Payback and other Financial Tests for Solar Electric Systems

By Andy Black

Solar electric systems can be a good financial investment for California homeowners with good sun (little shade) on a south, southwest, or west-facing roof, if they have a $100 a month or larger electric bill. The larger the bill, the better the investment pays off. The returns are attractive for businesses too.

Rates of return from 9% to 14% are common. If financed, the loan cost is usually less than the monthly utility bill savings. And if the home is sold, the solar system should increase the resale value by more than the system's installed cost.

The above claims are big, so rigorous treatment and critical analyses from several angles including Compound Annual Rate of Return, Cash Flow, Lifecycle Payback and Resale Value need to be considered to do a fair assessment. It is helpful to compare the solar investment to other investments on an even basis.

IN THIS ARTICLE:

- Why solar pays off, including incentive programs that help for both residential and commercial solar applications
- How to test the economic value in the ways listed above

WHY DOES SOLAR PAY OFF NOW?

High electric rates, Time-Of-Use metering, and government incentives have contributed to the financial viability of solar electricity. The key element for these analyses is the savings on the electric utility bill generated by the solar system. A properly sized, designed and installed solar system can easily eliminate almost all of the total annual electric bill. There are usually only minor monthly minimum charges remaining.

RATE STRUCTURES:

High Electricity Rates and California's tiered rate system (with top rates of 35¢/kWh) penalizes residential customers with high electric usage. The surcharges in the three top tiers (see Fig. 1) for residential customers are among the most important factors in the payback. Utility rates have also increased steadily at about 6.7% per year for 30 years (Fig. 2), and 5.4% over the last 22 years. Because state law prohibits changes to the rates for Tier 1 and Tier 2, all the increase must be borne in Tiers 3, 4 and 5. This means that if the average rate goes up 10%, but Tier 1 and 2 can't change, Tier 3 and up must increase approximately 50%. When this happened on January 1st, 2006, it came as a big shock to large users. To be very conservative, 5% utility rate inflation across all tiers is used in the analyses that follow. For comparison, the Consumer Price Index has increase 3.5% per year since 1980.

With **Net Metering on an Annual Basis,** full retail value is credited when excess electricity is produced and "sold" back to the utility (to a maximum credit of fully offsetting the annual electric bill). Much of this excess usually occurs during summer daytime hours. This credit gets used up over the winter and at night and can be held on account for up to a year. The utility ends up looking like a 100% efficient battery that can store energy for up to a year at no loss or penalty.

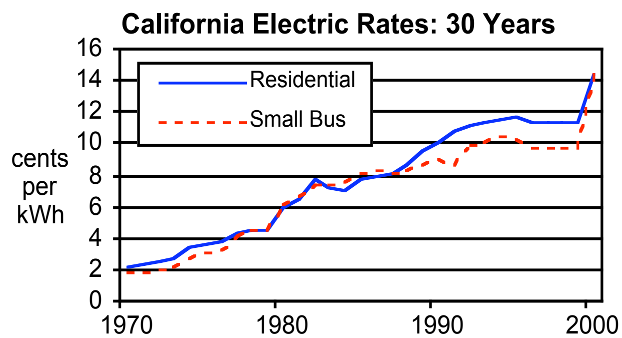

Fig. 2. Rates have gone up an average of 6.7% per year for 30 years. Source: CPUC "Electric Rate Compendium" Nov. 2001. This article assumes inflation will be 5% going forward.

Electricity is billed to customers on either a flat-rate schedule (PG&E E1 rates), where electricity costs the customer the same any time of the day, or on a Time of Use (TOU) schedule, (PG&E E6, E7

