PV IN COMMERCIAL BUILDINGS - MAPPING THE BREAKEVEN TURNKEY VALUE OF COMMERCIAL PV SYSTEMS IN THE US

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ABSTRACT

Rapid market growth for customer-sited photovoltaics (CSPV) is the direct result of new policy, program and tariff related incentives developed by a variety of energy industry stakeholders. In past publications [1],[2], the authors investigated the geographical distribution of the economic feasibility of customer-owned commercial PV systems in the US to assess the commercial market value. The market value is presented as a breakeven turn-key cost (BTC) by analyzing the installed and operating costs relative to incentives, energy savings and externality values over the life of the system.

This paper provides an updated snapshot of the commercial BTC values for the US. Included in the paper are:

- Current federal, state and local policies, programs and tariffs (production incentives)
- A tiered map of commercial BTC values.
- Representative commercial BTC, in a chart for 50 states plus DC, with stacked values of policy, energy, and externalities.
- A chart indicating the additional value of local government and utility policies.

The paper provides a measure of both the market value for industry targeting and the potential for incentives to affect market growth.

INTRODUCTION

Energy industry stakeholders have responded to a series of economic and political pressures in the past decade. First restructuring, then the western energy crisis, and more recently energy security have caused all stakeholders to consider extended energy values and choices. Utilities have developed customer policies and tariffs, federal, state and local policies have emerged, and the building industry has embraced distributed generation. Photovoltaics, the most modular and market accessible distributed generator realized a rapid market increase in customer sited photovoltaic (CSPV) applications as a result. US installed capacity of grid connected CSPV systems has doubled in the past two years. CSPV systems participating in the California Energy Commission incentive programs accounted for nearly 12 MW in 2002 of the estimated 22 MW of grid connected PV installed.

The commercial CSPV market sector economics are influenced by the wide variety of available rate structures, federal incentives, building integrated PV values (BIPV), building energy management/CSPV interface, emergency values, and environmental values, in addition to emerging incentives. To measure the market value, a geographic distribution of the commercial CSPV breakeven turn-key cost (BTC) is developed. Market potential is high when the installed price of the system is approximate to or less than the BTC. The objectives of the state-by-state BTC analysis are to:

- Identify high-value markets for the industry to target.
- Illustrate the value of incentives to consumers and therefore the potential for consumers to participate in policy.
- Tabulate and monitor commercial incentives.

The information is targeted for use by the PV manufacturing industry, federal, state, and local governments, as well as utilities 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 [3].

2.0 APPROACH

The breakeven turnkey cost represents the installed turnkey cost of a PV system that a representative commercial consumer in each state could pay for the system and neither make nor 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 by a commercial loan at 6% for 10 years (buy-downs and grants were subtracted from the financed cost), unless other financing is available as noted in Table 1. The loan's interest is a deductible expense on federal income tax. A 34% tax bracket is assumed.
- Over 150 rate tariffs were analyzed for the largest utilities in each state. The database of rates available in The Policy/ Market Evaluation Tool [4]. This allowed CSPV generating profiles to be accurately priced according to usage tiers, time-of-use periods, demand ratchets and net metering policies. The electricity price is not escalated over time.
- Operation and maintenance costs are included at a rate of 1¢/kWh.
- The discount rate is equal to the loan interest rate.

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, utility bill tax effects) to zero by varying the installed cost. The BTC is calculated on a per kW basis. A representative BTC value was selected for each state including only incentives available statewide. The impact of local and utility specific incentives is presented separately from the state-by-state BTC values.

2.1 Incentives

All BTC calculations included the federal 10% tax credit for commercial CSPV systems as well as the accelerated depreciation allowance, including the extra 30% in the first year of service. A snapshot of state, local and utility-based incentives are presented by state in Table 1 [5]. These incentives continuously change, including multiple changes during the period of time spent on this analysis. The Database of State Incentives for Renewable Energy (DSIRE) [5] should be consulted for current information and details concerning the application of incentives. DSIRE includes Federal, State, local, and utility incentives. Incentive types include:

- Tax credits occur at the end of the first year of service, and are a full value direct reduction of the commercial business tax bill.
- Tax deductions add to the expense deduction of the taxable revenue and therefore have a value equal to the tax rate.
- Net metering, allows full retail value for all energy produced by the CSPV system including any energy the may flow back to the utility distribution grid during low consumer load seasons or times of day. Some net metering is actually net billing in that the utility pays for the excess energy produces by the CSPV at the avoided cost. (i.e. Arizona)
- Sales and Property tax exemptions exempt consumers from sales tax for the system and increases in property values and associated taxes as a result of the CSPV system (does not effect the analysis, because of installed cost basis).
- Buy downs and grants reduce the net cost of the system and occur in the first year of service. These incentives often include maximum limits based on $/kW, % of installed cost and/or maximum dollar amount.
- Production incentives are an annual payment for the energy (kWh) produced by the system. These incentive payments are made for the first 2-10 years of system operation. The Bonneville Environmental Foundation production incentive is a purchase of the "green tag" or environmental value of the energy produced. The Chelan, WA Public Utility District and the Energy Coop in PA are purchases of the energy value of the kWh.

