PAYBACK ON RESIDENTIAL PV SYSTEMS WITH 2009-2016 UNCAPPED 30% FEDERAL INVESTMENT TAX CREDIT

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ABSTRACT

The United States federal government enacted an extension and expansion of the 30% Federal Investment Tax Credit (ITC) for individual (residential) tax filers in October 2008. The expansion from a former cap of $2,000 on the ITC to the new uncapped full 30% ITC substantially reduces the net cost of ownership, and thereby dramatically improves the potential financial returns and benefits to many prospective customers.

This paper presents revised and expanded financial analyses of residential cases presented in previous papers. It will look at Internal Rate of Return (IRR) only (for simplicity of cross comparison) for the previously studied Northern California cases, accounting for the increase in the ITC and brought up-to-date with current electric tariffs, incentives (federal, state & local) and, as applicable, Solar Renewable Energy Certificate (SREC) values. The paper then expands coverage to additional US states (NJ, NC, CT, AZ, HI, CO), and also performs a couple of "what if" scenarios to illustrate the effects of changes in individual variables.

1. INTRODUCTION

Attractive end-user economics are critical to wide market acceptance of photovoltaics. While attractive tariff structures, high and rising electric rates, and low and falling system installed costs are the critical components to reach permanent "grid parity" for any particular market, incentives play an important part in temporarily making the economics more attractive until the aforementioned factors come into alignment to allow for a self-supporting industry.

Incentives have been provided to end-consumers and the solar industry by governments at all levels and in a variety of ways. The United States federal government expanded the 30% Federal Investment Tax Credit (ITC) for individual (residential) tax filers in October 2008 for installations completed from January 2009 thru December 2016.[1]

For most homeowners installing a PV system, this represents a huge increase in available incentive compared to the $2,000 capped ITC available from 2006 to 2008, and $0 before 2006. This change dramatically improves the economics for homeowners nationwide, and increases the number of locations and taxpayers for whom an investment in solar might be considered economically attractive.

Previous papers from 2003[2], 2004[3], and 2006[4] discussed residential economics. A number of the variables have changed. This paper will discuss those changes, then present the previous and latest economic analysis results. The paper will then explore "what if" scenarios looking at various levels of tax credit and future system cost reductions, while holding other variables constant.

2. VARIABLES THAT CHANGED SINCE 2003

Although the title of this paper implies that the 30% uncapped ITC is the big change and topic of this paper, it is not the only significant change that has occurred. Depending on location and customer type, one or more of the following may also have occurred; other incentives have been added or removed, substantial changes in electric rates, and changes in what electric rate schedules are available.

2.1 Incentives

The big change that is the main topic of this paper is the enactment of a 30% Federal Investment Tax Credit (ITC) capped at $2,000 for tax years 2006-2008, and the subsequent uncapping in October 2008 of that ITC to allow a full 30% ITC for homeowners installing PV.

There have been changes to incentives at the state and local level as well. California has substantially reduced the incentives for PV from a peak of $4.50/CEC AC watt (roughly equivalent to $5.40/STC DC watt) combined with a state tax credit of 15% to a current level of $1.55 to $2.20/CEC AC watt and no state tax credit.

Other states have held their incentives steady, such as Hawaii with a 35% state tax credit. Still others have added incentives, such as Oregon's 50% state tax credit and North Carolina's 35% state tax credit.

New Jersey, Connecticut and Colorado (and many others) have both increased, then, decreased the available incentive as their programs met goals or in response to the expansion of the federal ITC in October 2008.

There are now local incentives that have become available in some areas as well. The City of San Francisco, located within Pacific Gas & Electric territory, offers a grant in addition to the California Solar Initiative incentive.

The DSIRE Database (The Database for State Incentives for Renewable Energy) lists all current incentives at the federal, state, local and utility level for PV and other renewable energy technologies, plus energy efficiency measures, and can be found online at: www.dsireusa.org.

