mountain Power, Idaho)

National Renewable Energy Laboratory to estimate system performance and financial impacts of renewable energy projects. This financial model considers the value of electricity generated by the system, incentives, the cost of installation, operation and maintenance, taxes, and debt to simulate a detailed cash flow over the system's lifetime. Figure 7 shows the SAM summary results for the utility bill savings of installing a 10 kW solar system from two separate simulation models.

As illustrated in Figure 7, the expected utility bill savings over the 25-year life of a system is $61,827 for a farm that is on a rate structure (25) with no demand meter charges. In comparison, the same PV solar system would



28 - General Service - Single Phase Primary
Demand Max: 20.5 kW
Energy Max: 5000 kWh

Fixed Charge: $39.00
Energy Charge (buy rate): $0.0352
Demand charge per kW: $16.20

25 - Small Gen Service - Single Phase Primary
Demand Max: 20.5 kW
Energy Max: 5000 kWh

Fixed Charge: $27.25
Energy Charge (buy rate): $0.0726
Demand charge per kW: N/A

Figure 7: Value of Utility Bill Savings (Cumulative) 10 kW PV Solar System Calculated by the System Advisory Model (SAM)

only generate a utility bill savings of $36,138 if the farm had a rate structure (28) that includes demand charges and higher fixed charges. In summary, two PV solar systems that have the same electrical production (kWh) may experience very different energy bill savings based on the rate structure used to calculate their bills.

ENERGY ESCALATION

The final consideration for evaluating the value of PV-produced electricity is to identify the assumptions used to calculate the annual energy escalation rate. The nominal energy escalation rate estimates the annual rate energy prices will increase including overall inflation. The real energy escalation rate is the rate of change in energy prices with the overall inflation rate subtracted. For example, a nominal 3 percent energy escalation rate with 2 percent inflation results in a 1 percent real energy escalation rate. The distinction between nominal and real can significantly influence the expected value of PV-produced electricity in alternative proposals, and you must understand how each potential installer calculates energy savings to properly evaluate alternatives.

Accurately forecasting the energy escalation rate is difficult. Figure 8 shows how real and nominal residential electricity prices have changed since 1960. Around 2000, the real price of electricity began to increase, so most PV proposals assume real prices will continue to grow. Real escalation rates between 0.5 percent and 2 percent are commonly assumed. You can express your beliefs by changing this value. If you believe policy or environmental concerns will drastically increase electricity prices, use a higher value. If you believe technology will lead to reductions, use a lower factor.

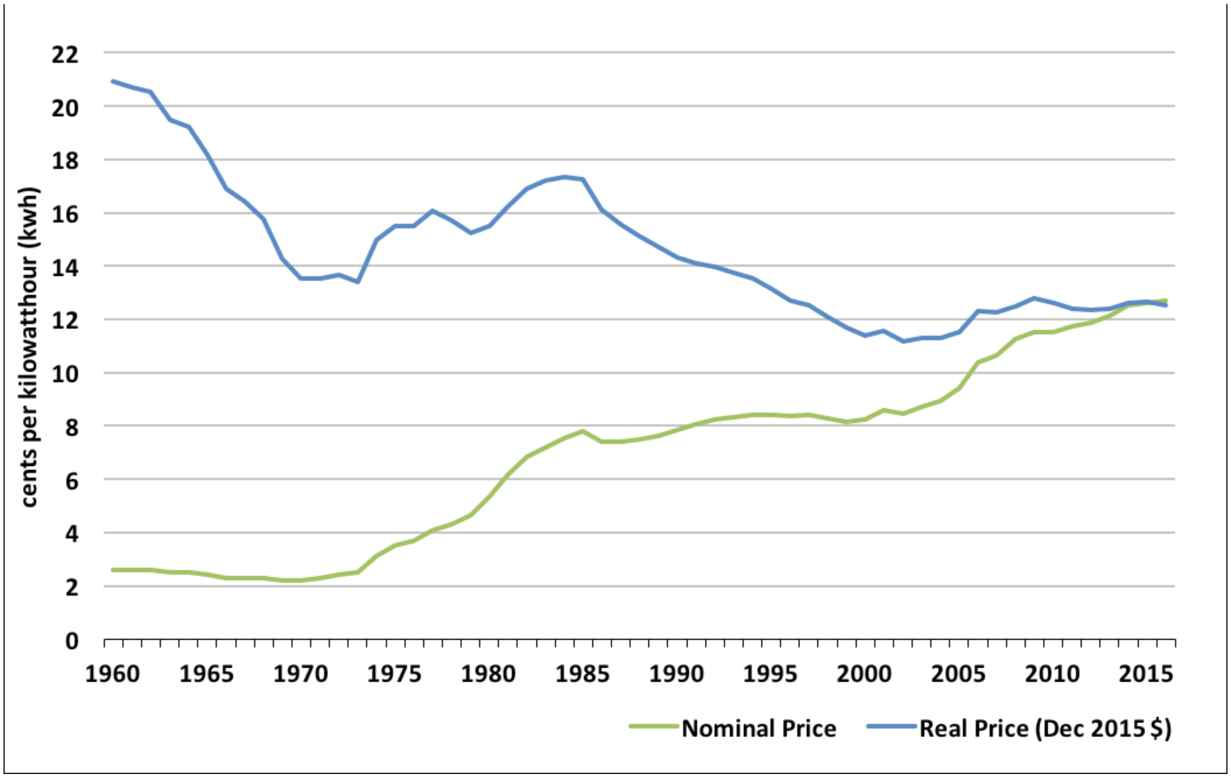


Figure 8: Annual Average Residential Electricity Price (Source: EIA Short-Term Energy Outlook, December 2015)

KEY QUESTIONS:

- Is the value of electricity based on an average utility rate, or are fixed fees, demand changes, and energy charges evaluated separately?

