FINANCIAL PAYBACK ON RESIDENTIAL CALIFORNIA SOLAR ELECTRIC SYSTEMS AFTER THE STATE REBATES ARE GONE

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ABSTRACT

Cost effectiveness of solar electric systems remains a high priority for many consumers in the California residential market. The California Energy Commission (CEC) Emerging Renewables Buydown Program (Rebate) funding is running very low on funding and is expected to be depleted of funds long before the 2007 intended end date.

Including the CEC Rebate, it was demonstrated in *Financial Payback on California Solar Electric Systems*[1] that customers who used more than $75 per month in electricity could receive attractive financial returns.

If the CEC Rebate program is suspended due to lack of funds, customers who used more than $145 per month in electricity could receive similarly attractive financial returns. Attractive returns will be demonstrated in Rate of Return greater than 11%, per annum, increase in property value greater than system net cost, and positive cash flow using equity financing compared to utility bill savings.

1. INTRODUCTION

Financial Payback on California Solar Electric Systems presented at ASES 2003, offered mechanisms for evaluating solar projects on several financial bases. That paper determined that solar electric systems could provide attractive financial returns for customers who used more than $75 per month in electricity if they received a rebate through the California Energy Commission (CEC) Emerging Renewables Buydown Program (Rebate).

The CEC Rebate program had received a large amount of funding intended to carry it through 2007. Built into the new rebate program were periodic declines in funding per watt of installed solar electric capacity, with the intent to help wean the solar industry off subsidies by a measured and predictable means.

Nine months later, in December 2003, the industry had used or reserved 75% of the available rebate funding for the 4-year period. The CEC took action, accelerating the reduction in rebate level and infusing the rebate pool with about 25% more funding. Even at the reduce level, in March 2004, the original funds are 95% allocated.

It is likely that by end of June 2004, all the funding will be used, leaving 3 years without rebate funding.

The Rebate currently reduces the final cost of a system to the consumer by 30% to 40% for most systems in California's public utilities territories. This substantial discount has helped to accelerate the adoption of solar electricity. However, a number of other factors have also helped make solar electricity financially viable in California.

If the industry is to survive, it needs to demonstrate that solar is economically viable without this subsidy. Fortunately, except for the rebate, the same factors that contributed to making solar financially attractive to customers a year ago are still in place.

2. FACTORS THAT MAKE SOLAR VIABLE

The contributing factors to this financial feasibility are:

- Net Metering on an Annual Basis
- Time of Use Billing
- High Electric Rates & High Rate Inflation
- Declining System Costs
- High Tax Brackets
- State Tax Credit for Solar
- California's Tiered Rate System

The first five factors are discussed in detail in *Financial Payback on California Solar Electric Systems*[1]. The sixth factor, the California State Tax Credit for Solar has changed slightly. The tax credit has declined, and is now 7.5% of the net cost. The tax credit is available for systems installed in 2004 and 2005.

The seventh factor illustrates the severe penalty that larger residential users face for their excesses (see Fig. 1). Average users use 130% of baseline and pay rates in both of the first two tiers. High users are penalized for excess energy consumption. Usage above average (130% of baseline) is charged first at $0.194, then $0.238, and finally $0.258 per kWh for each kWh over 300% of baseline. The "baseline" quantity is intended to represent 70% of what the average consumer uses.

Solar with the tiered nature of California electric rates shaves off the highest cost energy first. Solar creates an apparent reduction in consumption, so it first moves the user out of the highest penalty tier, then the next, etc. High users will see substantially larger annual savings.

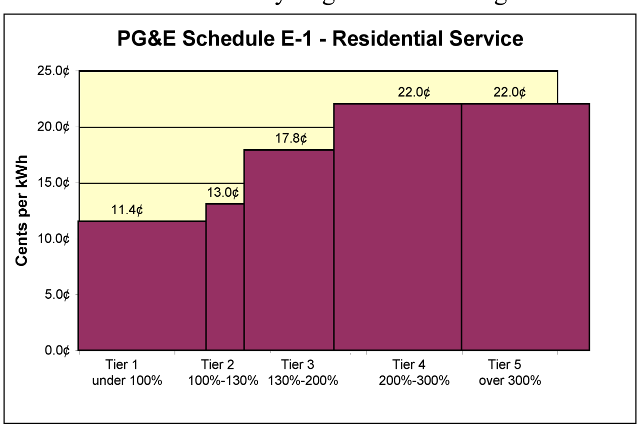

Fig 1: PG&E Rate Tiers with penalty surcharges for high levels of usage.