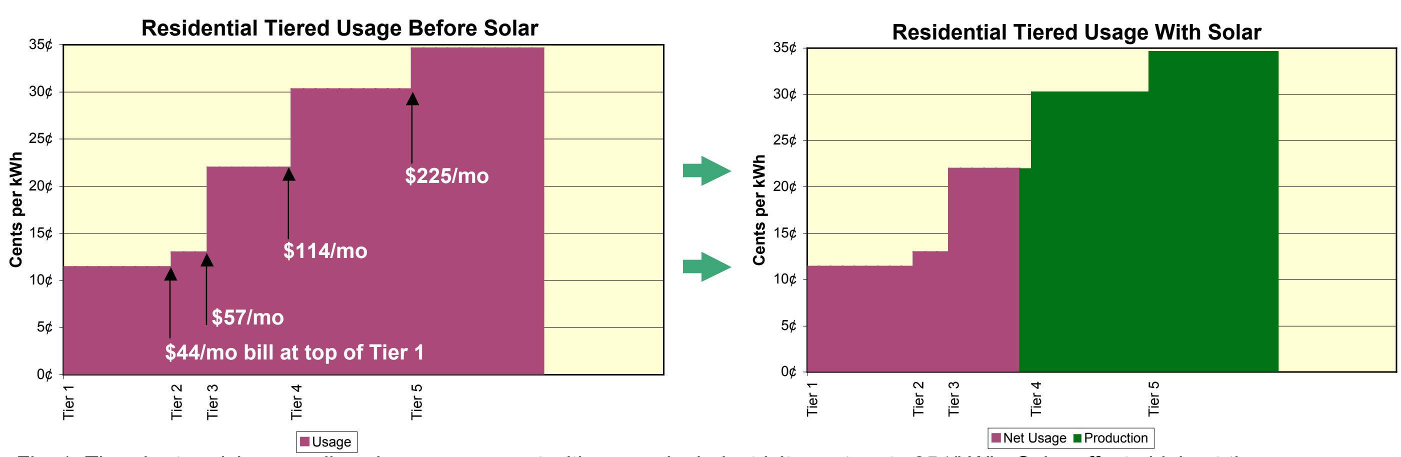

Fig. 1. Tiered rate pricing penalizes large users most with a marginal electricity cost up to 35¢/kWh. Solar offsets highest tier usage first, making the solar customer look like a small user with a marginal cost as low as 11¢/kWh. The graphic on the left indicates which tier a user is in for a given monthly electric bill in San Jose, CA. On the right, how much is offset by solar ($266 out of $360).

Residential Time-of-Use Peak Pricing Periods

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Midnight - 6am	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak
6am - Noon	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak
Noon - 6pm	Off-Peak	**Peak**	**Peak**	**Peak**	**Peak**	**Peak**	Off-Peak
6pm - Midnight	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak

Fig. 3. Simplified example of Time-of-Use peak and off-peak periods under the old PG&E E7 rate structure

Residential "E6" Time-of-Use Pricing Periods

	Sunday	Monday	Tuesday	Wednesda	Thursday	Friday	Saturday
Midnight - 6am	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak
6am - 10am	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak
10am - 1pm	Off-Peak	Part-Peak	Part-Peak	Part-Peak	Part-Peak	Part-Peak	Off-Peak
1pm - 7pm	Off-Peak	**Peak**	**Peak**	**Peak**	**Peak**	**Peak**	Off-Peak
7pm - 9pm	Part-Peak	Part-Peak	Part-Peak	Part-Peak	Part-Peak	Part-Peak	Part-Peak
9pm - Midnight	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak	Off-Peak

Fig. 4. PG&E E6 Time-of-Use rate structure showing more complicated peak, part-peak and off-peak periods

or E9), where the cost depends on the time of day and year. The PG&E E6 schedule (the only broadly practical TOU rate for solar as of May 1, 2006, has peak rates (before the Tier surcharges are applied) during summer weekday afternoons of 21¢/kWh and off-peak rates at most other times at a cost of 9-11¢/kWh. The surcharges for Tier 3, 4 & 5 apply to all residential rates, including the E6 TOU rate. So on the E6 rate schedule, peak rates for the largest users will be 44¢/kWh. A solar customer on the E6 rate would get this amount of credit for any excess production during the peak time period. Fig. 3 shows a simplified example of Time-of-Use pricing periods for the old E7 rate (no longer available). The E6 rate periods shown in Fig. 4 are significantly more complicated, adding part-peak pricing and weekend periods.

On May 1, 2006, the relatively simple PG&E E7 rate structure was closed to new customers (existing customers were grandfathered in), and the E6 rate schedule was created in its place. E6 added a part-peak pricing period, and more accurately defined when peak, part-peak, and off-peak occurred, shifting the peak period one hour later to better match real system data.

Combining Net Metering with TOU allows a solar customer to "sell" power back to the utility during peak periods at the high rate, and buy back during off-peak hours. The customer gets credited or charged for the value of the electricity when it is bought or sold. The utility then looks like a 200% efficient battery because most solar electricity is produced during peak hours, and most is consumed in a residence during part-peak and off-peak hours. The customer gets more value for the same kWh produced, and therefore needs a smaller solar system to offset their electric bill.

This works especially well if the customer can mount their solar array facing southwest or south at an angle near 25 degrees up from horizontal (equal to a 6:12 roof). Slopes from 5 to 40 degrees and southeast and west arrays work nearly as well. Southwest is preferred because it maximizes afternoon peak generation at a high value. This orientation also better matches the utilities peak load profile. Note: it is generally not economically feasible to tilt a solar array away from parallel with the roofs surface to optimize performance, because the gain in savings is not worth the additional cost.

The elimination of E7 and the creation of the E6 rate caused a relative collapse of the pricing differential between peak and off-peak rates. Under E7, the rate differential was about 20¢/kWh. Under E6, the differential is about 11¢/kWh. This reduction in differential significantly reduces the time period multiplier benefit from a solar system, however, this change affects much more than just solar owners.

Time-of-Use rates are a powerful tool for the utility to motivate customers to voluntarily use less power during predictable times of shortage, such as weekday summer afternoons, when business are open and using lots of air conditioning. The greater the differential between peak and off-peak, the more motivated the user will be (solar or not) to conserve during peak pricing periods.

As of August 2006, protests relating to the elimination of E7 have been filed, and it is the author's belief that it is logical and likely that a widening of the spread between peak and off-peak will occur in whichever time-of-use rate schedule is made available. This will benefit all solar customers served under it, and enhance the results discussed in this article. For the writing of this article, the analysis assumes only the E6 rate is available at its current rates.

INCENTIVES:

There are several **Government Incentive** programs to promote solar. The **California Energy Commission (CEC) Emerging Renewables Rebate Program** (referred to here as the CEC Rebate Program) cuts final cost 30% to 35% for most systems in PG&E, SCE and SDG&E utility territories. This program doesn't apply to municipal utilities, but some have their own programs – see www.dsireusa.org to find these programs.