- What is the escalation rate used to calculate energy savings? Is it real or nominal?

4. Understanding Incentives

Developing a PV solar project requires significant upfront capital investments. To help foster the development of PV solar projects, government agencies and utilities offer numerous incentives, such as tax credits, deductions, net metering, grants, and rebates to offset the initial investment. Incentive programs vary widely based upon location (state and utility) and project ownership. For example, businesses and residences are eligible for different incentives. Similarly, folks in Nebraska are eligible for different incentives than those in Iowa. This bulletin helps navigate the all-important incentive landscape as of 2016.

WHAT ARE THE IMPORTANT INCENTIVES?

Despite rapidly declining costs for PV solar, incentives are still important to the cost-effectiveness of a project. Incentives come from four primary sources – federal, state and local government, and utility companies. Each has different reasons for providing incentives, from fostering the growth of energy independence and environmental responsibility (federal), to reducing individual energy costs and demand (state and utility), but all believe renewable energy and energy efficiency merit financial support. Incentives typically target specific sectors, so different incentives exist for residences, businesses, and agricultural producers. For example, a bonus depreciation program serves as an incentive for businesses to invest in PV solar, allowing them to depreciate the value of the project assets over multiple years to reduce taxable income. However, this program provides no benefit to a residential system owner, Figure 9. While the focus of this bulletin is on incentives for agricultural operations, many of the concepts also apply to residential systems. Table 2 details the most significant renewable energy incentives for agricultural operations. The table may seem daunting, but the benefit of harnessing available incentives makes understanding it worthwhile. Figure 10 shows instillation of a residential solar array on a roof.

KEY RESIDENTIAL INCENTIVES

Although local or utility programs may exist, the key incentives for residential applications are:

- Residential Renewable Energy Tax Credit (RRETC)
- Net metering policies

The 30 percent RRETC is similar to tax credits for businesses described below.

Figure 9.

http://bit.ly/2bbSqi9 – Photo by: Jon Callas – Figure 10

Table 2 – Business and Agriculture Incentives for Small-scale Renewable Energy Projects

Name	Description	Eligible Technologies	Expiration Date
Business Investment Tax Credit	30% or 10% tax credit (no limit)	Solar (electric and thermal), small wind – 30% Combined heat/power and geothermal heat pumps – 10%	12/31/2021 (reduces to 10% in subsequent years)
Modified Accelerated Cost-Recovery System (MACRS)	5-year depreciation schedule	Solar (thermal and electric), geothermal heat pumps, and wind	N/A
Net Metering	Allows many RE systems to receive the full retail rate for production up to total consumption and pays avoided cost for excess production	All renewable energy technologies that generate electricity	N/A
Renewable Energy Credits	Generated from a qualifying renewable energy system. One megawatt-hour of electricity is equal to one renewable energy credit.	May vary by state; however, most include all renewable energy technologies	N/A – Variable based on state policy
USDA - Rural Energy for America Program (REAP) Grants	25% grant available only to rural small businesses (currently all areas except Cheyenne and Casper); loan guarantees also available	All renewable energy sources	N/A – Variable program funding

FEDERAL BUSINESS ENERGY INVESTMENT TAX CREDIT (ITC)

Originally established in the Energy Policy Act of 2005, the Federal Business Energy Investment Tax Credit (ITC) is one of the most significant renewable energy incentives. Further defined by the Energy Improvement and Extension Act of 2008, the ITC program was scheduled for elimination or drastic reductions after December 31, 2016; however, passage of an omnibus budget bill (Consolidated Appropriations Act) extended these credits for certain renewable energy systems. This extension is exciting news for agricultural operations and businesses planning to install a renewable energy system. The federal ITC program offers system owners a dollar-for-dollar tax credit for eligible (construction and equipment) project costs toward their federal tax liability. For PV solar systems, the tax credit amount is currently set at 30 percent of the eligible project cost and will gradually decrease to 10 percent as shown in Table 3.

Table 3: The Federal Business Energy Investment Tax Credit (ITC) Schedule for Photovoltaic Solar

12/31/2016	30%
12/31/2017	30%
12/31/2018	30%
12/31/2019	30%
12/31/2020	26%
12/31/2021	22%
12/31/2022	10%
Future Years	10%

To accurately assess a project proposal, investors need to determine if cash incentives are subject to federal or state income tax. In most cases, grants are taxable income that must be reported on a income tax return. In general, if you pay taxes on the incentive, you are not required to reduce the basis for calculating the ITC; however, the incentive may not be taxable, in which case you should reduce the net system cost by the amount of the incentive before calculating the ITC.