2.2 Electric Rates

Electric rates have in general risen since 2003.[5] California rates are among the most complex in the nation. Residential customers in Tier 1 and Tier 2 haven't seen their rates rise since 1996 due to laws relating to deregulation enacted in 1995. However, customer in Tier 3-5 have born the brunt of all the rate hikes required to keep the utilities solvent from 2001 on and have seen rates rise much faster than the historical 6.7% compound annual average from 1970 to 2001.[6]

2.3 Electric Rates Structures and Available Tariffs

In California there have been changes in the available electric tariffs a customer can choose when going solar in Pacific Gas & Electric (PG&E) territory. In 2003 the PG&E "E-7" rate schedule was available. In May of 2005, the "E-7" rate schedule was closed and a new "E-6" rate schedule became the only Time-of-Use rate schedule available to homeowners. E-7 was a more attractive rate schedule for solar customers because it had a bigger peak to off-peak ratio and because its peak time window was Noon to 6pm, vs. 1pm to 7pm for E-6. E-6 offered about half the relative benefit E-7 had, compared to the E-1 non-Time-of-Use rate. In some cases, E-7 was a 30% advantage, where E-6 now offers only a 15% advantage.

In the case of San Diego Gas & Electric (SDG&E) and Southern California Edison (SCE) territories, there are now new rates available to solar. SDG&E now offers a two new "Solar" rates for customers who get solar and interconnect through a net-metering agreement: DR-SES for residential, and DG-R for commercial. SCE offers the "Option A" alternative for commercial customers on its GS-2 and GS-3 rate schedules, that they might enjoy selling at higher peak time rates and simultaneously reduce their demand charges.

2.4 System Costs

Surprisingly, there has been no substantial reduction in system costs. In fact, average module prices have risen substantially since 2003[7] due primarily to increased demand on the world market due to in large part to rapid growth in the German and Spanish markets thru 2008. This has been offset by reductions in inverter, racking, and mounting hardware cost reductions and reduction in labor hours due to better mounting and inverter designs. System installed costs have stayed roughly flat over the last 6 years according to California incentive program data.[8]

3. CURRENT AND FORMER ECONOMIC RESULTS

A comparison of the results then vs. now shows a relative change in the customer's economics.

3.1 2003-2006 "Payback" Results from Previous Works

In 2003, 2004, and 2006, the author presented the results in the top half of Table 1, based on the assumptions listed in Table 3.

Please note the various rating types are generally based on the rating system used in that state, except for the 2006 examples, which are normalized to their STC ratings for the purposes of that paper.

3.2 2009 "Payback" results

In 2009, a variety of scenarios similar to the earlier works were analyzed for comparison. Additionally, the other two large California Investor Owned Utilities are now included (SCE and SDG&E), as well as 6 other states. These results

TABLE 1. "PAYBACK" RESULTS PRESENTED IN PREVIOUS PAPERS AND UPDATED FOR 2009 RATES & INCENTIVES. Please note the various rating types are generally based on the rating system used in that state, except for the 2006 examples, which are normalized to their STC ratings for the purposes of that paper.

PV System Year, State, Utility, Size and Rating Type	Pre-Solar Monthly Electric Bill	Usage kWh /month	Cost Before Incentive	Final Net Cost	Pre-Tax Annual IRR
2003 CA PG&E 2.0 kW CEC	$75	570		$14K	11.4%
2003 CA PG&E 2.8 kW CEC	$100	710		$17K	13.8%
2003 CA PG&E 2.8 kW CEC	$150	930		$17K	17.4%
2003 CA PG&E 2.8 kW CEC	$250	1340		$17K	21.3%
2004 CA PG&E 2.6 kW CEC	$145	905	$25K		11.2%
2004 CA PG&E 2.6 kW CEC	$200	1145	$25K		13.2%
2004 CA PG&E 5.2 kW CEC	$200	1145	$46K		11.1%
2004 CA PG&E 2.6 kW CEC	$290	1500	$25K		15.0%
2004 CA PG&E 7.8 kW CEC	$290	1500	$69K		11.2%
2006 NJ PSE&G 9.9 kW STC	$124	1000	$73K		17.6%
2006 CA PG&E PBI 8.9 kW STC	$322	1500	$66K		15.1%
2006 CA PG&E Rebate 8.9 kW STC	$322	1500	$66K		17.3%
2006 CA PG&E PBI 3.2 kW STC	$75	600	$25K		9.5%
2006 CA PG&E Rebate 3.2 kW STC	$75	600	$25K		10.8%
2009 CA PG&E 3 kW CEC	$74	550	$28K	$17K	9.9%
2009 CA PG&E 6 kW CEC	$258	1100	$55K	$33K	19.5%
2009 CA PG&E 9 kW CEC	$499	1650	$81K	$48K	24.6%
2009 CA SCE 3 kW CEC	$81	550	$28K	$16K	12.8%
2009 CA SCE 6 kW CEC	$219	1100	$55K	$30K	18.3%
2009 CA SCE 9 kW CEC	$373	1650	$81K	$43K	21.1%
2009 CA SDG&E 3 kW CEC	$97	550	$28K	$16K	13.5%
2009 CA SDG&E 6 kW CEC	$278	1100	$55K	$31K	20.7%
2009 CA SDG&E 9 kW CEC	$460	1650	$81K	$45K	23.5%
2009 NJ JCP&L 5 kW STC	$130	800	$41K	$24K	17.9%
2009 NC Progress 5 kW STC	$80	800	$41K	$22K	6.8%
2009 CT UI 5 kW PTC	$183	800	$44K	$31K	9.9%
2009 AZ APS 5 kW STC	$89	800	$41K	$20K	8.7%
2009 HI HECO 5 kW STC	$164	800	$41K	$26K	13.4%
2009 CO Xcel 5 kW STC	$70	800	$41K	$17K	1.4%