The CEC program pays a rebate of $2.60 (as of September 2006) per rated AC watt of system output for systems up to 30 kW in size, upon installation of a compliant system. Affordable Housing projects get a 25% higher level of rebate. Please see www.consumerenergycenter.com/erprebate for more information and for reservation forms, or call the CEC at (800) 555-7794. This rebate is intended to decline by 20¢ per watt every six months on January 1 and July 1. The funding situation is uncertain, but it appears that there will be enough funds to last the program through 2006 until the new California Solar Initiative (CSI) begins. To use the CEC Rebate Program, one needs to submit a complete reservation request before the rebate level drops. From the time of approval, the project has 9 months to install the system (18 months if new construction).

For systems over 30 kW in size, each of the public utilities provides an incentive under the Self Generation Incentive Program (SGIP). This program has a current rebate level of $2.50 per rated watt. For more information, see www.sgip-ca.com. This program ends this year, and will be replaced by the CSI next year.

There is an alternate CEC incentive program called the "Pilot Performance-Based Incentive Program" (PBI Program). Under this program, a solar system owner is paid an incentive based on the production of the system in kWh. For more information, visit: www.energy.ca.gov/renewables/performance_based. This program will also be replaced by the CSI in 2007.

The **California Solar Initiative (CSI)** is the new 10-year, $3.2 billion program starting in January 2007. The CSI is a. Under this program, systems are again divided into two groups based on size, with 100 kW being the dividing point. Residential and Commercial (for-profit) systems under 100 kW will receive a rebate of $2.50 per rated watt. Non-profit and government owned systems will get a rebate of $3.25 per rated watt. Large systems, those over 100 kW, will be paid a Performance Based Incentive (PBI). The incentive will be 39¢/kWh for each kWh produced during the first 5 years for commercial, for-profit systems, and 50¢/kWh for non-profit and government systems. The incentives will decline periodically as installation milestones are reached, ultimately being almost completely phased out after 3,000 MW of solar is installed over the estimated 10-year period.

A goal of the new CSI program is to create a performance based incentive that ensures the best systems are being rewarded the most. The rating and rebate of the smaller (under 100 kW) systems will take into account expected performance based on tilt, orientation, and shading.

The author favors Performance Based Incentives, but believes the market would be most efficient at setting the appropriate incentive level via an auction system. An auction system would reward only the best systems that needed the least incentive, encourage continuous cost reductions, stretch the incentive money supplied by the public to the furthest extent possible, and create maximum long term stimulation and stability for the PV industry who could be certain that the incentive program money would last the length of the program period. For more information on this "PBI Auction" concept, please see www.ongrid.net/papers/PBIViaAuctionSWCph.pdf

The CSI only provides incentives for PV systems installed in the investor owned utility territories (IOU) of PG&E, SCE, and SDG&E. California state Senate Bill 1 (SB-1), which was passed in August 2006, compliments the CSI, and requires the creation of incentive programs in the many municipal utility territories by 2008. Administration of the CSI program is likely to shift from the CEC to another entity, possibly the utility serving the territory, or a third party administrator. These and other details are being finalized in the last few months of 2006. More details will become available at: www.cpuc.ca.gov/static/energy/solar

Tax treatment of the incentives depends on the type of customer, and possibly on the type of incentive. Contrary to what was written in previous versions of this article, it now appears that there may be significant grounds under which individual (residential) taxpayers could claim that the **rebate** payment is non-taxable. Section 136 of the IRS Code specifies that rebates paid by utilities, directly or indirectly, for energy efficiency (PV systems appear to be included) are tax-exempt. An important question is whether the CEC as the payer qualifies as "indirect" because it is using public benefits funds collected by the utilities from ratepayers. The IRS has not ruled on this. This grey area may provide a rebate recipient enough confidence to claim it and wait for the IRS to prove otherwise.

One thing is sure, if this exemption is not claimed and tax is paid on the rebate, the IRS is not likely to rush to find you to refund it, if they do decided to make a ruling. As of now, the author knows of no intention by the IRS to make a ruling, so it's likely to remain grey. In some cases, the CEC has issued 1099 tax forms to recipients of the rebate. Simply receiving such a form may not require payment of taxes. Please check with a qualified tax attorney or advisor when making these important decisions. This information comes from: www.millionsolarroofs.org/articles/static/1/binaries/GouchoeASES.pdf

It was suggested in previous writings of this article, that the installer should accept the rebate on the customer's behalf, in part because it may eliminate the rebate tax liability. The author has been informed that this is not true, and that tax is due when value is received (Source: Ryan Wiser, Lawrence Berkeley National Laboratory), unless specifically exempted (as may be the case with Sect 136). There are a couple of other reasons why it is still better for the consumer to have the installer accept the rebate as part of payment for the project: less cash is required during the project, and the consumer has greater leverage over the installer should they do a substandard job (if the consumer or inspector doesn't sign off on the job, the rebate is withheld). It is a little less attractive for the installer because it hurts their cash flow, but there is essentially no risk the CEC won't pay assuming the installer completes the job and satisfies the inspector. It doesn't impact the installer's tax return because it is part of the job's revenue, which is already subject to taxation, minus their expenses.