For additional information, download the Department of the Treasury Internal Revenue Service (IRS) Form 3468 instructions at www.irs.gov/pub/irs-pdf/i3468.pdf.

DEPRECIATION

Much like investments in other types of equipment, investments in a PV solar system can be depreciated to reduce taxable income. A qualifying PV solar system installed on a farm or business is eligible to depreciate the value of the project assets using the Modified Accelerated Cost Recovery System (MACRS) deduction method over a five-year recovery period. The MACRS deduction method also includes special renewable energy system bonus depreciation. Bonus depreciation is an additional amount that is allowed to be deducted in the year that the asset was placed in service. Equipment put in service before January 1, 2018, can qualify for 50 percent bonus depreciation. Equipment placed in service during 2018 can qualify for 40 percent bonus depreciation, while equipment put in service during 2019 can qualify for 30 percent bonus depreciation.

For equipment that claims a tax credit, the owner must reduce the project's depreciable basis by one-half the value of the ITC. For example, if a system owner claims the 30 percent investment tax credit on a PV solar project, the same project will reduce the depreciable portion of the project assets by 15 percent (half of the total tax credit), allowing the owner to depreciate 85 percent of the project. Table 4 provides an example of how to depreciate a PV solar project that costs $31,000 and claimed a 30% ITC, with zero bonus depreciation, using the MACRS method.

State depreciation schedules may vary, and tax laws are continually undergoing changes. Discuss your project with a qualified tax professional to identify potential alternative depreciation options.

Table 4: PV Solar Project Depreciation Example Using the Modified Accelerated Cost Recovery System (MACRS) Method

Year	Depreciation Rate[1]		Depreciable Basis for the System[2]		Depreciation Amount
1	20.00%	*	$26,350	=	$5,270
2	32.00%	*	$26,350	=	$8,432
3	19.20%	*	$26,350	=	$5,059
4	11.52%	*	$26,350	=	$3,036
5	11.52%	*	$26,350	=	$3,036
6	5.76%	*	$26,350	=	$1,518

[1] Using 5-year recovery period from MACRS Percentage Table Guide Table A1 from IRS Publication 946 (2014).

[2] If you claim the 30% ITC, you must reduce the depreciable portion of the system by 1/2 the tax credit (e.g. $31,000 * .85 = $26,350).

NET METERING

Much like grants or tax credits, net metering policies promote the development of distributed (on-site) renewable energy systems. Net metering programs vary by state and utility, yet most follow a similar process. In general, electricity produced by a renewable energy system may be used by the home or business load or flow to the utility's distribution system to service other loads. Each electric bill will indicate the net amount of electricity for that billing period (electricity used – electricity produced). If there is net excess generation the utility will apply a credit (kWh or dollar) to the electric bill to offset charges in future months. Each State and Utility may differ in how this credit is applied. In states without net metering the same thing happens yet federal rules for distributed renewable generation are applied.

Most net metering agreements have a true-up period at the end of the year when credits are settled at a predetermined rate between the utility and the system owner. Regulations may restrict some net metering policies to a particular type of electric generation system. Common technologies included in net metering programs are solar, wind, geothermal, hydroelectric, anaerobic digesters, municipal solid waste, landfill gas, fuel cells, and tidal and wave energy. As shown in Figure 11, most states have established capacity limits within their net metering rules to restrict the size of distributed energy system. Specific capacity limits often differ by states, utilities, customer type, and technology.

