CUSTOMER-SITED PHOTOVOLTAICS: STATE MARKET ANALYSIS

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ABSTRACT
As the energy industry seeks new definition, either within regulation or through utility restructuring, emerging policies have resulted in more favorable economics for residential customer-sited photovoltaic (CSPV). The authors have previously published two papers [1, 2] identifying the breakeven turnkey cost (BTC) on a state-by-state basis. An arbitrary near term market breakpoint was chosen at $4/Watt BTC. Between 1996 and 1999, the market expanded from five to 15 states with a BTC above the market breakpoint. Now, the United States Treasury Department has asked what effect would a 15% residential tax credit have on the CSPV market? The paper will include the federal tax credit and updated state PV deployment incentives in the life-cycle cash flow analysis, and develop new state-by-state BTCs. Though energy policy is currently unpredictable, federal tax credits are historically effective tools for both the business and private sector as part of overall government economic objectives.

1.0 INTRODUCTION

In 1999, when the last residential BTC analysis [2] was completed, most states were engaged in or considering restructuring with specific timelines. Since that time, the energy crisis in the western United States demonstrated the potential volatility in the electricity market when certain conditions emerge. The unacceptable consequences of rolling blackouts and extreme electricity prices resulted in many states reconsidering and slowing down electric industry restructuring. However, this has not slowed the emergence of CSPV policy incentives.

- 23 states now have system benefit charge funds (SBCs) [3]; 16 of the funds have renewable energy components.
- 11 states have some form of renewable portfolio (RPS) standards [9]; 3 states have renewable portfolio goals.
- 36 states have net metering.
- 3 states, CA, TX, and NY, have interconnection rules; an IEEE[1] standard, 1547, is close to completion; the Federal Energy Regulatory Commission has expanded its jurisdiction to include distribution interconnection; and the Senate recently passed interconnection language [4]
- 14 states have tax credits or deductions for CSPV. See Table 1.
- 10 states have loan programs. See Table 1.
- 12 states have some form of buy-down or grant. This reflects seven new state programs and six expired state programs (the Virginia Alliance for Solar Energy in MD, NJ, NC, PA, VA and the CO program). See Table 1.
- As a result of the Million Solar Roofs Initiative, many regional and local programs have also developed.

Though solar electric systems are still the most expensive form of renewable energy, they are still the most affordable and market-available for residential consumers. The modular aspect of the PV technology permits consumers to

[1] Institute of Electrical and Electronic Engineers

invest incrementally. CSPV allows consumers to exercise choice, independence, and environmental stewardship. Environmental externality values are not included in this paper. The Energy Information Agency has not released any new state emission data since the 1999 analysis [2].

The objectives of the state-by-state BTC analysis are to:

- Identify high-value markets for the industry to target.
- Illustrate the value of state policy to consumers and therefore the potential for consumers to participate in policy.
- Tabulate and monitor residential CSPV specific policies.

The information is targeted for used by the PV manufacturing industry and state, local, and municipal governments considering renewable energy policy. The information is not appropriate for use by consumers making investment decisions. States and manufacturers have developed software specifically for consumer investment decisions, such as the Clean Power Estimator [5].

2. APPROACH

The breakeven turnkey cost represents the installed turnkey cost of a PV system that an average residential consumer in each state could pay for the system and neither make or lose money--but rather break even--over the life of the system. It is the market hurdle value. The assumptions used in the analysis include the following:

- A CSPV system has a 30 year service life.
- A CSPV system is financed in a home mortgage or home equity loan at 10% down (buy-downs and grants were subtracted from the financed cost), at a 7% interest rate, for a 30-year term, unless other financing is available as noted in Table 1. The loan's interest is deductible on federal income tax. A 28% tax bracket is assumed.
- The electricity bill savings are calculated using the state's average residential revenue per kWh [6], and the average CSPV system production of kWh/kW-yr [2]. The electricity price is escalated at 2%[2]. Full retail value is assumed for all energy produced by the PV system as though it is either net metered or sized well below the residential load.
- Operation and maintenance costs are included at a rate of 1¢/kWh escalated at 3.5%.
- The discount rate is 5%.