An unanswered question is the tax treatment of the PBI payments. Since these payments will be received by the system owner after the installation, rather than as a rebate at the time of installation, they are not likely to be exempt under IRS Section 136, and may not be exempt under any other section. Therefore, they are probably taxable, which makes them less attractive to the consumer.

Note: The information in this article regarding taxes, tax credits and depreciation is meant to make the reader aware of these benefits, risks and potential expenses, and help avoid overblown claims by aggressive salespeople. It is not tax advice, and the author is not a qualified tax professional. Please seek professional advice from a qualified tax advisor to check the applicability and eligibility before claiming any tax benefits or exemptions.

Tax treatment for rebates for commercial systems will be discussed after the tax credit and depreciation benefit section. Of course, municipal and non-profit entities do not have to worry about these tax issues, as they are generally tax-exempt.

Tax incentives include tax credits and depreciation. The **Federal Investment Tax Credit** for **Residential** is 30% of net system cost, capped at $2,000. It is a one-time credit, but may be carried forward (and possibly back) if not completely useable in the system installation tax year. It only applies for systems that are installed in 2006 and 2007. It is likely to be extended past its current 2007 expiration date. Check back for updates. Also, the IRS hasn't produced the form required for claiming this credit for individual filers.

The **Federal Investment Tax Credit** for **Commercial and Business** owned systems is 30% of net system cost with no cap. This applies for systems that are installed in 2006 and 2007. After 2007, if not extended, the tax credit will revert to the previous level of 10%. The IRS current federal form is 3468 available at www.irs.gov/formspubs. In the past, this credit could be carried forward 15 or back 3 years. It's not clear if this has changed.

Home-based businesses typically can qualify for this tax credit as well. Because the credit applies on both individual (residential) and business tax returns, but is capped on residential, it needs to be properly apportioned on each return to ensure the right credit is claimed. Home-based businesses are typically apportioned based on percentage of square footage attributed exclusively to the business. To figure the credit, one typically applies the percentages to the two separate calculations then sums the results.

Before Solar		Solar System Size & Cost				Results, Savings, & Benefits					
Electric Bill	kWh Usage per Month	PV System Size (CEC Rating)	Gross Cost	State Rebate @ $2.60/W	Final Net Cost w/ $2K Fed Tax Credit	Pre-Tax Compound Annual Rate of Return	Appraisal Equity / Resale Increase in First Year	New Electric Bill With Solar	Net Monthly Cash Flow Compared to 7.5% 30-yr Loan in First Year	Net Monthly Cash Flow Compared to 7.5% 30-yr Loan in Fifth Year	Total Savings Over 25 Years
$ 100	680	3.0 kW	$28.4K	$7.8K	$19.1K	9.2%	$16.2K	$27/mo	$-23/mo	$-9/mo	$34K
$ 201	1030	6.0 kW	$55.4K	$15.6K	$38.3K	11.6%	$41.6K	$16/mo	$-8/mo	$31/mo	$89K
$ 360	1500	9.0 kW	$81.1K	$23.4K	$56.2K	14.4%	$76.9K	$22/mo	$55/mo	$127/mo	$166K
$ 360	1500	6.0 kW	$55.4K	$15.6K	$38.3K	16.5%	$60.4K	$97/mo	$71/mo	$128/mo	$131K

Table 1. Example residential systems and their financial costs and benefits

It may also be possible to apply the federal tax credit against the alternative minimum tax. See a tax advisor to apply it to a particular situation.

California offered a **State Income Tax Credit** thru the end of 2005. This is now expired, and a bill renewing it died last January in the CA legislature. Those in states who enjoy tax credits should be aware, that if they itemize their federal tax deductions, a state tax credit isn't worth its full face value. When itemizing, state taxes are deductible off federal income. Reducing state taxes by the state tax credit means that federal taxable income will go up. In effect, federal income tax is being paid on the value of the state tax credit. For most people, a state tax credit is worth about 75% of its face value.

Business owned systems may also be eligible for **MACRS 5-year Accelerated Depreciation** using IRS federal form 4562. Home-based business systems may also qualify for partial depreciation. The depreciable basis amount is the tax credit basis, minus one-half the federal tax credit amount (85% in the case of the current 30% tax credit, 95% in the case of the original 10% tax credit).

Paying federal **tax** on the **rebate** for **businesses** appears to be a choice and the solar industry has "educated" the public illustrating both scenarios. It isn't, however, a free lunch. If one chooses to make the rebate tax-free, they can claim the tax credit based only on the "after-rebate" amount of the system cost. If they pay tax on the rebate, then they can claim the credit on the full cost of the system.

While it might seem obvious to avoid the rebate tax, while the federal tax credit is at 30%, it is actually financially more attractive to claim the rebate as taxable, pay the tax, then claim a higher basis for each of the federal tax credit and depreciation. If the tax credit drops back to 10%, then the reverse is true.

California state depreciation is split between "Corporate" and "Non-Corporate" businesses. Non-Corporate businesses use the same MACRS 5-year accelerated depreciation. Corporate businesses use a standard 12-year straight-lin depreciation schedule for their state taxes.