As in the previous paper, these seven factors form the basis for making solar viable in California for certain customers. The next four sections illustrate the tests by which financial viability is measured.

For the purposes of this paper, "viable" is defined as a solar system that can earn 11% or better pre-tax annual rate of return over 25 years, have a immediate positive cash flow compared to 7% 30 year fixed rate equity financing, and cause an appraisable equity improvement greater than the net cost of system installation.

3. RATE OF RETURN

The Rate of Return is an interest rate that can be compared with other investments. For customers with electric bills over $140 per month, residential solar projects in California often have Internal Rates of Return in the 11% to 16% range, which compares favorably with the long-term stock market at 10.5% over the last 80 years.

Using a 25-year timeline (the warranted life of most modules) to represent cash flows for each year in the analysis allows the accurate inclusion of all relevant cost and benefits components. Tax savings and consequences, inverter replacement, cleaning & maintenance, and other significant financial events can be included at their appropriate places on the timeline. The total cash flow for each year in the analysis can be summed. Using an "Internal Rate or Return" analysis, the effective interest rate paid by the project can be found.

It is then easy to incorporate inflation in the electricity savings, as well as maintenance costs. It is also possible to include effects from solar module degradation and the resultant reduction in production over time.

To make the analysis most meaningful and comparable, it is necessary to convert the entire analysis to the appropriate pre-tax values for all amounts.

To illustrate rates of return for various system sizes and usages, please see Table 1.

To illustrate the effect of a 2.6kW system on various usages, please see Table 2. The reason for the variation is due to the tiered pricing, with the solar system eliminating the highest priced electricity first.

4. INCREASE IN PROPERTY VALUE

Solar electric systems increase the value of homes in several ways. They can reduce or eliminate the energy operating cost of the home. They hedge against or eliminate the effect of electric rate inflation. As a component of the home, in many cases they can provide an attractive vehicle for financial investment.

These benefits are financially quantifiable. A solar electric system increases home value by $20,000 for each $1,000 in annual reduced operating costs, according to articles published in the *Appraisal Journal*[2,3].

According to the articles by Nevin, the increase in appraisal value for a home with an energy efficiency measure (in this case, a solar electric system) is about twenty (20) times the annual reduction in operating costs due to that energy efficiency measure.

That is to say, if a solar system can reduce the electric bill by $1,000 per year, the home is worth about $20,000 more in increased appraisable and resale value.

The rational is that if the $1,000 is not spent on electricity, it is available to be spent on a larger mortgage payment at no net change in the cost of living. The amount of mortgage that can be supported by $1,000 depends on mortgage rates and the tax rate of the borrower.

Nevin states that after-tax mortgage rates have averaged about 5% over the longer term. At 5%, a $20,000 mortgage costs $1,000 per year, hence the 20:1 ratio. Mortgage rates vary, so depending on market conditions, the ratio has ranged from less than 10:1 to over 25:1. As of March 2004, long term mortgage rates at historic lows of 5.5% before tax, or 3.3% after-tax. At these very low rates, the ratio is about 30:1.

The assurance to a consumer of good resale value for the solar system may be important over the near-term, mid-term, or long-term futures. It would be inappropriate to assume rates will stay at low levels over the mid-term and long-term, so it is more reasonable to continue with Nevin's estimate of 5% after-tax giving the 20:1 ratio.

A solar electric system compares very favorably with other home improvements in percentage of cost recovered. Often, a solar system can recover much more than 100% of its cost, and this percentage actually increases over time as electric rates rise.