All incentives are available in some geographic region of the US. Incentives available to only a local segment of a state are highlighted and have been analyzed separately.

2.2 Commercial Rate Structures

The values of energy, ¢/kWh, and demand, $/kW-mnth have direct effect on the BTC market value, but more importantly is the rate structure. Many commercial rate structures are disincentives [6] for CSPV and energy efficiency. All types of rate structures were included in the analysis, with the exception of inclining tiered rates (not available). The most common rate structures include:

- Time-of-use (TOU) rates, which vary according to the time of day the consumption occurs. Since high demand and therefore high cost of energy typically occurs during the middle of the day, when CSPV is generating the most, this rate structure can benefit PV. The exception is when the TOU rate is so much lower than the general service rate that the savings resulting from CSPV are also lower than if the consumer were on the general service rate initially.

TABLE 1: STATE-BY-STATE COMMERCIAL PV INCENTIVES

State	Tax Credit,Deduct	Net Meter	Prop. Tax	Sales Tax	Loan	Buy Down, Grant, Production Incentive
AL						$0.15/kWh_10 yrs. (TVA)[a]
AK						
AZ		Y		Y_$5,000		TEP $2/W AC; APS $2/W DC
AR		Y				
CA	15%_$4.50/W	Y	Y			$4.00/W/50% (<=30kW); $4.50/W/50% (>30kW)[b]; $6/W_85%_$2M (LADWP)[c]
CO		Y (u)				$0.25/kWh_4yrs._$4K(Holy Cross)[d]
CT			(L)			$6/W[e]
DE		Y				35%_$250K
FL				Y		$4/W_30%/$50K(JEA)[f]
GA		Y				
HI	35% (carryover)	Y				
ID		Y			4%_5 yrs._$1K-100K	
IL		Y(u)	Y			100%_$1M; 60%_$6/W_$300K;$1.25/W_50kW ComEd
IN		Y				30%/_$30K
IA		Y	Y		50% red._20 yrs.	
KS			Y			Not for profit grant program
KY		Y(u)				
LA						
ME		Y				
MD	15%_$2,000; GB[g]		(L)			
MA	100% tax deduction	Y	(L)			$4-5/W AC; payment over 3 yrs.[h]; Grants - $500K
MI						
MN		Y	Y	Y		$2/W_$8,000[i]
MS					2%<prime_80%/$300K_7yr	
MO						
MT	35% (carryover)	Y	Y[j]		Up to $10K_5 yrs.	$4/W_50kW max.[k]
NE					50% reduction	
NV		Y	Y			
NH		Y	(L)			
NJ		Y		Y		$5.50/W_70%< 10 kW (less for systems>10kW)
NM		Y				
NY	25-100% incremental costs_$3/W		Y		4.5%below mkt./5yrs, $500K[l], 6% on LI	$5/W_$50K_10kW max (LIPA);$4/W (<=10kW), $5/W (>10kW)_70%[l];$5/W_BIPV_$300K
NC	35%_$250K[m]				1%_$250K_10 yrs.	$0.18/kWh proposed for NC Green Power
ND	15% (3% for 5 years)	Y	Y			
OH		Y	Y	Y	50% red[n]	
OK		Y				
OR	35%_$10M[o]	Y	Y		5.5%_15 yrs._$20K - 20M	$600/kW_25kW_$15K (OTEC); $0.10/kWh_10kW_5yrs.(BEF – Green Tags)
PA		Y			Varies_$1M(limited to select utilities)	$4/W_$20K+$1/kWh/1yr._$5K_5kW (PECO); $0.20/kWh_5kW(Energy Coop, combines w/PECO)
RI		Y	Y	Y		$5/W_50%
SC						
SD			Y (50%)			
TN					5%_$100K_7 yrs[p]	$0.15/kWh_10yrs. (TVA)[a]
TX	Deduction[q]	Y	Y			
UT	10%_$50K(carryover)	Y				
VT		Y	(L)	Y		
VA		Y	(L)			
WA		Y		Y		$1.50/kWh (Chelan PUD)[r]; $0.10/kWh_10kW_5yrs.(BEF Green Tags)
WV						
WI		Y	Y			$2/kWh_1st yr. gen_50%_$50K; $1/W[s]
WY		Y				