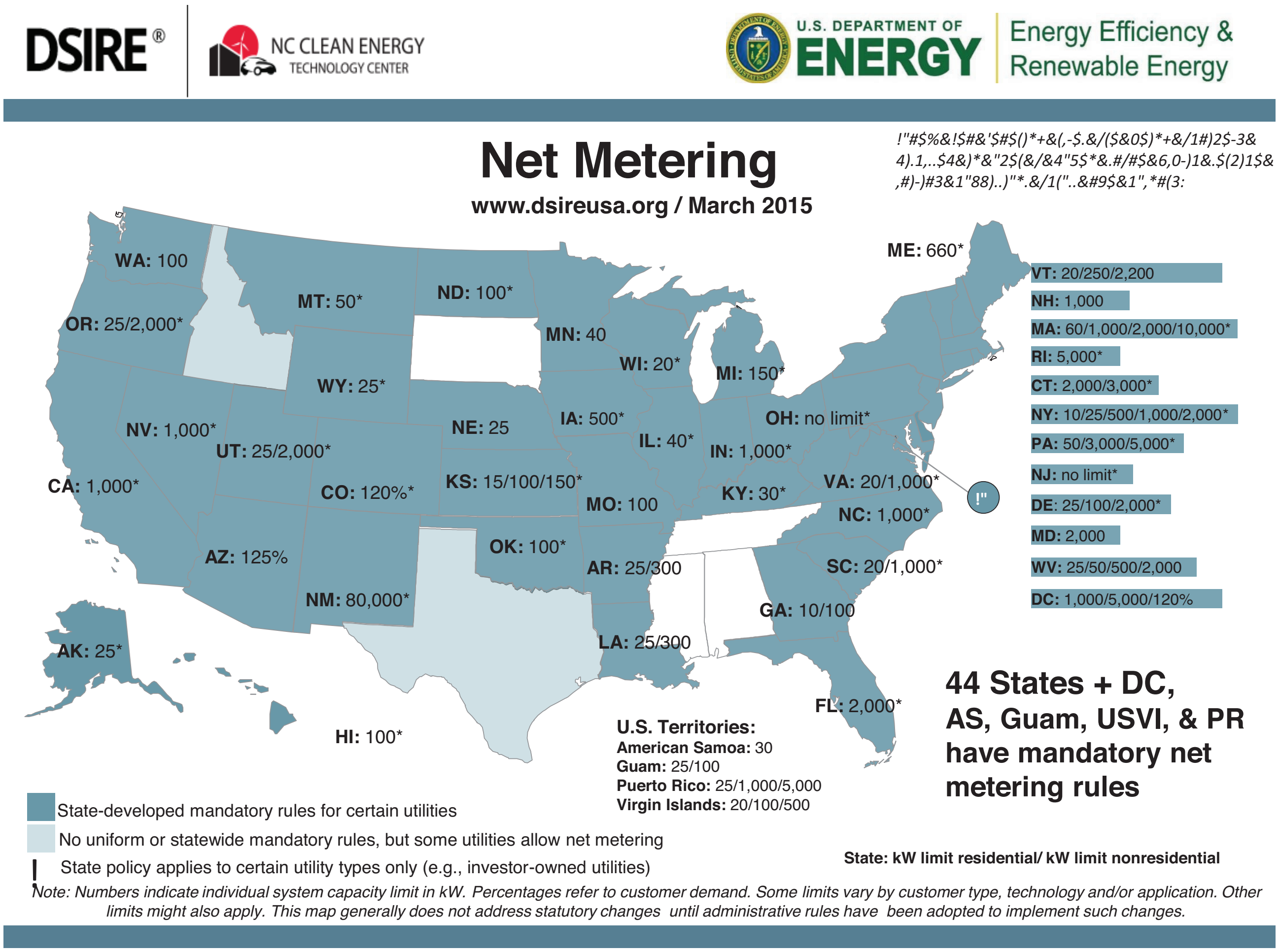


Figure 11: Net Metering Net Excess Generation Credits (Source: www.dsireusa.org)

As described earlier, net metering provides system owners a credit for excess generation; however, there are different compensation rates for net excess generation. For example, the net metering program in Nebraska typically includes a billing arrangement that applies a dollar amount credit to a customer's next bill for net excess generation based on excess kWh times rate (typically lower than retail referred to as the avoided cost) and resolves any balance annually. The avoided cost is the cost to an electric utility to procure (or generate) the same amount of energy acquired from another source. This approach allows renewable energy system owners who produce their own electricity to receive the full retail rate for production up to total consumption and pays avoided cost for excess production.

In comparison, the compensation for net excess generation in Iowa is much different. In Iowa, net metering agreements with investor-owned utilities will apply credits for net excess generation to the customer's next bill at retail rate, credits can carry over indefinitely, and excess credits cannot be cashed out. There are also examples where net metering credits are limited to kWh charges only and will not reimburse system owners for distribution services, transmission services, demand meter fees, or other fixed monthly charges. In other words, even if a PV solar system generates all of the electricity for a farm, there could still be additional monthly charges remaining on the electric bill. To ensure the accuracy of a financial analysis, identify any costs that will remain and exclude them from the calculation of the electricity savings in a PV solar proposal.

Feed-in tariffs are not as common as net metering agreements, yet several states do have feed-in tariff programs. In general, for eligible PV solar systems, a feed-in tariff establishes a fixed price for the electricity a system generates. Simply put, a feed-in tariff compensates at a predetermined amount (normally above market rate) for all of the electricity from a PV solar system, and the PV system owner continues to purchase electricity from the utility based on its rate structure.

RENEWABLE ENERGY CREDITS

State-driven policy programs designed to nurture the development of renewable energy projects include renewable portfolio standards, alternative energy portfolio standards, or renewable energy goals. While the details of various renewable energy policies differ, these policies generally require specified utilities or electric services companies to generate a percentage of electricity from renewable energy sources. Renewable energy certificates (RECs) help monitor the generation of electricity from qualifying renewable energy facilities and represent the environmental attributes of renewable energy. Based on production, every time a qualifying renewable energy system generates a megawatt-hour of electricity, the system also creates a REC. Some policies have a specific carve-out for solar, where a Solar Renewable Energy Credit (SREC) is electricity generated by a PV solar energy system. To comply with the policy requirements, utilities or electric service companies can purchase RECs from other renewable energy systems.

The sale of SRECs can generate significant income for PV system owners that can help offset the high upfront installation cost. There are different ways a system owner can sell their SRECs. For example, the owner may choose to directly manage the sale of their SRECs, enter into an SREC agreement with an aggregator or broker, or sell the SRECs directly to the system developer. Some PV solar proposals will try to oversimplify the transaction of SRECs by calling it a discount, rebate, payment, allowance, or refund. Regardless of names, the value of these agreements is significant, and the contract terms can extend for 20 years or more. There has also been ongoing debate related to the taxation of income from SREC sales. Consult a qualified tax professional to determine how to treat SREC proceeds for your project. Additional information on renewable energy credits is available at www3.epa.gov/greenpower/gpmarket/rec.htm.