A solar electric system can also supply numerous intangible

TABLE 1: EXAMPLES OF THE FOUR TESTS FOR VARIOUS USAGES AND SYSTEM SIZES.

Pre-Solar Bill	kWh per Month	System AC Size	Final Net Cost w/ 7.5% State Tax Credit	Appraisal Equity Increase	Pre-Tax Annual Return	Net Monthly Cash Flow Compared to 7% 30yr Loan	Lifetime Avoided Utility Bills	New Electric Bill with Solar
$145	905	2.6 kW	$24.6K	$24.8K	11.2%	+$6/mo	$58.5K	$42/mo
$200	1145	5.2 kW	$45.6K	$45.6K	11.1%	+$9/mo	$107.3K	$12/mo
$290	1500	7.8 kW	$67.6K	$68.2K	11.2%	+$16/mo	$160.5K	$6/mo

Variables & Assumptions: 31% Federal Tax Bracket and 9.3% state tax bracket.

- Each 2.6kW is one 2500 watt, 94% efficient inverter at with eighteen 175-watt modules, facing south at an 25° pitch, with a simple roof installation by a full service provider with no complications near San Jose, CA.
- System AC Size refers to the California Energy Commission rating of the AC power production capability of the system. It includes some loss factors, but not others. Those other loss factors have been included elsewhere to adjust the estimated system productivity to the conservative side of realistic for the region. Assumes no shading losses.
- Final Net Cost refers to the total net cash out of pocket including total of installed system costs, $600 Permit Fee, $277 Time-of-Use meter fee, 7.5% State Tax Credit savings, and federal costs on the state tax credit. No rebate.
- Billing starting on PG&E E-1 flat rate residential tariff and switching to PG&E E-7 Time-of-Use Net Metering.
- 30-year fixed home equity loan equal to the final net cost with deductible 7% interest.
- Electric rate inflation is 5.4%. 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 $2,700 occurs in year 20.

TABLE 2: EXAMPLES OF THE FOUR TESTS FOR A 2.6KW SYSTEM WITH VARIOUS UAGES.

Pre-Solar Bill	kWh per Month	System AC Size	Final Net Cost w/ 7.5% State Tax Credit	Appraisal Equity Increase	Pre-Tax Annual Return	Net Monthly Cash Flow Compared to 7% 30yr Loan	Lifetime Avoided Utility Bills	New Electric Bill with Solar
$145	905	2.6 kW	$24.6K	$24.8K	11.2%	+$6/mo	$58.5K	$42/mo
$200	1145	2.6 kW	$24.6K	$29.1K	13.2%	+$23/mo	$68.4K	$80/mo
$290	1500	2.6 kW	$24.6K	$33.1K	15.0%	+$40/mo	$78.0K	$152/mo

Variables & Assumptions: The same apply from Table 1.

benefits that may be valued by buyers, boosting value.

For more details on increased home value due to a solar system, please see *Why Is A Solar Electric Home Worth More?*[4].

To illustrate the increased property values for various system sizes and usages, please see Table 1.

To illustrate the effect of a 2.6kW system on various usages, please see Table 2. The reason for the variation is due to the tiered pricing, with the solar system eliminating the highest priced electricity first.

5. CASH FLOW USING FINANCING

The Cash Flow test compares the savings on the utility bill with the cost of financing the system. In many cases starting the first month, it costs less to borrow the money to put a system in, than it does to keep paying the utility.

Borrowing at a fixed interest rate gets more advantageous as the utility rates go up. When this happens, the effective savings grows, but the loan payment stays the same.

Borrowing with a variable interest rate can be an even greater advantage in the short term, and most adjustable loans have rate caps, so the maximum cost of the loan can be determined in advance. In either case, the cost of the loan is limited by its terms and is not subject to inflation, but the cost of electricity and the possible savings are unlimited and are subject to inflation (see Fig. 2).

