Energy and Capacity Valuation of Photovoltaic Power Generation in New York

Prepared by Richard Perez & Thomas E. Hoff, Clean Power Research

for the Solar Alliance and the New York Solar Energy Industry Association

March, 2008.

Executive Summary

This initial investigation in the value of photovoltaic (PV) power generation for New York focuses on the value to utilities. Specifically, the report asks whether PV net-metering constitutes a loss to the utilities which would negatively affect their rate payers.

The value of customer-sited PV generation to a utility includes generation-level energy and capacity, as well as environmental compliance benefits, fuel price hedge protection, and location specific-transmission and distribution (T&D) and loss savings benefits.

Results show that, because of the strong coincidence that exists between peak demand and solar resource availability both downstate and upstate, the generation energy and capacity value of PV alone amount to 75% of the revenue loss utilities would incur from their net-metered customers. It is very likely that the other value elements: environmental compliance, fuel price risk mitigation, and localized T&D/loss savings, which will be quantified in detail in a subsequent study, will bridge the remaining 25% gap[1], making distributed PV a net benefit to New York utilities, and by extension to their rate payers.

Introduction

What is the value of distributed photovoltaics (PV)? The answer is driven by the perspective of the one who is asking the question [2, 4, 5]. Table 1 conceptually illustrates how to incorporate perspective for a program that is designed to incentivize

[1] a modest carbon fee of $40 per metric ton alone would bridge much of this gap

individual owners to invest in PV. The table suggests that there are really three questions, not just one question.

1. Individual customers (i.e., potential system owners) want to know if there is sufficient economic incentive to invest; this occurs when incentives plus utility bill savings plus tax effects exceed PV system cost

2. Utilities want to know if the cost savings associated with the addition of PV to the utility grid offset the reduced revenue from lower utility bill sales

3. Constituents (ratepayers and taxpayers) want to know if the benefits to them exceed the cost of the direct incentive program and tax effects

Table 1
Effect of Perspective on Question: What is the Value of PV?

	System Owners	**Utility**	**Constituents**
Equipment	cost		
Incentives	benefit		cost
Utility Bill	benefit	cost	
Tax Effects	benefit		cost
Utility Cost Savings		benefit	
Constituent Benefits			benefit
Net Benefit	**???**	**???**	**???**

Objective

As an initial step towards a comprehensive New York State PV valuation study, the objective of this project is to assemble and contextualize the key underlying facts central to the utility's perspective. Some of the key benefits to the utility include energy production value, generation capacity value, transmission and distribution (T&D) system capacity deferral value, loss savings, environmental value, and fuel price hedge protection [3]. This initial work will focus on the energy production value and the generation capacity value.

Subsequent phases of this work should address the comprehensive value to all parties involved. In particular, the following benefits to the utility need to be evaluated:

- T&D capacity deferral value
- Loss savings

- Environmental compliance value
- Fuel price hedge protection

In addition, the benefits to ratepayers need to be addressed, including:

- Long-term, system-wide rate protection [1]
- Environmental health benefits [1]
- Business development opportunities (job and business creation) [1]
- Use of in-state resource and reduction of state imports
- Power grid security enhancement
- Disaster recovery [3]

While this study focuses on the generation energy and capacity value to the utility, a preliminary discussion of the value of the other benefits to the utility and ratepayers is provided in the Appendix 2.

Value to Utility

Energy Value

The value of PV-generated energy was quantified at the wholesale level using the location-based-marginal energy generation pricing administered by NYISO for the year 2007 for three selected regions in the state of New York: Western, Capital and Long Island (see Figure 1) while considering three PV geometry configurations: South-facing tilted (30^o slope), southwest-facing tilted (30^o slope), and horizontal.

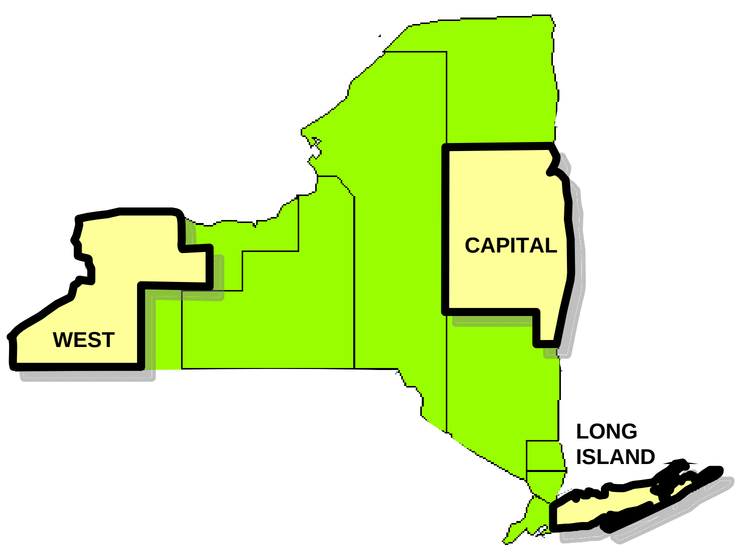

Figure 1: Selected NYISO Electrical regions

The regions were selected to represent the electrical and climatic landscape of New York State, from the Long Island load pocket (most expensive wholesale energy) to the western frontier (typically the least expensive rates), with the capital region at a crossroads.

The PV configurations were selected to represent optimal energy gain (south-facing tilt), optimal summer peak time match (southwest-facing tilt) and least-cost commercial applications (horizontal).