GRANTS

There are also some direct cash incentives available for renewable energy projects, such as federal, state, or utility grants. One important incentive program for renewable energy and energy efficiency projects is the USDA Rural Development Rural Energy for America Program (REAP), which helps agricultural producers and rural small for-profit businesses reduce energy costs and energy consumption. REAP provides grants for up to 25 percent of total eligible project costs not to exceed $500,000 and loan guarantees on loans up to 75 percent of total eligible project costs. If the grant and loan program are used together, the total may not exceed 75 percent of the project. The competitive application process does not guarantee funding. Future awards for the USDA REAP program are subject to annual appropriation levels.

Some installers or developers make assumptions and include competitive grants as a key component of their proposals. If a developer includes a grant in a proposal, investors should request details of the funding program and make sure they understand how the grant assumptions influence the proposal.

The Database of State Incentives for Renewables and Efficiency (www.dsireusa.org) website, created by the Department of Energy and North Carolina State University Solar Center, provides a comprehensive list of renewable energy incentives and policies that can be filtered by location, technology, and sector (e.g., you can filter incentive programs for a commercial PV solar project in Wyoming).

As with any financial matter, consulting a qualified tax professional to ensure eligibility for tax incentives and grants is strongly encouraged. Please contact a local extension educator if you have additional questions.

5. Conducting a Financial Analysis

Understanding your solar production resource, PV system cost, value of electricity, and available incentives enables a robust financial analysis. To make an informed decision, investors need to understand the key components of a PV proposal and how to determine if the system is a sound investment. This bulletin empowers you to make that informed decision.

THE IMPORTANCE OF PRE-TAX AND POST-TAX

Another key consideration is to make sure the proposal accounts for the tax benefits and any tax increases due to the reduction in utility costs. Many proposals present the system cost after all of the tax benefits while listing the electric savings on a pre-tax basis. Energy savings on agricultural or commercial solar systems (not residential) may lower the value of tax-deductible operating expense or "write offs" of electricity purchases from a utility provider.

For example, a proposal with a total system cost of $45,000 may show the cost as $8,500 after applying all the grants and tax benefits, yet it will present the electric savings as $1,224 per year; however, if the taxpayer is in the 39.6 percent federal tax bracket, the after-tax cost of the electric savings is only $739. Although excessively simplistic and not accurate, the installer/developer may divide the after-tax cost of the system ($8,500) by the before-tax cost of the electric savings ($1,224) and claim that the payback is 6.9 years. However, when evaluating everything on an after-tax basis and dividing $8,500 by $739, the result is a significantly longer payback period of 11.4 years. In summary, ensure proposals are consistent in how they apply tax affects.

Insurance is a critical topic, yet it is sometimes overlooked and excluded from a proposal. For example, PV system owners who use the Federal Business Energy Investment Tax Credit (ITC) must retain ownership and operate the system for five full years after the original project commission date. Insurance can ensure you have the financial resource to replace a PV system in the event of a natural disaster. When reviewing proposals, PV system owners should contact their insurance providers and get a quote to add the PV solar system to the their policy. While this will most likely lead to an increase in insurance rates, it is important to accurately consider insurance costs in the project cash flow analysis and perhaps more important to ensure the investment is fully protected. A common way to calculate the insurance cost is to multiply the insurance rate by the total system cost. Insurance costs also increase annually by the inflation rate selected for the project analysis. For farm and business applications, the insurance cost is a tax-deductible operating expense.

In addition, for residential applications contact your home insurance provider and add the PV system to your homeowner policy to include the cost of a replacement solar system in the event of a catastrophe.

EVALUATING THE FINANCIAL RETURN

While the decision to purchase a PV system is seldom based on costs alone – social and environmental criteria matter, too (how much do you value energy independence? how much do you value clean electricity?) – purchasing a PV system is a significant financial investment. Sound investment decisions require more than just understanding the production of a PV system and interpretation of a system proposal. Sound investment decisions require thorough economic analysis of expected costs and benefits.

Simple payback is one of the most requested measures of a PV system's economic feasibility. Simple payback determines the number of years for the energy savings from the PV system to offset the initial cost of the investment:

$$\text{Payback (years)} = \frac{\text{Initial Cost (\$)}}{\text{Annual Production (kWh/year)} \times \text{Value (\$/kWh)} - \text{O\&M (\$/year)}}$$

Simple payback is an attractive calculation because the calculation is straightforward and easy to understand. Investors can assess how quickly an investment might pay back (the smaller the simple payback, the better the investment) and whether the investment might pay back within the expected lifetime of the project. However, because of the simplicity of the simple payback calculation, there are limitations when assessing the economic feasibility of PV projects. 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 can 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 chance to use that dollar right away, such as investing that dollar and earning interest. For example, if you invest $10,000 in a PV solar 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 underestimation 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 PV investments that occur in the future should be discounted to accurately analyze the investment decision. No single discount rate makes sense for everyone (personal discount rate is based on an individual's risk and time preferences), but in general the discount rate 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 suggest 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 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 (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 a PV 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, 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 (tiered or block pricing). The cost per kWh depends on the number of kWh consumed – in some cases, the price per kWh may increase or decrease with greater consumption. A grid-connected PV system could offset the highest-priced electricity by bringing a household down to a lower pricing tier. This added benefit of renewable energy systems is not easily captured in the simple payback calculation. Ignoring variable pricing will tend to overestimate the actual payback period.