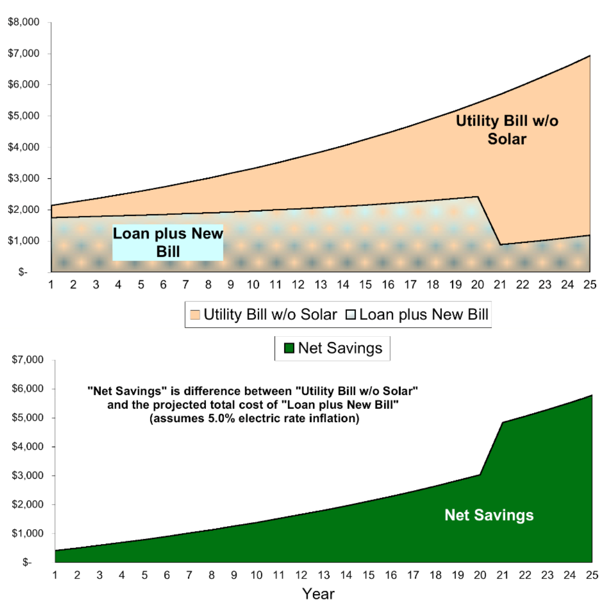

Fig. 2: Loan costs are fixed. Savings grow with inflation.

Home equity financing is often the most cost effective because of the lower rates and the deductibility of the interest. Higher income tax brackets mean greater relative value of the deduction, resulting in lower net loan costs.

These projects often achieve positive cash flow at the outset. This improves as inflation increases the electric bill savings. If interest rates rise from their historic lows at the time of this writing (March 2004), the gain may not be profound.

Financing also makes the large capital outlay for a solar system achievable to more consumers.

To illustrate positive cash flows for various system sizes and usages, please see Table 1.

To illustrate the effect of a 2.6kW system on various usages, please see Table 2. The reason for the variation is due to the tiered pricing, with the solar system eliminating the highest priced electricity first.

6. LIFETIME UTILITY PAYMENTS AVOIDED

The simplest financial feasibility test looks at all the costs and all the savings, including inflation, over the life of the project. If the net savings are larger than net costs, then the project pays for itself in these simple terms. Even without rebate, solar systems can pay back 2 to 3 times as much as they cost. This test does not account for the "Time Value of Money."

This test can also be expanded into the Payback test, which asks when a system has "Paid For Itself." This is a crude test, because it does not account for the future value of the assured savings that will be accrued due to the long life and warrantees on solar electric modules. Without rebate, paybacks for viable systems can occur in 11 to 13 years, leaving 14 to 17 years of system life and much larger future savings remaining to be enjoyed.

To illustrate lifetime avoided utility bills for various system sizes and usages, please see Table 1.

To illustrate the effect of a 2.6kW system on various usages, please see Table 2. The reason for the variation is due to the tiered pricing, with the solar system eliminating the highest priced electricity first.

7. CONCLUSION

The end of the Rebate Program will not mean the end of financially viable residential solar. Without any rebate,

customers with $145/month or larger electric bills could receive a greater than 11% return on investment, get 100% back on the system at resale, or be cash positive when taking a 7% 30 year loan to purchase the system with $0 out of pocket cost.

The rebate is helpful, but doesn't need to exist to make solar worthwhile for a larger residential customer. The other factors of Time-of-Use Net Metering, high base electric rates with high inflation, and tiered electric tariffs which penalize large users are sufficient.

With the potential end of the Rebate Program, the only remaining direct state subsidy of solar energy on the residential level will be the 7.5% state tax credit. If the state tax credit were ignored, solar becomes viable for customers with a $155/month or larger electric bill.

Because of the tiered electric rate tariffs, the larger the customer's usage, the more cost effective a solar system is. Solar electricity has become economically viable without any direct subsidy.

As an investment, a hedge against inflation, a positive cash flow generator, and an increaser of home equity, unsubsidized solar systems can make good economic sense for the residential homeowner in California that uses large quantities of electricity.