The BTC is calculated by forcing the net present value of the benefits (energy savings, tax savings, and buy-downs or grants) and costs (down payment, loan payment, and O&M) to zero, at a 5% discount rate, by varying the installed cost. The BTC is calculated on a per kW basis. Few incentive maximum limits are encountered, but these maximums would limit the value on the incentive for multi-kilowatt systems. Since average energy prices and PV production values are used, the BTC does not reflect high regional values, such as the $5/W buy-down at the Los Angeles Department of Water and Power. More importantly, the policies, which can drive high BTC values, are mainly state policies[3], though some local policies have been included.

The average price for a turnkey CSPV system has recently escalated with market demand resulting from the western energy crisis. The average cost of a CSPV system purchased as part of the California buy-down program is $9/W [7]. However, the Sacramento Municipal Utility District (SMUD) has negotiated a turnkey price of less than $5/W, through a high-volume long-term contract [8].

2.1 Database Development

Table 1 represents the database used to calculate the state breakeven turnkey cost. With the exception of the Chelan Public Utility District $1.50/kWh production incentive used for the state of Washington, all policy information came from the DSIRE website [9]. The main policy attributes are provided in Table 1, but details are available either in the database or through the state links provided by the database.

2.1.1 Residential Rates

Since 1999, approximately half of the state average residential rates have decreased and half have increased. Most notable of those that decreased are NV at 22%, IL at 18%, NJ at 17%, CT at 12%, and MA at 10%. These rate declines are reflected in the BTCs, especially in IL, MA, and NJ, all of which have strong policy incentives. Though California implemented higher block tiered rate structures early in 2001, because the data table rates are base on 2000 revenues the value of shaving the high cost upper tier usage rate with a CSPV system is not reflected.

2.1.2 State Personal Income Tax Credits and Deductions

Tax credits and deductions have a high impact on the BTC, because they occur in the cash flow stream the second year, or the year immediately following installation, and have a high net present value. There are six new tax credits and deductions that were not included in the 1999 analysis. California has implemented both a tax credit and a

[2] All escalation rates reflect the total assumed for both price and inflation.

[3] The Database for State Incentives for Renewable Energy is now collecting regional and municipal policies [9].

TABLE 1: STATE-BY STATE ATTRIBUTES AND INCENTIVES [9]