Consumers should evaluate both PV and energy efficiency options to make the most financially sound investment decision (compare a PV 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 – payback treats a wind turbine with an expected life of 15 years and solar PV system with a life of 25 years as equal. The economic worth of an investment, however, is actually 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 (one will continue to produce benefits much longer than the other) will be incorrectly judged the same by the simple payback criterion, Figure 12.

Despite simple payback's several drawbacks, it can be used to effectively screen clearly undesirable investments that have extremely long payback periods compared to the life of the PV system. For instance, a system with an expected life of 25 years but a simple payback of 40 years is unlikely to be a sound investment decision regardless of whether you account for the drawbacks to simple payback.

Fortunately, investment analysis has several alternative metrics that, while requiring more effort, solve most of the drawbacks of simple payback. These metrics, particularly net present value and levelized cost of energy, consider important factors, such as time value of money and escalation. The National Renewable Energy Lab's System Advisor Model (SAM), which is used for the example in Part 6, calculates both measures as part of project analysis.

Net present value (NPV) considers both the savings and cost of PV project. The savings and costs are also both discounted. In general, a positive net present value reveals an economically feasible project, but there are nuances to this assessment. The greater the NPV, the better, but a positive NPV does not necessarily mean the investment should be made. The opportunity cost of the capital is also important. Are there better ways (higher NPV) to invest? The lifespan of the investment matters, too, making comparison of investments that have different timeframes difficult.

KEY SIMPLE PAYBACK TERMS

Initial Cost: Total price paid for PV installation

Annual Production: Amount of energy produced per year (kilowatt-hours per year for electric systems)

Value: Price paid for energy from utility or conventional source if not provided by PV system

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

Figure 12

Levelized cost of energy (LCOE) expresses the cost of the energy produced from a PV system. The measure includes construction and operation costs, and if shown as real LCOE, is closely related to the net present value. The principal advantage of LCOE is that comparisons are possible between different electricity sources, such as utility-provided electricity and roof-mounted PV. You can also make comparisons across different system lifespans. However, be cautious when using LCOE to compare different types of renewable energy generation to that of a dispatchable energy source such as a natural gas or coal generator. While LCOE can help inform the decision, it should be noted that because PV solar electricity is a variable resource, other energy sources are required for the PV solar to take advantage of a low LCOE. Although seemingly the best option for comparing alternatives, LCOE is not immune to the effects of poorly considered discount and energy escalation rates. Be careful with your choices!

The take-home message is that simple payback can provide an initial indication of economic viability but does not provide enough information to make a sound decision on such a large investment. Purchasing a PV system based on the simple payback alone may result in very disappointing returns. Net present value and levelized cost of energy offer more complex, but more complete, measures of economic viability. Part 6: PV Solar Example provides examples of simple payback, net present value, and levelized cost of energy in action. Figure 13 shows a ground mount solar array.

Figure 13. Ground Mount Solar Array – F. John Hay

6. 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 section 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.

Figure 14. Output Summary of NREL System

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, Figure 14. 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 NEBRASKA 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 photo-voltaic solar project. We examine a PV solar project for a small swine and goat operation near Lincoln, NE with a farrowing house and nursery 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 3166 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 5). Both assume the agricultural operation will provide 100 percent equity toward the project and require 0 percent debt financing.

This section 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 5: 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
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 35° tilt, no shading. Both scenarios had similar energy yield with an average production of 14,638 kWh annually and 344,807 kWh over the 25-year project life cycle. 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. Figure 15 shows how tilt influences production.

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 15

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 $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 16, on average scenario 2 will include additional costs of $327 per year or $8,823 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.