It should be noted that some or all of a solar system may be deducted using IRS Section 179, if available. This allows a taxpayer to deduct in the first year, approximately $108,000 of otherwise depreciable property. Of course, this only applies to solar if the Sect 179 benefit isn't already being used for other depreciable items.

This information will be evolving as the CSI & IRS rules and forms get created. The author maintains an updated version of this article at: www.ongrid.net/papers/PaybackOnSolarSERG.pdf.

A source for information on all state and federal incentive programs around the country is available at the DSIRE project: www.dsireusa.org. In addition, the Solar Energy Industries Association has put together a "Guide to Federal Tax Incentives for Solar Energy", available for free at www.seia.org.

Customers in **higher income tax brackets** see comparatively more value because residential electricity expenses are paid with after-tax dollars – they aren't tax deductible. More on this in the "proof" section of this article.

Installed system costs have generally declined 5%-7% per year due to manufacturing economies of scale, installation efficiencies, new products, and competition. However this trend has recently reversed because of growing worldwide interest in solar, a rapidly expanding market and a shortage of silicon & solar panels. Installed system costs are likely to be stable or rising for the next couple of years, then may begin to decline again.

Renewable Energy Credits (**RECs**, also known as **Green Tags**) are a new and growing way to extract value from a solar energy system. RECs represent the bundle of legal rights to the green part of each kWh produced by a solar system. This green part can be sold for a value, which generates additional revenue for the seller. California system owners can now sell their RECs. A market is being established and the price of solar RECs is expected to be between 2¢/kWh and 20¢/kWh in contracts ranging from 1 to 20 years. See www.green-e.org for more information about RECs and the buying or selling thereof. It's not yet clear if or how the RECs from systems receiving CSI incentives will be owned, valued, or restricted.

One should take care to consider whether they really want to sell the RECs their system generates. By selling them, they lose the right to claim they are using any of the clean green energy generated by the system. That right would belong to the new REC owner. The system owner could claim they are a host for the generation, but not a user. The distinction is important in order to prevent double counting of the RECs, which is important to maintaining their value.

HOW IS THE SOLAR PAYOFF PROVEN?

Independent tests of the financial viability of solar energy include:

- Rate of Return similar to growth and high yield investments
- Payback in a reasonable time
- Total Lifecycle Payback
- Net increase in property value with respect to system cost
- Positive cash flow when financing the project with equity

RATE OF RETURN:

Compound Annual Rate of Return on an investment is another term for interest rate, which is a way of comparing one investment to another. For example, a savings account might pay 1% interest, and the long-term stock market has paid about 11%. The author chose 10% as the test point for solar, because that is among the higher of long term average returns from common, readily accessible, higher yielding investments such as stocks and bonds.

In order to compare solar to other investments, all investments should be placed on the same side of the tax equation. Since most investments are taxable (i.e. stocks, savings interest, etc.), it is most meaningful to convert solar savings to its taxable equivalent (i.e. *PreTax* value).

AfterTax dollars are worth more to a taxpayer than the same number of *PreTax* dollars, because *PreTax* dollars are subject to taxation. Therefore, an *AfterTax* dollar saved (with solar) is worth more than $1 on a *PreTax* basis, by an amount proportional to the

Investment Type	Investment Amount	Interest Earned or Net Electric Bill Savings	After-Tax Value the First Year	After-Tax Value the Eighth Year	Payback including inflation
Savings	$30,000	$300 (at 1% rate)	$188	$188	160 years
Stocks	$30,000	$3,300 (at 11% rate)	$2,069	$2,069	14.5 years
Solar – 5.5 kW	$30,000	$2,069 (1st year)	$2,069	$2,960	12.9 years

Table 2. Payback Investment Comparisons. Solar savings grows due to inflation, so payback is faster.

taxation rate. To find the *PreTax* value, the following equation can be used to adjust each *AfterTax* amount, where *TaxRate* is the net total effective income tax rate:

$$PreTax = \frac{AfterTax}{(1 - TaxRate)}$$

Once the value of the savings, maintenance costs and other amounts are properly adjusted to their pre-tax values, they can be inserted into a 25-year financial timeline (the warranted life of most solar electric/PV modules) representing the cash flows for each year to calculate the Compound Annual Rate of Return. This allows the accurate inclusion of all relevant cost and benefit components.

The initial capital cost is the only amount that doesn't get adjusted. That amount is the net system up front cost (total out of pocket), and is unaffected by the taxation or lack thereof of future savings in the utility bill. Consider it the same as principal that is invested anywhere. The principal is not taxed upon its departure or return.

Tax savings and consequences, inverter replacement, maintenance, and other significant financial events can be included at their appropriate places on the timeline. Inflation and module degradation are also easily included. Then total cash flow for each year in the analysis can be summed. Using the Internal Rate of Return (IRR) tool in a spreadsheet, one can find the Compound Annual (interest) Rate of Return (CARR) for the investment.

