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

Christy Herig
Subcontractor
National Renewable Energy Lab
1617 Cole Blvd.
Golden, CO, 80401
christy_herig@nrel.gov

Susan Gouchoe
North Carolina Solar Center
Campus Box 7401
NC State University
Raleigh, NC 27695-7401
susan_gouchoe@ncsu.edu

Richard Perez
ASRC, The University at Albany
251 Fuller Rd
Albany, NY 12203
perez@asrc.cestm.albany.edu

Tom Hoff
Clean Power Research
10 Glen Ct
Napa, CA 94558
tomhoff@clean-power.com

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 previous publications [1,2], the authors investigated the geographical distribution of the economic feasibility of customer-owned commercial photovoltaic (PV) systems in the U. S. 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 PV 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 the 50 states plus the District of Columbia, 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.

1.0 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 governments have implemented new policies;, 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. U.S. 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 state and utility incentives. To measure the market value, a geographic distribution of the commercial CSPV breakeven turn-key cost (BTC) is provided in the U.S. map in Figure 1. Market potential is high when the installed price of the system is approximate to or less than the BTC. With installed commercial system prices across the U.S. ranging from $7 to $12/W, 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 eight additional states (IL, ME, AZ, RI, DE, NM, OR, and CT) with near term market potential. The objectives of the state-by-state BTC analysis are as follows:

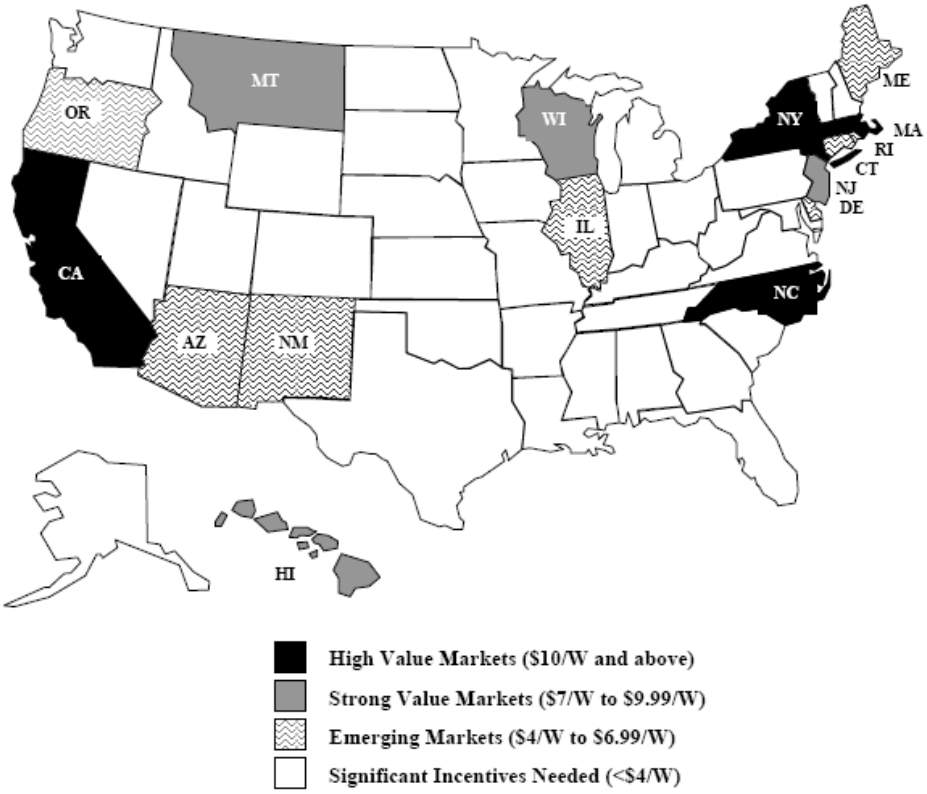


Figure 1: State-by-State BTC Map

- 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, by federal, state, and local governments, and by utilities considering renewable energy policy. The information is not appropriate for use by consumers making investment decisions. States and manufacturers have developed software, such as the Clean Power Estimator [3], specifically for consumer investment decisions.