State	Rank	Res[6] Rate	Tax Credit	Tax Deduction	Net Meter	Prop. Tax	Sales Tax	Loan	Buy Down Grant	kWh/ kW-yr	BTC ($/kW)
Alabama	42	7.1								1664	$1,880
Alaska	32	11.5								1051	$2,082
Arizona	9	8.4	25%_$1K		Y		Y		$2/W (TEP)	2102	$5,935
Arkansas	36	7.5			Y					1664	$2,006
California	2	10.9	15%_$4.5/W	100% of Int	Y	Y			50%/$4.50/W	1927	$11,930
Colorado	27	7.3			Y					2015	$2,373
Connecticut	17	10.9			Y	(L)		6%_10 yrs		1577	$3,177
Delaware	15	8.5			Y				35%_$10.5K	1577	$3,433
Florida	8	7.8					Y		$4/W_$16K*	1664	$6,108
Georgia	34	7.6			Y					1664	$2,054
Hawaii	4	16.4	35%_$1,750		Y					2102	$7,831
Idaho	46	5.4		40% yr1;20%-3yrs	Y			4%_5 yrs.		1840	$1,746
Illinois	10	8.8			Y(u)	Y			60%_$5K	1577	$5,800
Indiana	47	6.9			Y					1489	$1,628
Iowa	24	8.4			Y	Y		1/2BTC-0%-20 yrs		1664	$2,493
Kansas	29	7.7				Y				1840	$2,241
Kentucky	50	5.5			Y(u)					1489	$1,200
Louisiana	30	7.7								1752	$2,141
Maine	20	12.9			Y					1402	$3,104
Maryland	28	8.0	15%_$2,000		Y	(L)				1577	$2,339
Mass.	16	10.5	15%_$1,000		Y	(L)	Y			1577	$3,229
Michigan	39	8.5								1402	$1,940
Minnesota	14	7.5			Y	Y	Y		$2K/kW_$8K	1489	$3,777
Mississippi	45	6.9								1664	$1,801
Missouri	44	7.0								1664	$1,835
Montana	23	6.5	35%		Y	Y		$10K_5 yrs.		1664	$2,579
Nebraska	33	6.5						1/2BTC-0%		1752	$2,054
Nevada	26	7.3			Y	Y				2102	$2,414
New Hamp	18	13.1			Y	(L)				1402	$3,162
New Jersey	7	10.3			Y		Y		$5/W_60%	1577	$6,769
New Mexico	21	8.4			Y					2190	$2,961
New York	1	14.0	25%_$3.75K		Y	Y		4.5%<mkt_5yrs;6%-LI	$3/W;$6 -LI	1577	$13,556
N. Carolina	19	8.0	35%_$10.5K							1664	$3,155
North Dakota	40	6.4	3%-5 yrs		Y	Y				1664	$1,899
Ohio	31	8.6			Y			50%<mkt_5yrs		1402	$2,128
Oklahoma	35	7.0			Y					1840	$2,025
Oregon	12	5.9	$3/W_$1.5K		Y	Y		6.50%		1577	$4,245
Pennsylvania	5	9.4			Y				$3/W_$6,000	1402	$7,829
Rhode Island	3	11.3	15%_$15K		Y		Y		$3/W_50%	1577	$8,406
S.Carolina	37	7.6								1664	$2,005
South Dakota	38	7.4				Y				1664	$1,955
Tennessee	48	6.3								1577	$1,527
Texas	25	8.0			Y	Y				1927	$2,460
Utah	13	6.3	25%_$2K		Y					2102	$3,859
Vermont	22	12.3			Y	(L)	Y			1402	$2,939
Virginia	41	7.5			Y	(L)				1577	$1,882
Washington	6	5.1			Y		Y	$5K_25 yr.	$1.50/kWh (u)	1314	$7,505
W.Virginia	49	6.3								1489	$1,425
Wisconsin	11	7.5			Y	Y		1.99%_3-10yrs	$1/kWh-1yr;$1/W	1402	$7,074
Wyoming	43	6.5			Y					1840	$1,841

(u) Offered by select utilities (ComEd territory in IL; LG&E and KU territory in KY, Chelan PUD in Washington

(L) local governments are granted authority to offer property tax exemptions

(p) personal tax credit only

(*) Current funding spent, new funding anticipated deduction of 100% of the loan interest. Tax credits have also been added for MD, MT, and RI, and a four-year tax deduction is included for ID. There are two tax credit policies for WI, a $1/kWh, with a maximum of 25% of the installed cost, and a $1/W. Though these credits may be exclusive, it was not evident in the legislation, and both were included in the BTC calculation.

2.1.3 Loans

The DSIRE database identified 10 financing incentive programs, as noted in Table 1. High capital cost technologies like PV need low-interest financing. In Germany, low-interest loans have been shown to be a strongmarket driver. However, the BTC analysis approach depends on loan payments spread out over the system life. And, although in every case, the BTC was higher using the loan policy than using a 7% interest, 30-year loan, the full market value of loan incentive policy is not fully reflected in this type of analysis.