One should note that there is a significant and very important difference between **Compound** Annual Rate of Return (CARR) and **average** return or total return divided by the number of years an investment is held. Average return does not factor in compounding of interest, and may make an investment look more attractive than it really is. This article uses CARR for all items under consideration (solar, stocks, savings, etc). The difference becomes more visible the longer the time horizon. A brief example: Suppose an investment doubles every year. Its CARR would be 100% because you get 100% increase each year on your investment. No matter how long you hold it, its CARR is 100% because you need to compound for the number of years it's held. Alternatively, if you were to look at the "average rate of return", over 1 year, it would still be 100%. However, if you held it 3 years, your investment would be 800% of the original, or a total return of 800% (100%>200%>400%>800%). The average annual return would be 800%/3years-100% or 167%, which looks great, but isn't representative, because it isn't factoring in the compounding. This faulty method of analysis is highlighted here because unfortunately there are several faulty solar analyses and sales presentations being given to the public that use averaging, rather than compounding.

Please see Table 1 for several examples showing Compound Annual Rates of Return. These cases are for full service residential system installations in San Jose, California, using typical installed system costs on a simple composition shingle roof.

Assumptions for Table 1:

- Pre-Solar Bill: electric bill before solar using PG&E E1 Flat Residential Rates
- Post-Solar Bill: electric bill with solar using PG&E E6 Time-of-Use Residential Rates
- System AC Size refers to the CEC AC power rating, which includes some (but not all) loss factors. The analyses here-in include the CEC's and additional loss factors to give a conservative estimate of production (1,630 kWh/yr per kW of CEC AC rating) for use in calculating the Post-Solar Electric Bill
- Final Net Cost refers to the total net cash out of pocket including total of installed system costs, permitting, sales tax, PG&E fees, the federal tax credit for residential.
- Assumes the customer is in the 28% federal and 9.3% state tax bracket and is eligible for the Federal Tax Credit. Electric rate inflation is 5.0%. Module degradation is 0.5% per year. System maintenance cost is 0.25% of gross system cost per year, adjusted for inflation. Inverter replacement costing $700/kW occurs in year 15.

An alternative tool to evaluate/verify solar financial results is the Clean Power Estimator: www.consumerenergycenter.org/renewable/estimator

PAYBACK:

What about calculating the **payback**? Payback is a simple but crude tool for comparing investments. Solar is an inflation-protected investment but many others are not. This improves the payback for solar (electric rates double every 13 years at 5.4% historical inflation). To properly calculate the solar payback, it is necessary to add in the inflation adjusted savings of each successive year until payback has been achieved. Savings in the latter years is larger than savings in the first years, so the payback is faster than simply dividing the cost by the savings.

Payback analysis on an after-tax basis does not reflect the true value of the saved utility expense, because after-tax savings are worth more on a pre-tax basis. However, trying to do payback using the pre-tax value gives an unrealistically optimistic view of when "payback" has occurred. The examples in Table 2 show how long paybacks on other investments really are, when taken on an after-tax basis.

There are numerous other flaws in using payback for a residential long-term investment; it does not properly include the tax savings and consequences, it does not account for maintenance or inverter replacement expenses, and it makes it difficult to compare to other investments such as stocks, savings, etc. because of inflation and other factors.

TOTAL LIFECYCLE PAYBACK:

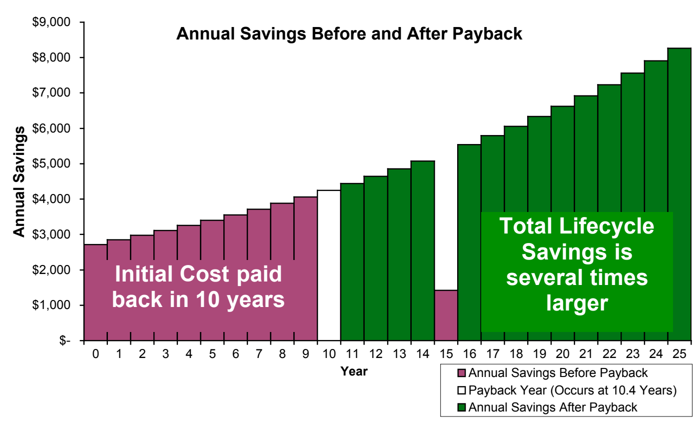

Fig. 5. Simple Payback vs. Total Lifecycle Payback. Total 25 year Lifecycle Savings is several times the initial cost represented by the savings up until year 10. Year 15 shows diminished savings in that one year due to inverter replacement.

Comparing the savings of a solar electric system over 25 years of operation to its initial cost is a better way of looking at payback, because it more fairly values the savings due to the compounding effect of electric rate inflation. Because of this effect, the savings in the later years is much greater than the savings in the first few years. Typical systems give back 1.5 to 3 times their initial cost. See Table 1 for several examples and Fig. 5 for an illustration. One drawback to this analysis is it fails to account for the time value of money. A dollar saved in the future isn't worth as much as a dollar saved today, so that a total lifecycle payback isn't worth quite as much as it might initially appear. The better methods of comparing solar as an investment are the Compound Annual Rate of Return, Increase in Property Value, and Cash Flow.

INCREASE IN PROPERTY VALUE:

Solar electric systems **increase property value** by decreasing utility operating costs. According to the Appraisal Journal (Nevin, Rick et al, "Evidence of Rational Market Valuations for Home Energy Efficiency," Oct 1998, (available at various locations on-line, and at www.ongrid.net/AppraisalJournalPVValue10.98.pdf), a home's value is increased by $20,000 for every $1,000 reduction in annual operating costs from energy efficiency.

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 states that historic mortgage costs have an after-tax effective interest rate of about 5%. If $1,000 of reduced operating costs is put towards debt service at 5%, 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 their total cost doesn't change.

