PART 2:

Assessing System Cost

SOLAR ELECTRIC INVESTMENT ANALYSIS

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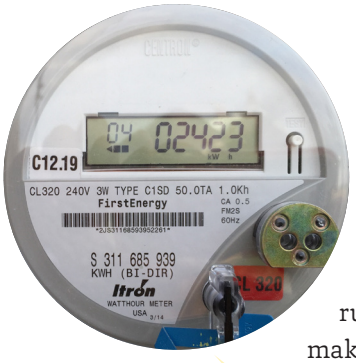


Introduction

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?

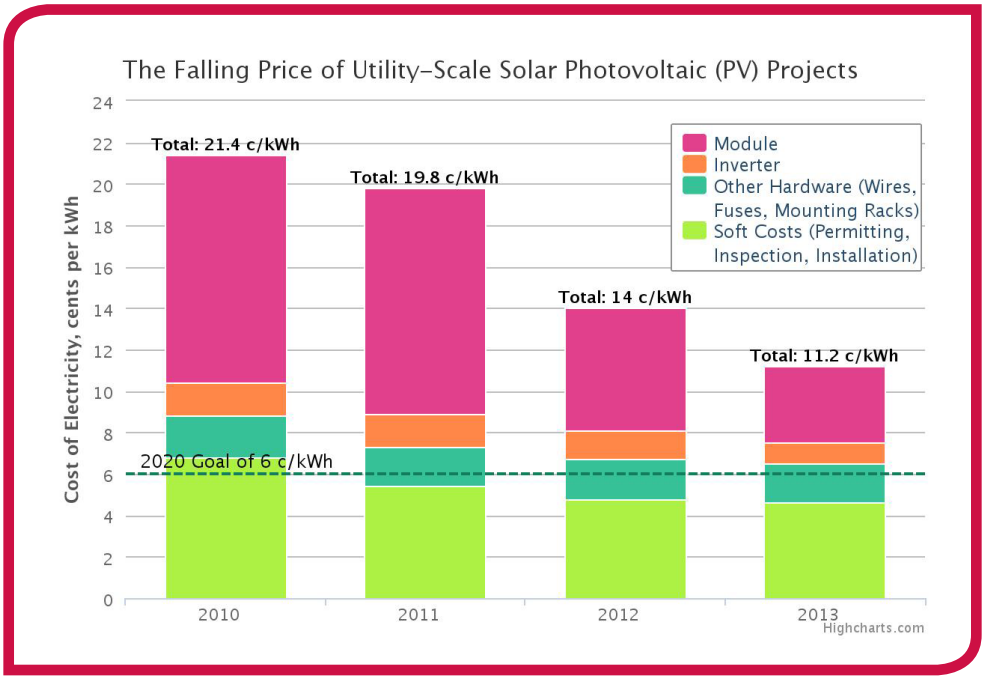
Solar electric is now the dominant type of distributed renewable energy system, but other renewable energy technologies, such as small wind, solar thermal, micro-hydropower, ground source heat pumps, and efficiency upgrades, require similar scrutiny. Systems that provide thermal energy, as opposed to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

Assessing 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 bulletin 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.



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 Image 1, 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 Image 1, 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

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**

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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.

Please contact a local extension educator if you have questions about the cost of a proposed PV 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?