TABLE 2. 2009 UTILITY SPECIFIC ASSUMPTIONS.

Utility	Insolation	AC kWh Production per rated kW	Cost per rated Watt	Staring/Ending Rate Schedule, Peak %	Incentives
CA - PG&E	San Francisco	1630 / CEC kW	3kW: $9.50 CEC 6kW: $9.25 CEC 9kW: $9.00 CEC	E1XB / E6XB, 35%	$1.55/W Rebate
CA - SCE	Los Angeles	1675 / CEC kW		D-10-Basic / TOU-D-1, 36%	$2.20/W Rebate
CA - SDG&E	San Diego	1700 / CEC kW		DR-Coastal-Basic / DR-SES, 28%	$1.90/W Rebate
NJ - JCP&L	Newark	1140 / STC kW	$8.25 STC	RS / RT, 58%	SRECs: 48¢/1yr, 30¢/12yrs, 10¢/12yrs $1.55/W Rebate
NC - Progress	Raleigh	1260 / STC kW	$8.25 STC	RES / R-TOUD, 60%	35% State Tax Credit
CT - UI	Hartford	1260 / PTC kW	$8.75 PTC	R / RT, 54%	None
AZ - APS	Phoenix	1660 / STC kW	$8.25 STC	E-12 / ET-2, 50%	$2.40/W Rebate (net) 25% State Tax Credit
HI - HECO	Honolulu	1460 / STC kW	$8.25 STC	Res	35% State Tax Credit
CO - Xcel	Boulder	1380 / STC kW	$8.25 STC	R	$3.50/W Rebate

TABLE 3. ASSUMPTIONS FOR THE ANALYSES.

Assumptions for all analyses unless otherwise stated:

1. Residential analysis taking advantage of all residential incentives (as an individual taxpayer)
2. Maintenance cost is 0.25% of gross system cost per year
3. Module degradation is 0.5% per year
4. CEC AC system size rating is the California Energy Commission AC power rating
5. Federal tax return itemizes deductions, reducing the net value of any state tax credit received
6. Rebates received are non-taxable but reduced federal tax credit basis as applicable
7. PBIs received are assumed taxable, but do not reduce federal tax credit basis as applicable

2003 Specific Assumptions:

1. Starting on PG&E E-1XB flat tiered residential tariff, switching to PG&E E-7 Time-of-Use residential tariff ($.31/kWh Summer Peak Noon-6pm Mon-Fri May-October, $.09-$.12/kWh other times, plus tier surcharges at all times depending on total monthly usage)
2. Electric rate inflation of 6%
3. $4.00/CEC AC Watt rebate
4. 31% Federal Tax Bracket and 9.3% state tax bracket
5. 15% California State Tax Credit
6. 20° pitch in San Jose, CA
7. $277 TOU meter fee, $500 permit fee
8. Inverter replacement costing $2,700 occurs in year 20

2004 Specific Assumptions:

1. Starting on PG&E E-1XB switching to E-7XB rate
2. Electric rate inflation of 5.4%
3. $4.00/CEC AC Watt rebate
4. 31% Federal Tax Bracket and 9.3% state tax bracket
5. 7.5% California State Tax Credit
6. 25° pitch in San Jose, CA
7. $277 TOU meter fee, $600 permit fee
8. Inverter replacement costing $2,700 occurs in year 20