Please see the column labeled "Appraisal Equity Increase" in Table 1 for examples of the increase in home value. In some cases, a solar system can increase home value by more than its cost to install. This effectively reduces the payback period to 0 years if the owner chose or needed to sell the property immediately. It could even lead to a profit on resale.

There are two limits to the increase in resale value over system net installed cost. First, why should a homeowner pay in total more for a home with a solar system, when they could buy a non-solar home, and solarize it for less money? Yet this happens with other remodels. Decks, on average across the nation, return 104% of their cost upon resale. However, in certain markets like San Francisco and Boston, decks add more than 215% of their value upon resale (Alfano, Sal, "2003 Cost vs. Value Report", Remodeling Online – www.remodeling.hw.net downloaded March 5, 2004). Other types of remodels like kitchens and bathrooms had similar results related to geography. So it makes sense that in certain geographies where the sun shines brightly and the 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 remodel. Table 3 lists projected resale value of various solar systems, compared with nationwide averages for some other home improvements.

The increase in property value to date is currently theoretical. A very high fraction of the grid-tied solar electric systems in California

Home Improvement Type	Investment Amount / Net System Cost	Resale Value Increase	% Return
Solar 3 kW	$19.1K	$16.2K	85%
Solar 6 kW	$38.3K	$41.6K	109%
Solar 9 kW	$56.2K	$76.9K	137%
Deck Addition	$6.3K	$6.7K	104%
Bathroom Remodel	$10.1K	$9.1K	89%
Window Replacement	$9.6K	$8.2K	85%
Kitchen Remodel	$44K	$33K	75%

Table 3. Resale value comparisons of various home improvements

were installed since the start of the state's Power Crises and the Deregulation fiasco in 2001. Most of these homes have not been sold, so there are no broad studies of comparable resale values available. However, some evidence is beginning to emerge that there are significant jumps in resale value being realized by some solar home sellers. The author is aware of 4 anecdotal cases, in which the sellers believe they got all of their cost as a premium, and have or plan to install a PV system on their new home.

The NREL (National Renewable Energy Laboratory) study Comparative Analysis of Homebuyer Response to New Zero Energy Homes, (www.nrel.gov/docs/fy04osti/35912.pdf), August 2004, by Farhar showed that 15 Shea Zero Energy Homes with 2.4 kW PV systems in San Diego increased in value faster than 12 comparable conventional homes in a nearby community. On average, the Shea 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 even outstrips the estimates shown in Table 1 and Table 3. It is likely that many factors were involved, and this sample size is not statistically significant. However, it is at least, not negative evidence.

It is also interesting to note that **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. All the calculations in this article assume electric rate inflation will be 5%. If so, the PV system will save 5% more value each successive year, and thus gain from the 20:1 multiplier effect. The resale value will then increase 5% per year compounded.

This cannot continue forever, as the increase in resale value runs into the second limit, which relates to the remaining life left in the system. For these analyses, the system is assumed to be worthless at the end of 25 years. This is probably very conservative, since the panels are warranted to be working at least 80% of their new performance. So if the system is worthless at the end of 25 years, the only value the system has as it nears that time, are the remaining savings it can generate before the end of the 25th year. Fig. 6 shows both the increasing value due to increasing savings and the remaining value limitation that takes over at approximately year 11. If the system does have additional resale value, so much the better.

Still, the skeptical homebuyer might question the above assertions in light of the lack of hard evidence. Perhaps the best evidence to present would be a stack of old bills showing usage and cost before solar, and a stack of new bills showing a substantial savings. The question might be posed, "What are a continuous, if not growing, stream of these savings worth to the prospective buyer?" That sort of evidence can't easily be ignored. Of course, other factors will

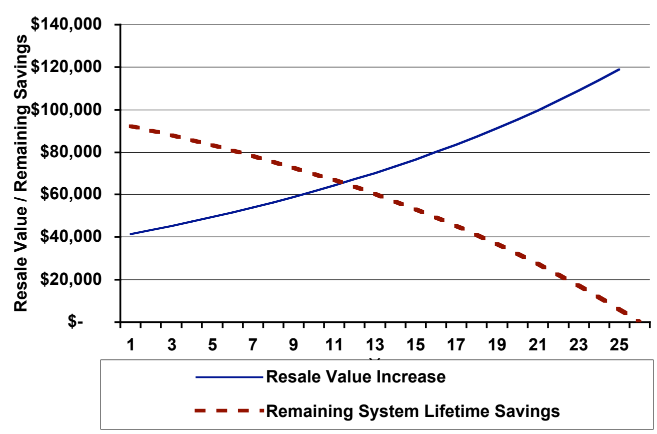

Fig 6. Resale value increases over time because savings get larger each year. Total remaining lifetime savings in the system declines annually, putting a limit on the increase in resale value after year 11

weigh heavily in the value. How attractive is the home? A tidy, attractive installation should add all of the value shown above, but like a spa, some prospective buyers may not care or value it, while others may love it.

As an additional benefit, solar systems installed between January 1, 1999 and January 1, 2010, are exempt from triggering Property Tax reassessments (California Taxation Code, section 73).