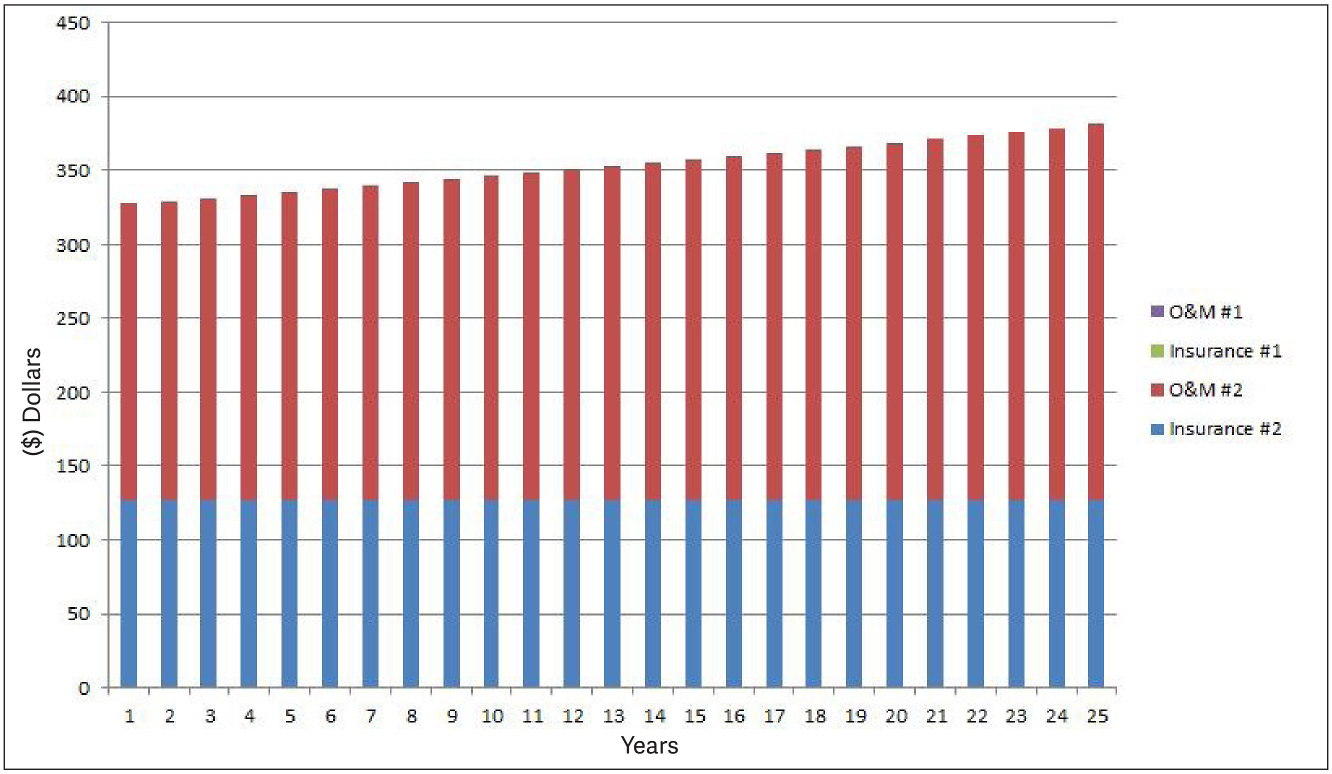


Figure 16. Annual Insurance, Operations, and Maintenance Costs [Note: Scenario 1 assumes no ongoing costs.]

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 a local NE utility with rural electric consumers. The rate structure used in scenario 2 includes a fixed monthly charge of $25 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 17, the aggressive assumptions used in scenario 1 exaggerate the value of energy from the project, estimating total energy savings of $82,000 over the 25-year project. In comparison, the simulation for scenario 2 is 58 percent less, estimating total energy savings of $34,000 over the 25-year project life.

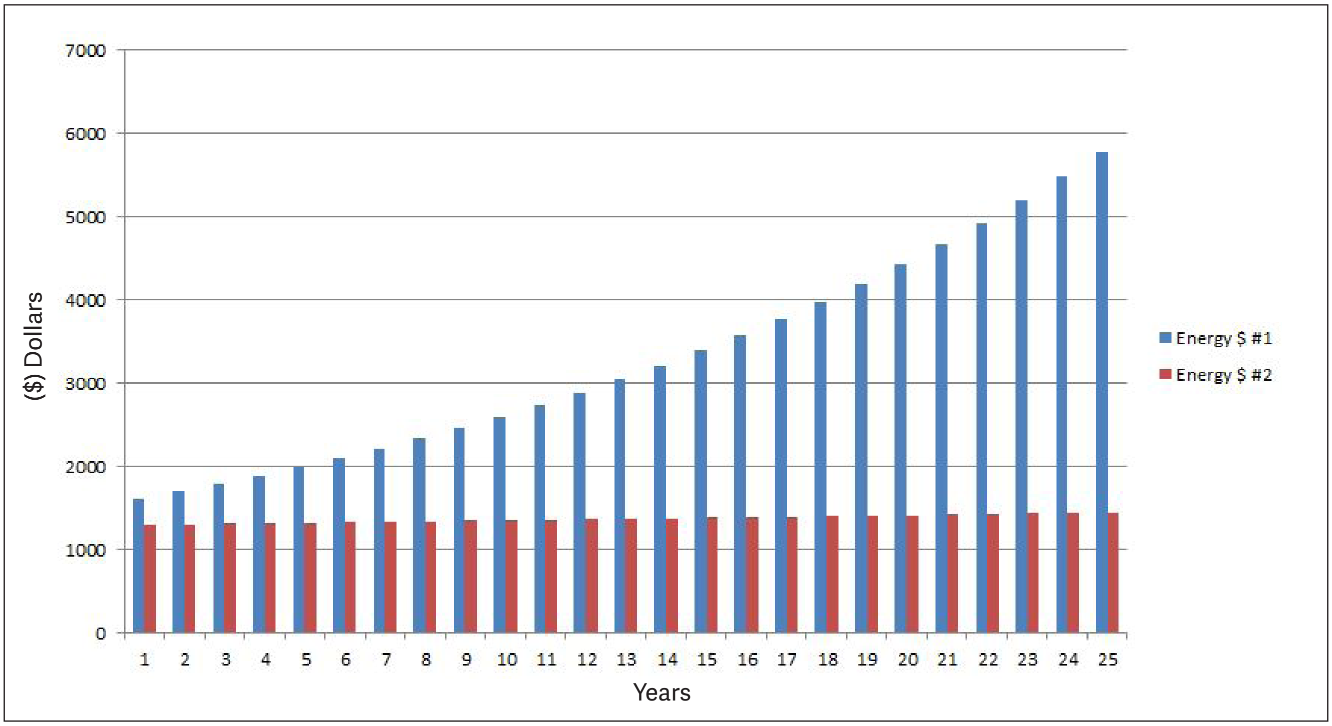


Figure 17. Value of Electricity (Annual)

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 5.4 years. According to simple payback, the electricity savings generated will offset the installation costs in about 5.4 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.