2006 Specific Assumptions:

1. Starting on PG&E E-1SB switching to E-7SB rate in CA; or PSE&G RS tariff in NJ
2. Electric rate inflation of 5%
3. $3.15/STC Watt rebate in CA or 50¢ PBI for 3 years
4. $4.95/STC Watt rebate in NJ plus S-RECs of 17¢/kWh for 10 years plus 10¢/kWh for next 15 years
5. 28% Federal Tax Bracket and 9.3% state tax bracket
6. $2,000 Federal Tax Credit (30% capped at $2,000)
7. 22° pitch in Sacramento, CA yielding 1424 kW AC per kW STC or Newark, NJ yielding 1146 kW AC per kW STC or
8. $277 TOU meter fee in CA, $500 permit fee
9. Inverter replacement costing $700/kW occurs in year 15

2009 Specific Assumptions (see also Table 2 of Utility Specific Assumptions):

1. Electric rate inflation of 5%
2. 28% Federal Tax Bracket, corresponding state tax bracket
3. Federal Tax Credit (30% uncapped)
4. 22° pitch facing south, no shade, slightly conservative performance estimate
5. $0 TOU meter fee in CA, $500 permit fee
6. Inverter replacement costing $700/kW occurs in year 15

can be seen in the lower half of Table 1, based on the assumptions in Table 2 and Table 3.

Diverging results can be seen in the table. For example, larger systems have gotten less expensive to the end consumer after all incentives, while electric rates for large residential consumers have risen dramatically, yielding much higher IRRs. Conversely, small systems in California have not enjoyed as much of an increase in the federal incentive, and the state incentive has declined

TABLE 4. "PAYBACK" COMPARISONS VARYING THE AMOUNT OF TAX CREDIT while holding all other variables (electric rates, other incentives, system costs, etc, to March 2009 levels.

PV System Year, State, Utility, Size and Rating Type	Pre-Solar Monthly Electric Bill	Usage kWh /month	Uncapped 30% ITC Pre-Tax IRR	$2,000 Capped 30% ITC Pre-Tax IRR	No ITC Pre-Tax IRR
CA PG&E 3 kW CEC	$74	550	9.9%	5.7%	4.6%
CA PG&E 6 kW CEC	$258	1100	19.5%	13.0%	12.2%
CA PG&E 9 kW CEC	$499	1650	24.6%	16.7%	16.1%
CA SCE 3 kW CEC	$81	550	12.8%	8.3%	7.0%
CA SCE 6 kW CEC	$219	1100	18.3%	12.1%	11.3%
CA SCE 9 kW CEC	$373	1650	21.1%	14.0%	13.4%
CA SDG&E 3 kW CEC	$97	550	13.5%	8.8%	7.5%
CA SDG&E 6 kW CEC	$278	1100	20.7%	14.0%	13.1%
CA SDG&E 9 kW CEC	$460	1650	23.5%	15.9%	15.3%
NJ JCP&L 5 kW STC	$130	800	17.9%	11.0%	9.9%
NC Progress 5 kW STC	$80	800	6.8%	1.6%	0.9%
CT UI 5 kW PTC	$183	800	9.9%	5.6%	5.0%
AZ APS 5 kW STC	$89	800	8.7%	4.7%	3.9%
HI HECO 5 kW STC	$164	800	13.4%	7.7%	6.2%
CO Xcel 5 kW STC	$70	800	1.4%	-1.9%	-2.8%

TABLE 5. "PAYBACK" COMPARISONS VARYING THE SYSTEM COST due to expected drops in module pricing.