Table 1 Notes

(L) Local governments are granted authority to offer property tax exemptions
(u) Offered by select utilities, e.g., ComEd territory in IL; LG&E and KU territory in KY
[a] Available from some TVA distribution utilities (500W-50kW), new, no participating utilities yet
[b] <30kW, decreasing $0.20/6 months beginning 7/1/02; $4.50W_50% for self gen program for>30kW
[c] For PV manufactured in LA; $4.50/watt_$1M_75% if manufactured outside LA; State rebates decline over time. Several other municipal utilities incentives.
[d] CORE Sun Power Pioneer Program, for Holy Cross Energy or Aspen Municipal Electric customer; half up front, the rest after 2 years.
[l] New, must be Connecticut Light & Power or United Illuminating customer. 75% payment up front, 25% payment after 1 yr.
[f] Local vendor – highest of $4 per watt or 30%; non-local vendor – highest of $2 per watt or 15% of total installed cost; $50K cap could be waived
[g] For green bldgs; 20% of the incremental cost for BIPV, 25% of incremental cost for non-BIPV; 10-yr. Carryover
[h] 70% after 30 days of successful operation, 30% paid quarterly production at a rate of $0.38/kWh of electrical output
[I] Xcel Energy customers 2003, all MN grid-connected electricity eligible starting 2004
[j] Can't combine with investment tax credit
[k] Grant is subject to advisory committee evaluation.
[l] IOU territory (NYSERDA), BIPV 70% incr. costs, for new bldgs only
[m] Credit in 5 equal installments, cannot exceed 50% of tax liability, carry over allowed for the next 5 succeeding years.
[n] Interest rate buydown is good for 5 years, although loan repayment terms vary by participating bank, for loans $5K-$500K.
[o] Taken over five years: 10% 1st and 2nd yrs., then 5% for each year thereafter; 8 year carryover
[p] For companies with 300 employees or less than $3.5 million in annual gross sales or receipts
[q] 100% from taxable capital or 10% from income
[r] Was 1.50 first year; 1.21 for the 4/1/02 - 3/31/03 period because amount depends on # of green pricing participants.
[s] $1/W available from some municipal utilities.

- Demand and TOU-demand rates are the most common commercial rate. A demand rate bills for kW demand on a monthly basis as well as energy use. A TOU-demand rate has varying kW-mnth charges according to period of time the demand is set.
- Demand ratchets include a kW-month demand charge in the rate set by the highest demand incurred in the last 12 months. In some cases the ratchet sets a minimum percent of the demand charge for the following twelve months or the full demand charge is set as the minimum last highest demand charge. Customers installing PV have to wait out the ratchet period before demand savings can occur
- Declining tiered rates are a holdover from a period when energy was abundant and customers were encouraged to use more energy, but they commonly. The energy charge declines in incremental usage blocks. The CSPV energy savings is valued at the highest usage tier, or the tier with the least value. For instance several rates were analyzed in PA, AZ, and NJ, where all savings were from the lowest price tier. The energy rate at this tier was 7-16 ¢/kWh less than the highest, low usage tier. Alternatively in NC, the usage block on the first tier was set so high that all savings were in the highest price tier.

2.3 Externalities

Four externality values were included in the analysis.