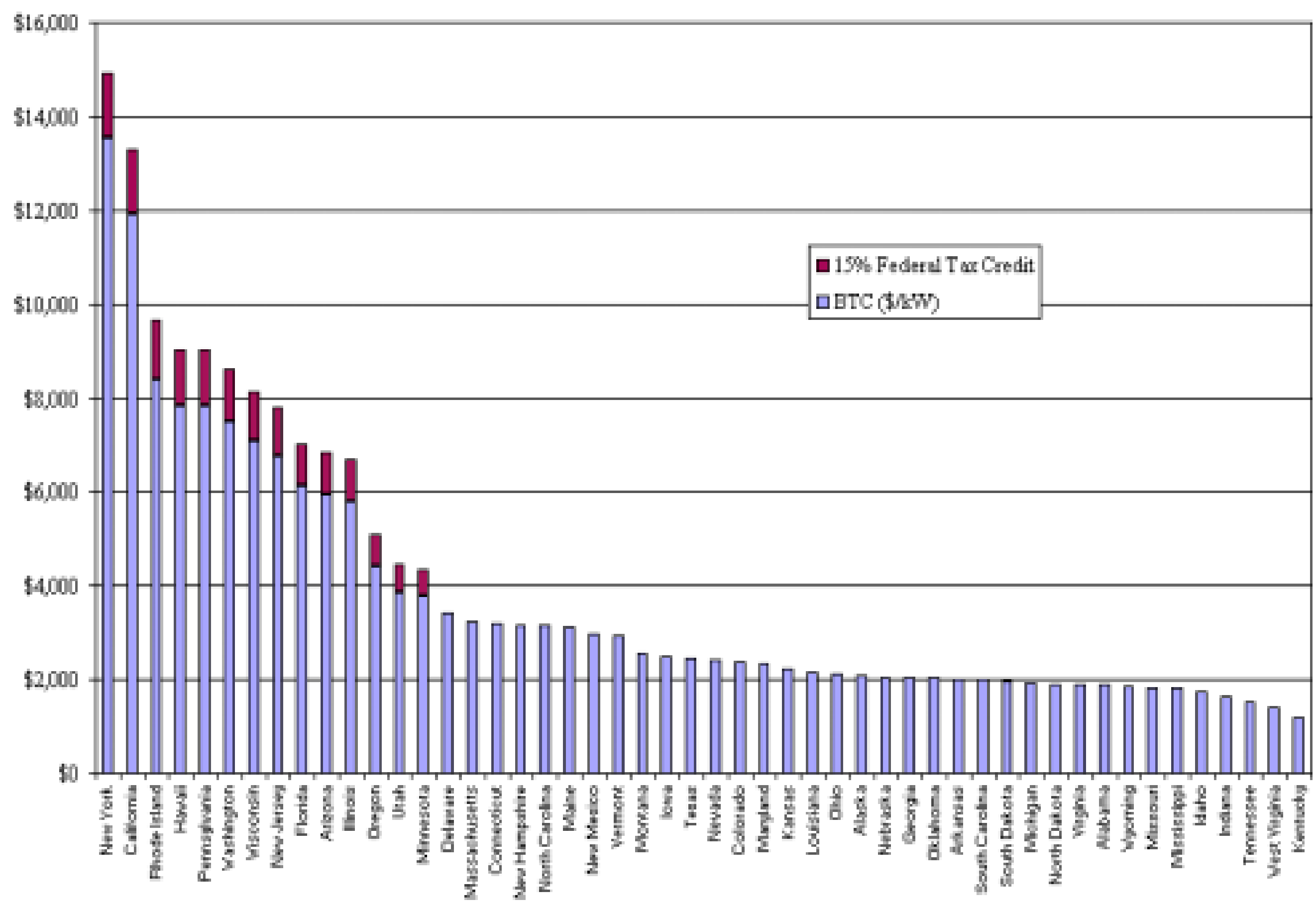
2.1.4 Buy-Downs and Grants

The buy-downs and grants indicated in Table 1 reflect seven new programs since the 1999 analysis. Additionally, both California and Florida increased the state buy-down amounts by 50% and 100%, respectively. Buy-downs are treated as an immediate reduction in system cost in the BTC analysis, and therefore reflect full net present value and have the highest impact on the BTC.

