What's the PAYBACK?

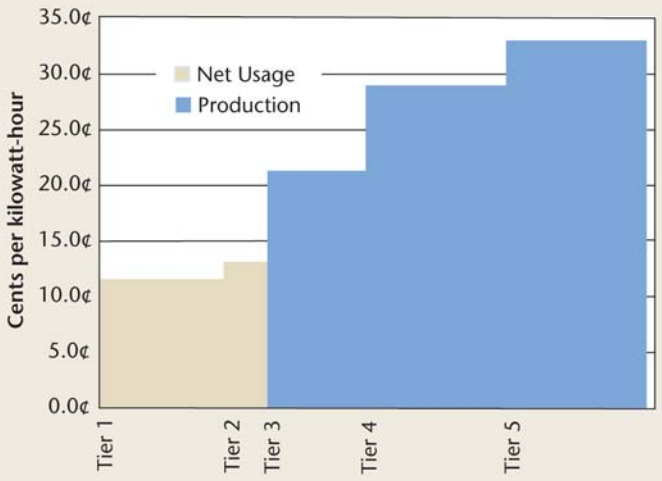
How to calculate the return on your solar electric system investment before you buy.

By Andy Black

Figure 1

Effect of Tiered Electric Rates on Large Users, and How Solar Helps

Tiered-rate pricing penalizes large users most with high marginal electricity rates. The combined tan and blue areas show the customer's total usage (equal to his usage before solar), and the relative value in each tier. Solar energy offsets highest-tier usage first, making the solar customer look like a small net user, with a lower marginal cost.



Source: Andy Black, OnGrid Solar

For years, questions about returns on the expensive investment in a solar electric system were dismissed with the analogy, "What's the payback on your swimming pool?" That sentiment might speak to the converted, but for most people considering a solar energy system, the financial case is a major deciding factor.

Fortunately, photovoltaic (PV) technology has matured such that the payback question can now be given a serious answer, backed by solid math and accounting. The answers vary significantly by local climate, utility rates and incentives. In the best cases — California and New Jersey — the compound annual rate of return is well over 10 percent, the cash flow is positive, and the increase in property resale value more than covers the cost of the PV system. In other parts of the country where electric rates are low and incentives may be less, a grid-tied system may barely cover its maintenance costs.

This article focuses on residential analyses. Similar calculations can be done for commercial situations, but significant differences in the tax and accounting rules exist. See the resources mentioned at the end of this article to learn more about commercial analyses.

What Factors Improve Payback?

The most important factors for making solar an attractive investment include high electric rates, financial incentives, net-metering policies and good sunlight (available in almost all of the continental United States).

High electric rates can come in various ways. California, Hawaii, New York and other states have average rates well above $0.15 per kilowatt-hour. California has a tiered pricing system penalizing large residential users with prices as high as $0.33 per kilowatt-hour *(see figure 1, left)*.

Under most net-metering laws (they vary by state or utility), solar energy offsets the retail cost of the electricity generated. Even better, in California, solar systems are allowed to operate on a time-of-use rate schedule, which enables users to sell back electricity to the utility at peak rates, which can be even more valuable. These high rates are the most important factor in improving the payback.

Direct incentives can include tax benefits such as credits or depreciation. The most celebrated recent incentive is the federal tax credit for solar systems that went into effect Jan. 1. The credit is for 30 percent of the system cost up to $2,000 for residential systems (no cap on commercial credits). For PV systems, that typically means a $2,000 credit on the purchaser's tax return for the year the system was installed. This credit can be coupled with state incentives. Another popular state incentive is the rebate, which can discount up to 60 percent of a system's cost.

Sample Scenarios for **Residential System Payback**

Example	Electric Bill Before Solar	Usage Before Solar per Month (kWh)	Solar System Size (Standard Test Conditions)	Solar System Cost Before Incentives	Final Net Cost with Tax Credits & Rebate	Pretax Compound Annual Return	Appraisal Equity/Resale Increase In First Year	Net Monthly Cash Flow Compared to 7 percent 30-yr Loan in First Year
California								
Medium System	$100	700	4.3 kW	$34K	$23K	10.1%	$22K	$(13)/mo
Large System	$345	1,500	9.4 kW	$70K	$48K	16.8%	$77K	+$109/mo
New Jersey	$117	900	9.9 kW	$74K	$26K	16.5%	$62K	+$142/mo
Hawaii	$200	825	7.2 kW	$54K	$39K	11.8%	$44K	+$7/mo

Source: Andy Black, OnGrid Solar

Some states also have a state tax credit, which can further reduce the up-front cost of a system. Consult a certified tax advisor to check the applicability of such incentives to your situation.

A big factor in some calculations is inflation in electric rates. Solar is an inflation-protected investment, because it offsets electricity costs at the current prevailing retail rate. As rates rise, the owner saves even more.

New forms of incentive, including RECs *(renewable energy credits, or "green tags"; see feature on page 30)*, can be combined with net metering and other incentives. With these, a PV system is capable of garnering substantial revenue per kilowatt-hour generated.