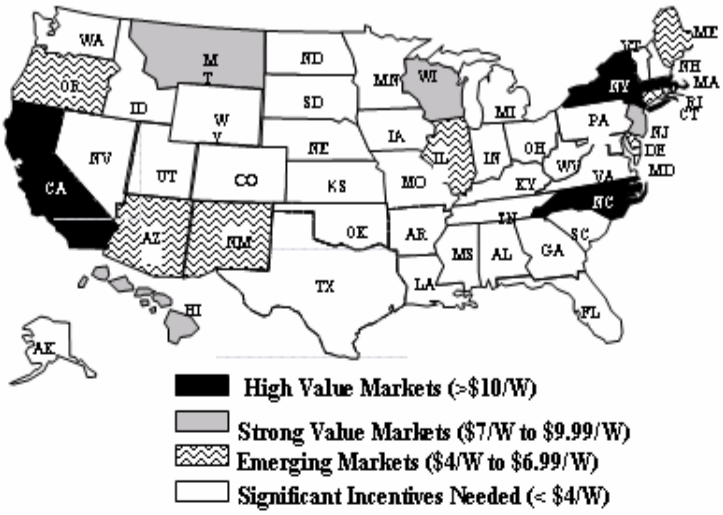
- Building Integrated PV replacement or efficiency value. PV systems may replace building materials such as glazing or stone siding at values of $1.50-$5/W [2]. PV integrated into window awnings and insulating roofing tiles can decrease building energy usage. A conservative value of increasing PV energy savings of 20% was included.
- Emergency Value is [2], $440/kW based on a conservative estimate of building insurance credits.
- Solar load control integration with the building's energy management systems was included at 20% of the PV systems demand savings. Solar load control is typically accomplished by setting back demand on air conditioning loads in response to changes in PV system generation.
- Environmental values were included from the 1999 residential CSPV analysis [7], calculated using the average solar resource converted to kWh produced per kW installed, multiplied times the average state emissions for NOX, SOX, and CO2. This was not included as a value when Green tag purchases were part of the incentive base.

The values included in the BTC are all tangible values, with the one exception of environmental. Commercial businesses also realize benefits such as PR from environmental stewardship and a degree of energy independence. Additionally, the assumptions included in the externalities were extremely conservative especially for the BIPV and SLC values.

3.0 RESULTS

The map in Figure 1 shows the geographic distribution of BTC values for the US. With installed commercial system prices across the US ranging from $7 to $12/kW, there are four states in the high value market (NY, MA, CA, and NC), four states with strong market value (NJ, WI, HI, and MT) and

Fig. 1 State BTC Map



eight additional states (IL, ME, AZ, RI, DE, NM, OR, and CT) with near term market potential.

value in the state, but rather a selected representative value.

In the top ranking states, the largest market driver is policy, and typically an array of policies (multiple federal and state incentives). The exception is Maine, for which the market driver is the result of high energy costs.

Figure 3 shows the market value contributions of local incentives. The local incentives are highlighted in Table 1. This is only a sample of local incentives. Many municipal utilities in California offer buy downs.
Many of the local incentives are production incentives, which add substantially to the market value. These incentives range from 0.15 to 1.50 $/kWh spread out over a number of years.

4.0 CONCLUSIONS

The market values have increased substantially since 1999. Only three states, CA, HI, and NY had BTC values above $5/W in 1999. The 2003 snapshot results with 12 states above this threshold and the emergence of local and utility specific policies adding five