3. RESULTS

The 2002 average state BTC ranking is reflected in Figure 1. Several states dropped from the top rankings because the incentive funds were depleted, as in NC, MD, VA, and CO. Residential rate decreases caused both IL and MA to drop in rank. And although NJ implemented a 60% or $5/W buy-down program, the drop in average residential rates counterbalanced this strong incentive. All state rankings in the top tier are direct reflections of the incentives. The

Figure 1 State Ranking



BTC for WA is somewhat misleading. This is caused by input of the Chelan PUD green pricing program, Sustainable Natural Alternative Power (SNAP) [10]. Chelan will pay up to $1.50/kWh as a production incentive. The incentive is based on the funds collected and the energy production of the renewable energy systems installed. The fund did pay the full $1.50/kWh in 2001. The BTC analysis included this production incentive declining at 50% for the first five years of the system life.

Though it is uncertain whether the federal tax credit legislation will move forward, the impact is far from negligible on the BTC as outlined in Figure 1. Without the federal tax incentive, the number of states above the arbitrary $4/W mark has declined compared to our 1996 and 1999 analysis.

United States, consumer investment in CSPV is one path towards decentralization of the energy grid. Federal state and local governments can encourage the investment through policy. The PV industry manufacturing capacity is small, but growing rapidly. In the long term, PV can participate in changing the U.S. electric grid infrastructure.

Electric utility restructuring is not the only mechanism for development of policy incentives. In the top tier ranking, six states, HI, WA, FL, WI, UT, and MI have not restructured. The threat of restructuring initiated in the early 1990's. From this period of time to the present, utilities have been preparing for restructuring. One such preparation included declining investments in system benefits [11], including renewables. It may be a good time to review the appropriate level of system benefits investments.

Table 2 Top Ranking States

State	Rank	Res[3] Rate	Tax Credit	Tax Deduction	Net Meter	Prop. Tax	Sales Tax	Loan	Buy Down Grant	kWh/ kW-yr
New York	1	14.0	25%_$3.75K		Y	Y		4.5%<mkt_5yrs;6%-LI	$3/W;$6/W-LI	1577
California	2	10.9	15%_$4.5/W	100% of Int	Y	Y			50%/$4.50/W	1927
Rhode Island	3	11.3	15%_$15K		Y		Y		$3/W_50%	1577
Hawaii	4	16.4	35%_$1,750		Y					2102
Pennsylvania	5	9.4			Y				$3/W_$6,000	1402
Washington	6	5.1			Y		Y	$5K_25 yr.	20%_$3.75K	1314
Wisconsin	11	7.5			Y	Y		1.99%_3-10yrs	$1/kWh-yr_$1/W	1402
New Jersey	7	10.3			Y		Y		$5/W_60%	1577
Florida	8	7.8					Y		$4/W_$16K	1664
Arizona	9	8.4	25%_$1K		Y		Y		$2/W (TEP)	2102
Illinois	10	8.8			Y(u)	Y			60%_$5K	1577
Oregon	12	5.9	60c/kWh_$1.5K		Y	Y		6.50%	$2,000	1577
Utah	13	6.3	25%_$2K		Y					2102
Minnesota	14	7.5			Y	Y	Y		$2K/kW_$8K	1489

4. CONCLUSIONS

The conclusions do not vary much among the 1996, 1999, and this current CSPV market value analysis.

Policy is the main driver of the grid-connected CSPV market.

The second most important attribute is utility rates with the solar resource impact as minimal. Without the federal tax incentive, the number of states above the arbitrary $4/W level has declined. This reflects short-term transitional policies. Table 2 shows the top 14 states and policies resulting in the high BTC value. Among these states, importance of utility rates is only secondary, while that of solar resource imperceptible. Policy remains the common factor. As homeland security continues to be an issue in the

5. ACKNOWLEDGMENTS

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