Determining the Payback

There are several ways to measure the economic value of a solar system: *compound annual rate of return, cash flow* and *increase in property resale value*. In strong economic cases, the returns will be over 10 percent, the cash flow positive and the increase in resale value greater than system cost. These are common returns in certain markets.

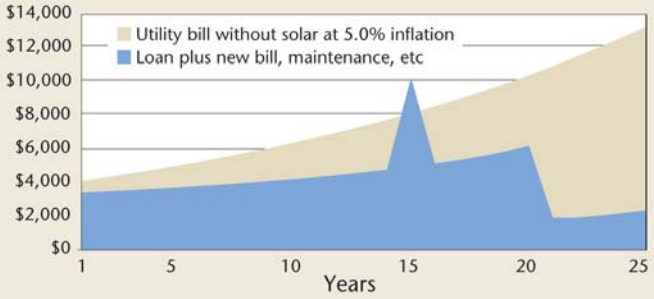
Compound annual rate of return, or CARR, on an investment is another term for interest-rate yield, which is a way of comparing one investment to another. For example, a savings account might pay 1 percent interest and the long-term stock market has paid about 10.5 percent. Solar systems in California, New Jersey and a few other locations can often see a pre-tax CARR of 10 percent or more.

Several examples are shown in the table, "Sample Scenarios for Residential System Payback," above. For more detailed information on these calculations, download www.ongrid.net/

Figure 2

Inflation's Effect on Loan Costs Versus Electric Costs Without Solar

In this case, the photovoltaic system loan term is 20 years, with inverter replacement occurring at year 15 (the large spike).



Source: Andy Black, OnGrid Solar

papers/PaybackOnSolarSERG.pdf.

The cash flow will be positive, either immediately or within the first few years, for many homeowners who finance their solar systems using home equity loans.

The cash-flow calculation compares the estimated savings on the electric bill to the cost of the loan. Monthly loan cost is the principal plus interest payment required to pay off the loan, less any tax savings. In the case of "deductible" loans, such as home equity-based loans, the interest is usually tax-deductible and thus the loan effectively costs less. Home equity loans are also excellent sources of funds because interest rates on real estate-secured loans are relatively low and payment terms can be long.

Inflation plays an important part. Inflation affects electric rates and thus effectively increases the savings from a solar system over time. Inflation doesn't affect loan rates, particularly with fixed-rate loans. Hence, as electric rates rise, the savings grows, but the cost of the loan stays relatively constant (it rises a little over time as the interest portion of the payment declines and the tax deductibility declines). See figure 2, left, for an example.

Figure 3

Net Annual Savings With a Photovoltaic System

Net annual savings consists of the old electric bill minus the new bill, loan principal payments, loan net interest (after taxes), maintenance and inverter-replacement costs. This example system is cash-positive from the first day at no "out of pocket" costs to the purchaser.

Source: Andy Black, OnGrid Solar

Figure 3, below, highlights the difference in the curves in figure 2. This figure shows the net annual savings — old bill minus new bill, loan, maintenance and inverter-replacement costs — and shows the effects of inflation over time. Note that these are examples of ideal cases in the states with the best economics.

The accumulation of net annual savings is free and clear with no initial outlay of cash, because that was covered by the loan. The savings are small though significant in the first years, but really jump when the loan payments stop.

The table on page 35 includes several examples showing the initial monthly cash flow, assuming 100 percent financing of a solar system's final net cost.

An Increase in Property Resale Value occurs in homes with solar electric systems because these systems decrease utility operating costs. According to a 1998 *Appraisal Journal* article by Rick Nevin and Gregory Watson, a home's value increases $20,000 for every $1,000 reduction in annual operating costs from energy efficiency. *(See www.icfconsulting.com/Markets/Community_Development/doc_files/apj1098.pdf.)*

The rationale is that the money from the reduction in operating costs can be spent on a larger mortgage with no net change in monthly cost of ownership. Nevin and Watson state that historic mortgage costs have an after-tax effective interest rate of about 5 percent. If $1,000 of reduced operating costs is put toward debt service at 5 percent, it can support an additional $20,000 of debt. To the borrower, total monthly cost of home ownership is identical. Instead of paying the utility, the homeowner pays the bank, but the total cost is unchanged.

See the column labeled "Appraisal Equity/Resale Increase" in the table on page 35 for examples of the increase in home value. This increase can effectively reduce the payback period to zero years if the owner chose to sell the property immediately, and it removes the purchase risk. It could even lead to a profit on resale in some cases.

This increase in property value to date is currently theoretical. A high fraction of the grid-tied solar electric systems have been installed since 2001. Most of these homes have not been sold, so there are no broad studies of comparable resale values available. However, emerging evidence suggests that some solar-home sellers are realizing significant jumps in resale value.