8. RECOMMENDATIONS FOR IMPLEMENTATION IN OTHER AREAS.

In the author's opinion the most important factors that could improve solar financial viability in other areas are:

- Implementation of Time-of-Use Net Metering
- Establishing a tiered electric rates penalizing high users
- Small and declining subsidies as needed

Small subsidies may be needed in certain regions with low electric rates until electric rates rise and solar costs fall as has happened in California. There are several states that have sufficiently high electric rates. If those states adopted Time-of-Use Net Metering and a tiered rate structure, solar for large users to be very close to financially viable without any subsidy, as is the case in California.

9. REFERENCES

(1) Black, Andrew, Financial Payback on California Solar Electric Systems, Proceedings of the 32nd ASES Annual Conference, The American Solar Energy Society, July 2003
(2) Nevin, Rick et al, Evidence of Rational Market Valuations for Home Energy Efficiency, The Appraisal Journal, The Appraisal Institute, http://www.natresnet.org/herseems/appraisal.htm, October 1998
(3) Nevin, Rick et al, More Evidence of Rational Market Values for Home Energy Efficiency, The Appraisal Journal, The Appraisal Institute, http://www.natresnet.org/herseems/appraisal.htm, October 1999
(4) Black, Andrew, Why Is A Solar Electric Home Worth More? Proceedings of the 33rd ASES Annual Conference, The American Solar Energy Society, July 2004

10. APPENDIX A: Financial Detail of the Examples.

See Figs. 3 & 4 for details on the 25-year financial analysis modeling.

Solar Electric System Analysis for:
Happy Customer
123 Solar Street
Sunnyvale, CA 94086
(800) SUN-PHONE
(800) SUN-FAX
savings@sun.com

v3.3 March 22, 2004

2.6	kW AC Solar System
18	Sharp NT-175U1 Photovoltaic Modules
1	SMA America SWR2500/D Inverter

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ELECTRICAL ENERGY USAGE, BILLING & TAX INPUTS

1,500	kWh Winter average monthly consumption
1,500	kWh Summer average monthly consumption
	Residential Rates
E1	Current Rate Schedule
E7	New Rate Schedule (E7=Time of Use)
X	Baseline Territory
B	Basic Quantities
	Avg Monthly Summer Baseline: 371.1
	Avg Monthly Winter Baseline: 349.8
2.0%	Utility Tax Rate
31%	Federal Income Tax Rate
9%	State Income Tax Rate
40%	Combined Fed & State Income Tax Rate
5.1%	Inflation
0.3%	Real Annual Increase in Electricity Price
5.4%	Total Electricity Price Inflation
	The CPI has increased 5.1% annually since 1970
	PG&E Electric Rates have increased 6.7% annually (including inflation) since 1970

ENERGY COSTS

CURRENT ENERGY COSTS WITHOUT SOLAR:

$	3,487.27	Annual Charges without Solar
$	**290.61**	**Average Monthly Charges without Solar**
$	0.19	Average per kWh energy charge

FUTURE ENERGY COSTS WITH SOLAR:

$	1,829.91	Annual Charges with Solar
$	152.49	Average Monthly Charges with Solar

SAVINGS USING SOLAR:

$	1,657.36	First Year Annual (after tax) Savings with Solar
		$ 2,776 pre-tax value of energy savings
$	**138.11**	**FIRST YEAR AVERAGE MONTHLY SAVINGS WITH SOLAR**

This information is provided as an illustration of potential financial benefits stemming from ownership of a renewable energy power system. This is not a production guarantee. These estimates should be confirmed by a professional accountant or tax advisor. REgrid Power does not warrant the applicability of these estimates for particular business cases

SOLAR ELECTRIC SYSTEM

25	Slope of Array (degrees up from horizontal)		
5.3	Equivalent Peak Sun Hours for this site (full sun is 5.3 +/- 9% for Sunnyvale Area)		
4.5	Effective peak sun hours. The lower effective sun level is used because of miscellaneous losses		
0.5%	Annual Module Degradation Rate (normally 0% to 1%)		
2.602	**kW = PV system size (CEC AC kW)**	4311	kWh/year conservative estimated production
-			approx 7% below Clean Power Estimator estimate
1	SMA America SWR2500/D Inverter	264	square feet (approximate) roof area required
18	Sharp NT-175U1 Photovoltaic Modules	33x62	module dimensions (inches)