CASH FLOW: FINANCING vs. BUYING ON CREDIT:

Two ways to look at using loans to finance a solar project include:

- Making the purchase more affordable to a larger audience
- Making a smart investment using borrowed money, the repayment of which (principal and interest) are less than the savings on the electric bill due to the investment

Buying on credit eliminates the large capital outlay for a solar system, making the purchase achievable to more consumers. The key determinant is how large a monthly payment the bank will approve for the borrower. This use of credit can expand the solar market, but isn't useful as a financial test to demonstrate the economic viability.

Financing the cost of a solar project as an investment through borrowing yields savings on the electric bill. However borrowing has a cost. If the cost of borrowing is lower than the savings, then the project is **Cash Positive**. This result depends on the interest rate and payment terms for the loan, the tax bracket of the borrower if the loan is deductible, and inflation increasing the savings over time.

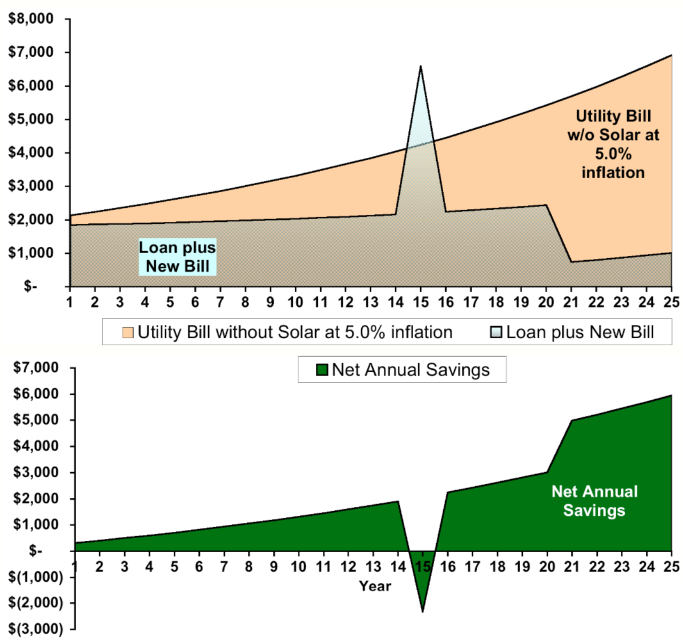

Fig. 7. Effect of a solar system financed over 20 years showing a cash positive result from the first day of ownership.

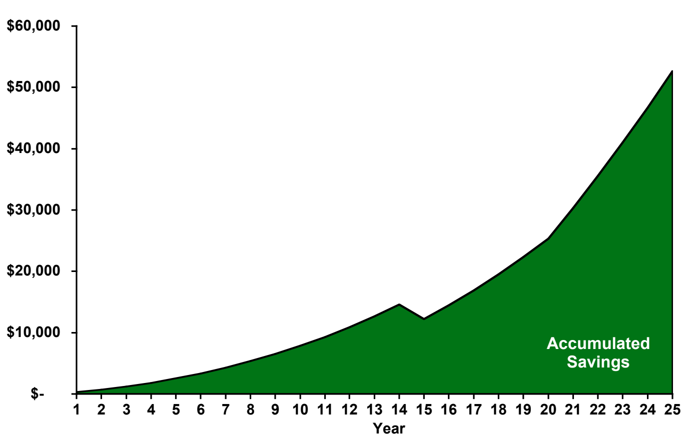

Fig. 8. Accumulated net savings of solar system financed over 20 years, including all costs, thus showing pure cash profit.

Home Equity loans are excellent sources of funds because interest rates on real estate secured loans are relatively low, payment terms can be long, and the interest is generally deductible. The net cost of these loans is often less than the savings on the electric bill. This effectively reduces the cost of ownership to less than $0 per month. It actually pays the owner, creating a positive cash flow from day one. With a fixed interest rate loan, as electric rates rise, the equation gets more cash positive over time, even when the interest deduction decreases. Fig. 7 shows an example where the net monthly expense of a system (loan + new utility bill) is less than the original pre-solar utility bill each year for 20 years, until the loan is paid off. Then the savings get really big!

Refer to Table 1 for several examples showing the initial monthly cash flow assuming 100% financing of a solar system's Final Net Cost using a 7.5% 30-year loan. The monthly cash flow becomes more positive each year due to the 5% inflation in electricity prices. This inflation increases the savings due to the solar system. The large spike at year 15 is the replacement cost of the inverter. It causes a one time negative cash flow for that year. However, when the total savings are accumulated as in Fig. 8, the dip is negligible compared to the savings to date, and especially to the savings yet to come.

CONCLUSION:

It is important to compare the solar investment to other investments on an even basis. Rigorous treatment and critical analyses from several angles including Compound Annual Rate of Return, Cash Flow, and Resale Value need to be considered to do a fair assessment.

Solar will make economic sense for many, but only a hard look at the numbers will tell. The reader is encouraged to check it out. Run the numbers, get evaluations and proposals from solar providers, and take them to a CPA to check them out. The sidebar gives additional thoughts to make sure the presentations stand up to the light of day!

 This information changes periodically. The author maintains an updated version of this article at: www.ongrid.net/papers/PaybackOnSolarSERG.pdf. For more info on solar payback, analysis tools, upcoming classes, and other papers and articles, see www.ongrid.net.

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