2.0 APPROACH

The breakeven turn-key cost represents the installed turn-key cost of a PV system that a representative commercial consumer in a 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.
- More than 150 rate tariffs were analyzed for the largest utilities in each state. The database of rates is available in the Policy/ Market Evaluation Tool [4], which also has monthly average load profiles. This database allowed CSPV monthly average generating profiles to be accurately priced according to usage tiers, time-of-use periods, demand, demand ratchets and net metering policies. The electricity price is not escalated over time.
- Operation and maintenance (O&M) 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, O&M, and 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 typically including only incentives available to a vast majority of the state's commercial customers. 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

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
MI						
MN		Y	Y	Y		$2/W_$8,000[i]
MS					2%<prime_80%/$300 K_7 yrs.	
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.
[e] Must be Connecticut Light & Power or United Illuminating customer. 75% payment up front, 25% payment after 1 yr. Grant awardees already selected; continuation of this incentive is uncertain.
[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] Clustered, 70% after 30 days of successful operation, 30% paid quarterly production at a rate of $0.38/kWh of electrical output; Also open grants up to $350K
[i] Xcel Energy customers 2003; all MN 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 buy down 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.

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 continually 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. Various incentive types are included:

- 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, they 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 because the utility pays for the excess energy produced by the CSPV at the avoided cost.
- 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 (This does not affect the analysis, because of the 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 U.S. Incentives available to only a local or limited segment of a state are highlighted in Table 1 and have been analyzed separately.

2.2 Commercial Rate Structures

The values of energy (¢/kWh) and demand ($/kW-month) have a direct effect on the BTC market value, but more important 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.

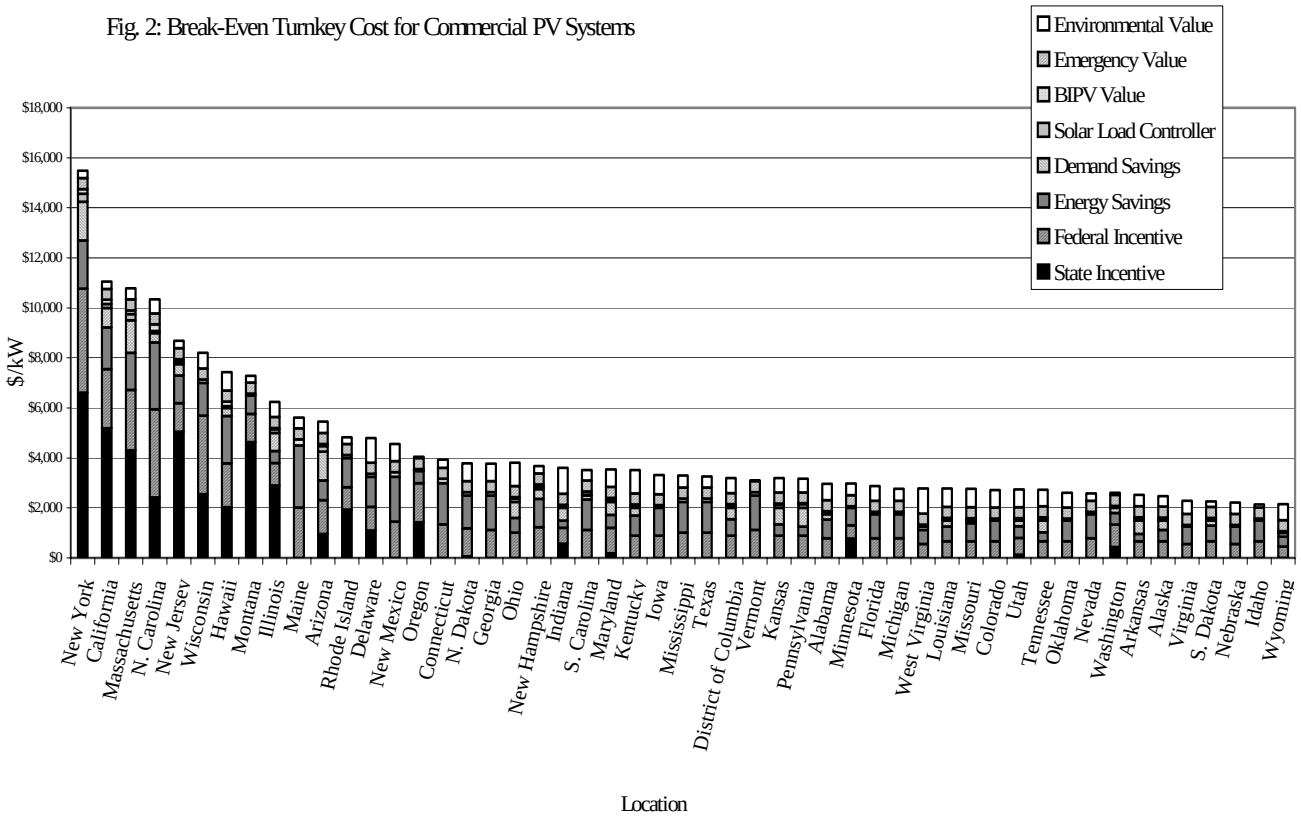
- Demand and TOU-demand rates are the most common commercial rate. A demand rate bills for kW demand on a monthly basis as well as for energy use. A TOU-demand rate has varying kW-month charges according to the period of time the demand is set.
- Demand ratchets include a kW-month demand charge in the 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 12 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 era when energy was abundant and customers were encouraged to use more energy, but still commonly exist in many states. 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.