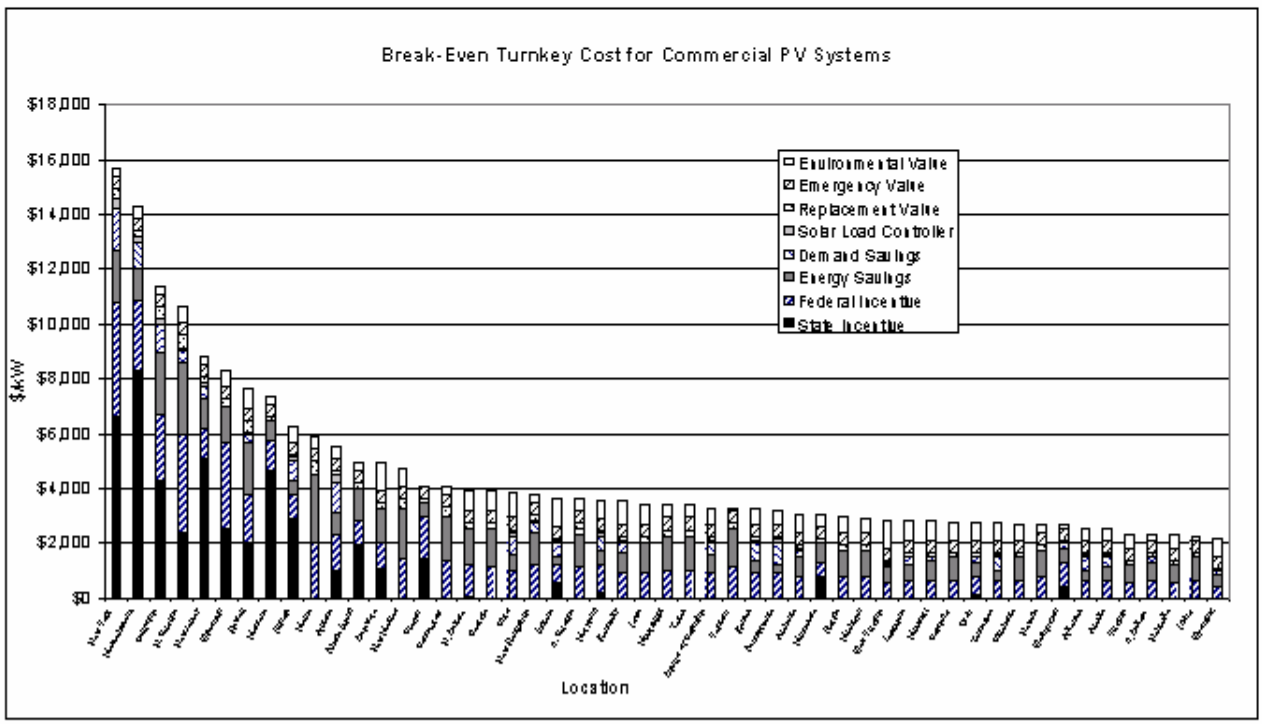
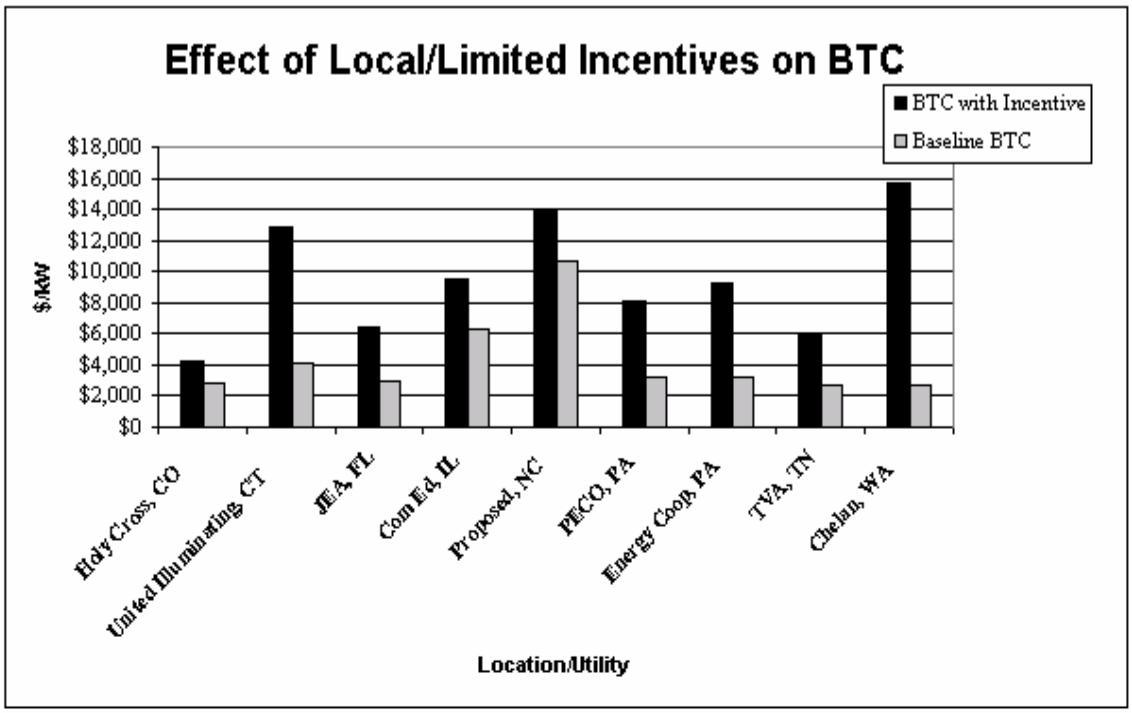


Fig 2: 50 States plus District of Columbia BTC

The relative value components of the BTC's for the fifty states and the District of Columbia are presented in Figure 2. The values graphed are neither the highest nor the lowest

local area BTC's above the $5 per watt level. Most of these markets are a result of an array of incentives. Commercial rates in the US are not favorable to CSPV values with only a few exceptions



Policy is the main market driver, seconded by rates. The next largest market driver will be building integration or Fig. 3 Impact of Local Incentives

BIPV values including material replacement, efficiency gains, solar load control, and emergency or critical power values. The market effect is not fully evaluated here due to conservative assumptions. The Internet based tool used for the analysis, The NREL Policy and Market Evaluation Tool [4], now includes BIPV values, such as SLC and efficiency in addition to the rate database and ability to evaluate incentives.

5.0 ACKNOWLEDGEMENTS

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