A 2004 National Renewable Energy Laboratory (NREL) study demonstrated that San Diego zero-energy homes with solar features increased in value faster than comparable conventional homes in a nearby community. *(Access the report at www.nrel.gov/docs/fy04osti/35912.pdf.)* On average, the homes increased in value $40,000 more than the conventional homes, at a higher rate of appreciation and with a shorter length of ownership. This boost in resale value outstrips the estimates shown in the table on page 35.

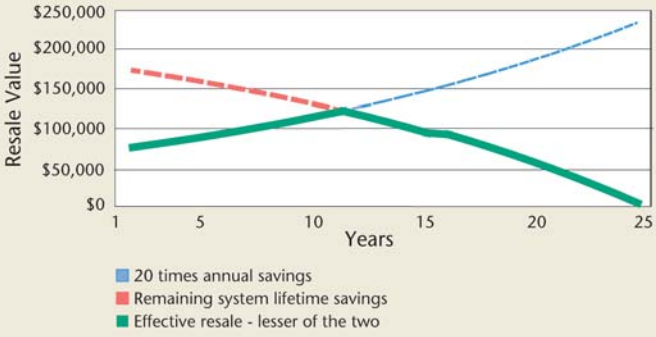
PV systems will appreciate over time, rather than depreciate as they age. The appreciation comes from the increasing annual savings the system will yield as electric rates and bill savings rise.

This appreciation cannot continue forever, as the increase in

Figure 4

Resale Value

Increases over time due to solar until limited by remaining system lifetime savings.



Source: Andy Black, OnGrid Solar

resale value runs into the second limit, which relates to the system's remaining life. For these analyses, the system is assumed to be worthless at the end of 25 years. This estimate is conservative, since the panels are warranted at 25 years to work at 80 percent of their new capability. If the system is worthless at the end of 25 years, the only value the system has as it nears that time are the savings it can generate before the end of the 25th year. Figure 4 shows both the increasing property resale value due to increasing annual savings and the remaining-value limitation that takes over at approximately year 11. As the NREL resale study suggests, however, actual resale could be much higher depending on the market mood for solar.

Creating Markets That Reward Investment

For more information on calculating photovoltaic system payback, access www.ongrid.net/papers. Additional resources are listed in the sidebar, "Payback Calculators and Resources." Be aware that some tools don't account for tiered or time-of-use electric rates in interaction with PV production, and as such, their results may over- or underestimate the value of a PV system in a particular situation.

In addition to avoiding oversimplified estimates, be cautious of aggressive sales pitches and "optimistic" financial analyses. Going solar, like any other major purchase, is a "buyer beware" situation. For 10 tips on how to detect unrealistic analyses, see the last page of the "Payback" article posted to my site: www.ongrid.net/papers/PaybackOnSolarSERG.pdf.

Solar has finally come into its own in certain markets. These markets are exploding because individuals are discovering the financial benefits of owning PV systems in those regions. In order to encourage widespread adoption of solar energy, we need to empower everyone with this knowledge and expand the components that make it possible — tiered rates, time-of-use net metering, RPSs with solar requirements and RECs. Market forces will take it from there. ●

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Payback Calculators and Resources

Database of State Incentives for Renewable Energy: **www.dsireusa.org**

The Clean Power Estimator: **www.consumerenergycenter.org/renewable/estimator**

FindSolar.com: **www.findsolar.com**

OnGrid Solar Financial Analysis Calculator: **www.ongrid.net/payback**

PV Watts: **http://rredc.nrel.gov/solar/codes_algs/PVWATTS**

QuickQuotes: **www.clean-power.com/cpeApps**

RETScreen: **www.retscreen.net**

Solar Energy Industries Association Guide to Federal Tax Incentives: **www.seia.org/manualdownload.php**

How Does Solar Compare to Remodeling Investments?

Why should a homeowner pay more for a house with a solar system when she could buy a nearby non-solar home and install a solar system for less money? Yet other remodeling upgrades increase resale value in this way.

Nationally, decks return an average 104 percent of their cost on resale. However, in certain markets like San Francisco and Boston, decks add more than 215 percent of their value upon resale (Remodeling Online, *www.remodeling.hw.net*). Kitchen and bathroom remodeling have similar results, depending on geography. So it makes sense that in certain regions where the sun shines brightly and electric rates are high, solar would return more than its installed cost, while in other states with less sun and lower rates, the return might be much lower, with a national average comparable to other types of house upgrade. The table below lists projected resale value of various solar systems, compared with nationwide averages for other home improvements.

Resale Value Comparisons of Various Home Improvements

Home Improvement Type	Investment Amount/ Net System Cost	Resale Value Increase	% Return
4.3-kilowatt Photovoltaic System, California	$23,000	$22,000	95%
9.4-kilowatt Photovoltaic System, California	$48,000	$77,000	160%
Deck Addition	$6,300	$6,700	104%
Bathroom Remodel	$10,100	$9,100	89%
Window Replacement	$9,600	$8,200	85%
Kitchen Remodel	$44,000	$33,000	75%

Analysis based on data from Remodeling Online*'s 2003 survey.*