SYSTEM PRICING

$	25,072	System Base Price
$	-	Mounting costs for Composition Shingle Roof
$	-	Additional Costs
$	25,072	Total System Price (includes full service, parts, delivery, sales tax, installation, 5 year warranty)
$	-	CEC Rebate at: $ - per Watt
$	25,072	After Rebate Price (Contract Price)
$	(1,946)	State Tax Credit: 7.5%
$	**23,126**	**System Cost including Rebate, Tax Credit, Parts, Installation, Sales Tax, Delivery**

Additional Costs of Ownership (included in the financial analysis)

	277	PG&E One-Time Fee for Time-of-Use metering
$	600	Permit Fee (estimate, this varies by jurisdiction, and will be billed as we are)
$	603	Effective Federal Tax on State Tax Credit
$	24,606	Total Net Bottom Line

RETURN ON INVESTMENT

15.0% Pre-Tax Annual Rate of Return
For comparison with other investments
Additional value as a hedge against future electric rate increases

CUMULATIVE SAVINGS OVER 25 YEARS:
$ 78,019 equals 317% return on initial system cost of $24,606

HOME EQUITY:
$ 33,147 Increase in Property Value at 5% loan cost compared to $24,606 system cost
$ 1,657 First Year Annual Savings
Home equity increases $20 for every $1 saved in annual utility expenses
ref: The Appraisal Journal, Oct 98
http://www.natresnet.org/herseems/appraisal.htm
135% Ratio of increase in home equity to system cost

LOANS:

	7.00%	Rate
	30	Year Term
$	24,606	Borrowed Amount (System cost minus tax credits = $0 out of pocket)
$	(163.71)	Loan Cost per month before tax deduction of interest
$	(97.73)	Initial after tax loan cost (when interest portion is dominant)
$	138.11	First Year Avg Monthly Energy Bill Savings
$	**40.38**	**INITIAL NET MONTHLY SAVINGS IN FIRST YEAR**

Net monthly savings will increase due to electricity inflation, but decrease due to reduced interest (tax deduction) portion of loan repayment. Savings get larger, because inflation works faster than reduction in interest.

Fig. 3: Input to the 25-year financial analysis tool and system description.

PreTax values: all values are adjusted to pre-tax equivalents

Year:	0	1	2	6	7	8	9	10	12	15	20	25
Operating Savings:												
Avoided electricity Purchases	-	2,776	2,912	3,526	3,699	3,880	4,070	4,270	4,699	5,424	6,889	8,751
	-	-	-	-	-	-	-	-	-	-	-	
Operating Expenses:												
System Maintenance (about .25%/yr)	-	(109)	(114)	(139)	(146)	(154)	(162)	(170)	(188)	(218)	(280)	(359)
Capital Cost - Initial System	(25,949)											
Capital Cost - Inverter Replacement									-		(2,680)	
Operating profit (loss):	(25,949)	2,667	2,798	3,387	3,553	3,726	3,909	4,100	4,511	5,206	3,930	8,392
Federal & State Tax benefits												
	-											
7.5% State Tax Credit (Pre-Tax Value)	3,260											
		-										
		-										
		-	-	-								
Taxable Income (loss) = Operating profit+depr		2,667	2,798	3,387	3,553	3,726	3,909	4,100	4,511	5,206	3,930	8,392
		-	-	-	-	-	-	-	-	-	-	-
Fed income tax on state tax credit		(1,011)										
		-	-	-								
Net Income after taxes	(22,689)	1,657	2,798	3,387	3,553	3,726	3,909	4,100	4,511	5,206	3,930	8,392
		-	-	-								
Pre-Tax Cash Flow, Net	**(22,689)**	**1,657**	**2,798**	**3,387**	**3,553**	**3,726**	**3,909**	**4,100**	**4,511**	**5,206**	**3,930**	**8,392**

15.0% IRR (Pre-Tax Rate of Return)

Fig. 4: Timelines for 25-year analysis of cash flows.