PV System Year, State, Utility, Size and Rating Type	Pre-Solar Monthly Electric Bill	Usage kWh /month	100% 2008 Module Price Pre-Tax IRR	80% of 2008 Module Price Pre-Tax IRR	60% of 2008 Module Price Pre-Tax IRR
2009 CA PG&E 3 kW CEC	$74	550	9.9%	11.3%	13.0%
2009 CA PG&E 6 kW CEC	$258	1100	19.5%	21.7%	24.5%
2009 CA PG&E 9 kW CEC	$499	1650	24.6%	27.4%	31.1%
2009 CA SCE 3 kW CEC	$81	550	12.8%	14.6%	16.8%
2009 CA SCE 6 kW CEC	$219	1100	18.3%	20.7%	23.8%
2009 CA SCE 9 kW CEC	$373	1650	21.1%	23.8%	27.5%
2009 CA SDG&E 3 kW CEC	$97	550	13.5%	15.2%	17.3%
2009 CA SDG&E 6 kW CEC	$278	1100	20.7%	23.2%	26.4%
2009 CA SDG&E 9 kW CEC	$460	1650	23.5%	26.4%	30.3%
2009 NJ JCP&L 5 kW STC	$130	800	17.9%	20.3%	23.3%
2009 NC Progress 5 kW STC	$80	800	6.8%	8.2%	9.9%
2009 CT UI 5 kW PTC	$183	800	9.9%	11.1%	12.5%
2009 AZ APS 5 kW STC	$89	800	8.7%	10.3%	12.3%
2009 HI HECO 5 kW STC	$164	800	13.4%	14.9%	16.7%
2009 CO Xcel 5 kW STC	$70	800	1.4%	3.1%	5.3%

proportionately. More significantly though is that the electric rates for Tier 1 and Tier 2 (at or below average) haven't increased at all since 1996, so their economic results haven't changed much since the first analysis.

When comparing results, bear in mind the powerful nature of the California tier pricing system. Analyses in earlier years sometimes put smaller systems on larger usage to illustrate a better selling case by "tier shaving" rather than eliminating all or most of the electric bill.

Other states now often show impressive results. Where the new uncapped Federal ITC might be seen as providing excessive returns in California, it is bringing the economics in others states up to attractive levels (in the author's opinion).

4. WHAT IF SCENARIOS

Several "What If" scenarios illustrate the relative impact of certain changes in the economic landscape for PV.

4.1 Effect of $2,000 and Full 30% ITC

In Table 4, comparing "No ITC" vs. "$2,000 Capped ITC" we can see that there is a relatively minor effect of approximately 100 basis points on the IRR. However, by uncapping the ITC, the relative benefit jumps at least 300 basis points, and sometimes as many as 800. This takes larger California systems from being "attractive" at better than 10% IRRs to what might be argued "over-incentivized" at greater than 20% IRRs (the equivalent of earning better than 20% pre-tax on one's money each year for 25 years). On the other hand, with the capped ITC or less, most other states were significantly less attractive with IRRs of less than 6%, but now some are much more interesting, yielding better than 8%.

4.2 Effect of 20% and 40% Drop in Module Prices

Module prices began falling in the United States as of November 2008. [7] If one assumes 20% and 40% drop in module prices from $4.00/W STC to $3.20/W and $2.40/W and those savings are passed thru in lower system costs (ignoring any other cost reductions that are also likely), IRRs improve as can be seen in Table 5.

5. OTHER CONSIDERATIONS

Perceived risk is not included in the above analyses and comparisons. Just because the rate of return is more or less in absolute terms doesn't reflect the whole truth about whether a typical customer might find PV attractive. From 2003 to March 2009, approximately 37,000 systems have been purchased (17,000 from 2003 to 2006[9] and almost 20,000 since CSI started in 2007[10]), compared with just 2,600 purchased in 2003.[9] The general public is now much more familiar with solar, and there is a much higher likelihood that an interested customer knows someone who has had a successful solar experience. This familiarity increases confidence that they too will meet with success, thereby reducing their concerns about risk. Where there is less perceived risk, less reward is required to attract investment. Therefore, even if the rates of return were equal today and in 2003, solar should be perceived as much more attractive because the risk is seen as lower.

This is being played out in several ways across the United States. In California, there have been regular reductions in the incentive levels as consumers sign up for solar and use up the allocated incentive money. In New Jersey and Connecticut, programs have sometimes been put on hold due to overwhelming demand, and in Colorado, the incentive was reduced as soon as the Federal ITC was uncapped.

6. CONCLUSION

We see that there has been a substantial increase in the rate of return because of both the ITC and higher electric rates, even though in some places, other incentives are now smaller. This, plus the perceived lower risk of an investment in solar, have caused a further acceleration of purchases of solar energy systems for homes in measured markets such as California.[9,10]

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