In comparison, when we account for these variables in the simulation of scenario 2, we get widely different payback estimates, Figure 18. 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 5, the payback increases from 5.4 years to 15.9 years, while the nominal levelized cost of electricity increases from 3.31¢/kWh in scenario 1 to 7.06¢/kWh in scenario 2. Similarly, scenario 1 suggests a net present value of $19,110, while the adjusted scenario 2 simulation yields a net present value of - $1,092. Figure 19 illustrates a comparison of the cash flow between the two scenarios.

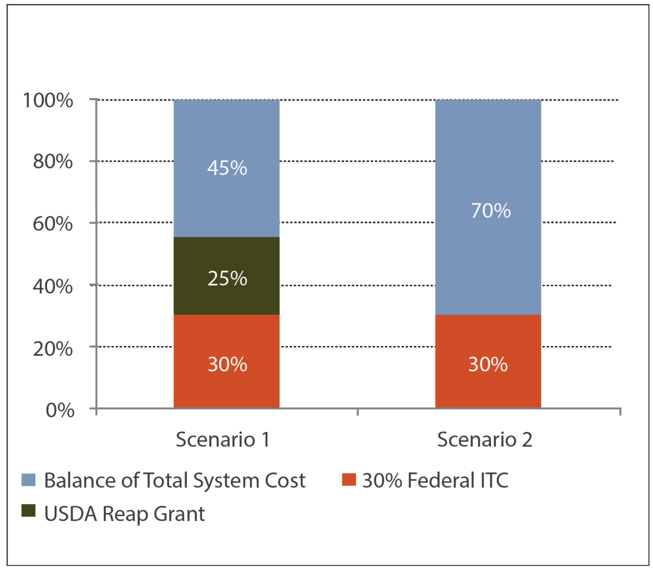


Figure 18. Incentives as a Percentage of the Total System

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 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. Figure 20 shows F. John Hay on a barn roof helping to install a 16 kw Solar array.

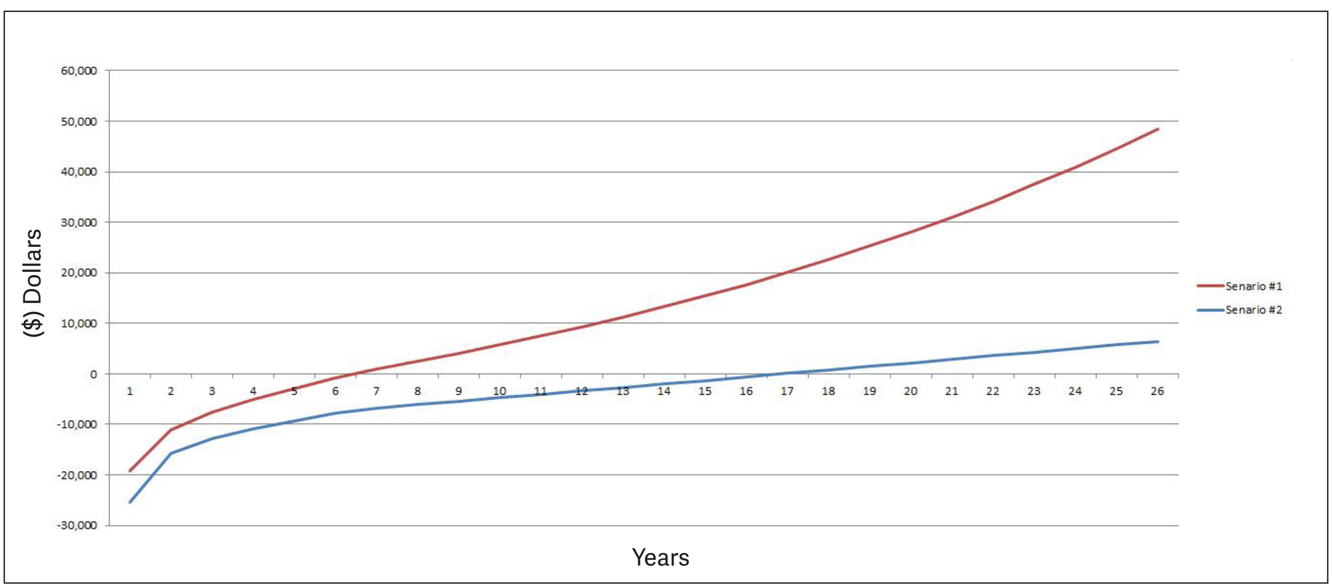


Figure 19. Comparison of System Cash Flow (cumulative)

Figure 20. – F. John Hay

For questions regarding the information in this publication please contact F. John Hay.

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