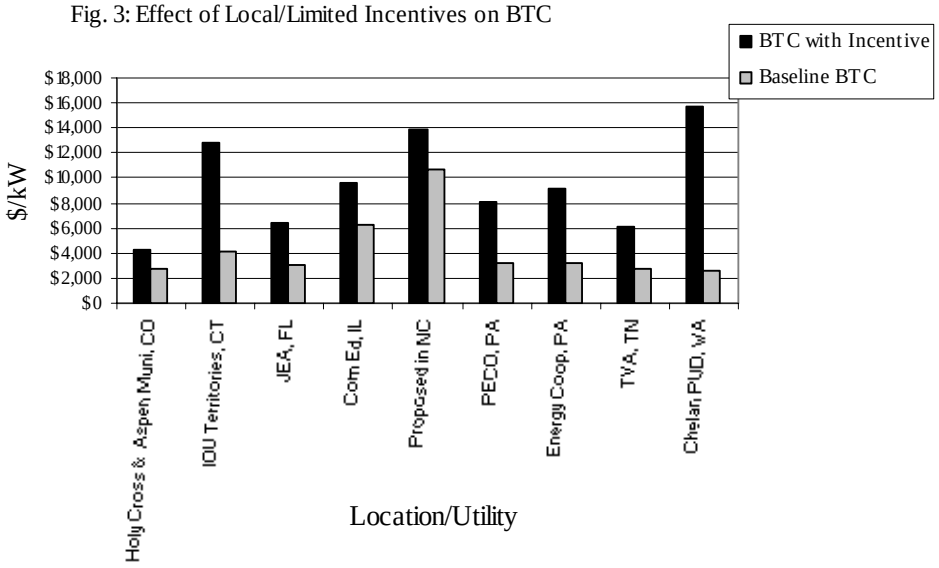
- Environmental values were included from the 1999 residential CSPV analysis [7], calculated by using the average solar resource converted to kWh produced per kW installed, multiplied by the average state emissions for NO_X, SO_X, and CO_2. This was not included as a value when green tag purchases were part of the incentive base.
- Emergency value [2] is, $440/kW based on a conservative estimate of building insurance credits.
- Solar load control (SLC) integration with the building's energy management systems was included at 20% of the PV systems demand savings. SLC is typically accomplished by setting back demand on air conditioning loads in response to changes in PV system generation.
- Building-integrated PV (BIPV) value could be replacement of building materials and or efficiency gains. Material replacement such as glazing or stone siding have values of $1.50-$5/W, but typically result in a change in orientation and therefore generating profile [2]. PV integrated into window awnings and insulating roofing tiles can decrease building energy usage. For ease of calculation and a conservative approach, the BIPV value was included as an efficiency gain of 10% of the PV system energy savings

Fig. 2: Break-Even Turnkey Cost for Commercial PV Systems



The values included in the BTC are all tangible values, with the one exception of environmental. Commercial businesses also realize benefits such as good public relations 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.

Fig. 3: Effect of Local/Limited Incentives on BTC



3.0 RESULTS

Figure 2 presents the relative value components of the BTC's for the fifty states and the District of Columbia. The values plotted in each state are neither the highest nor the lowest values, but rather, are selected representative values. In the top-ranking states, the largest market driver is policy, which typically consists of an array of policies (multiple federal and state incentives). The exception is Maine, where the market driver is the result of high energy costs. The BTC value in NC is the result of the 1% ten-year loan and resulting discount factor.

Figure 3 shows the market value contributions of local incentives. The local incentives are highlighted in Table 1, which provides 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 shows 11 states above this threshold and the emergence of local and utility-specific policies adding five 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 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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