<u>PV Energy Yield</u>: Table 2 summarizes the energy production of all selected PV configurations in each region in 2007.

TABLE 2

PV Output in kWh Normalized to one $kWac_{ptc}$[2] Systems

	PV Geometry		
Location	South 30° Tilt	Southest 30° Tilt	Horizontal
Long Island	1,652	1,560	1,415
Capital	1,593	1,497	1,360
West	1,457	1,388	1,288

Overall the energy yield in Long Island was roughly 15% higher than in the west and 6% higher than in the Capital region. South-facing tilted installations produce 10-13% more energy than a horizontal installations, while a southwest orientation still results in a 6-9% gain over the horizontal.

<u>Wholesale Energy Value</u>: Table 3 compares the wholesale value of PV energy when sold at the location-based marginal pricing (LBMP) and compares this value to the average LBMP traded in each considered region. The table includes both year-around and summer (June to September) values.

TABLE 3

LBMP Value of PV Energy vs. Average LBMP pricing ($/MWh)

ALL YEAR	PV Geometry			AVERAGE PRICE
Location	South 30° Tilt	Southest 30° Tilt	Horizontal	
Long Island	$ 106	$ 109	$ 107	$ 93
Capital	$ 78	$ 78	$ 78	$ 73
West	$ 61	$ 62	$ 61	$ 55
SUMMER	PV Geometry			AVERAGE PRICE
Location	South 30° Tilt	Southest 30° Tilt	Horizontal	
Long Island	$ 117	$ 123	$ 115	$ 91
Capital	$ 80	$ 81	$ 79	$ 69
West	$ 72	$ 73	$ 71	$ 60

[2] AC output at PTC conditions: 20 degrees C ambient and 1000 Watts per m^2 solar irradiance. The AC-PTC rating is typically 70%-80% of the dc system rating at standard test conditions (stc).

On a year-around basis, the PV MWh are worth more than the average traded price -- 7%, 11% and 15%, respectively for the Capital, West and Long Island regions. In summer the solar premium is higher, respectively 16%, 20% and 30% for the three regions. The southwest orientation yields a slightly higher per MWh premium, reaching 35% in summer for Long Island -- $123/Mwh against a $91/Mwh average traded price.

<u>Congestion Pricing</u>: In addition to the LBMP, the NYISO congestion pricing data reflect the value of producing the energy locally over importing it in the considered region. Congestion pricing data are summarized in Table 4. Congestion pricing represents the penalty imposed on out-of-zone generators (i.e., not imposed on PV that produces energy locally). Data show congestion pricing is a significant issue in the Long Island load pocket. There, the local congestion premium garnered by PV is considerably higher than the mean local congestion premium, exceeding 100% for southwest-oriented systems in summer.

TABLE 4
Avoided Congestion Pricing from Local PV Generation ($/MWh)

ALL YEAR	PV Geometry			AVERAGE PRICE
Location	South 30^o Tilt	Southest 30^o Tilt	Horizontal	
Long Island	$ (32)	$ (34)	$ (32)	$ (24)
Capital	$ (7)	$ (7)	$ (7)	$ (8)
West	$ (2)	$ (2)	$ (2)	$ (2)
SUMMER	PV Geometry			AVERAGE PRICE
Location	South 30^o Tilt	Southest 30^o Tilt	Horizontal	
Long Island	$ (35)	$ (39)	$ (34)	$ (19)
Capital	$ (1)	$ (2)	$ (1)	$ (1)
West	$ -	$ -	$ -	$ -

Capacity Value

<u>Quantifying Capacity Credit</u>: We used two metrics that were recently recommended by a panel of utility, solar industry and government professionals [7]. The two metrics are the Effective Load Carrying Capability (ELCC) and the Solar Load Control Capacity (SLC). Both metrics are described in detail in Appendix 1. The ELCC represents the increase in capacity available on a local grid and that is attributable to the added PV generation without increasing the grid's loss of load risk. The SLC reflects the synergy that exists between load control (e.g., demand response) and PV generation. The metric is an answer to the question: Given a certain amount of Demand Response (DR) available to a utility, how much more guaranteed load reduction is possible when PV is deployed?

Table 5 reports the ELCC and SLC of PV for grid penetration ranging from 2% to 20% as derived from the analysis of 2007 PV generation and load data. The table also reports the amount of demand response in MWh needed to achieve 100% PV capacity credit and the amount of DR that would have been necessary to achieve the same objective without PV. Capacity credit results are further summarized in Figure 2 for the southwest facing orientation, using a composite of the two metrics.

TABLE 5
PV Capacity Credit (%) as quantified by the ELCC and SLC Metrics
and DR (MWh) required to firmly displace peak with, and without PV

	PV PENETRATION	2%	5%	10%	15%	20%
Capital	ELCC South 30	71%	62%	59%	41%	31%
Capital	ELCC Southwest 30	84%	79%	70%	50%	39%
Capital	ELCC Horizontal	67%	60%	57%	42%	32%
Long Island	ELCC South 30	53%	53%	53%	43%	32%
Long Island	ELCC Southwest 30	70%	70%	70%	48%	38%
Long Island	ELCC Horizontal	51%	51%	51%	44%	33%
West	ELCC South 30	87%	81%	74%	59%	44%
West	ELCC Southwest 30	90%	90%	74%	59%	44%
West	ELCC Horizontal	81%	75%	73%	59%	44%
Capital	SLC South 30	75%	65%	56%	44%	40%
Capital	SLC Southwest 30	85%	82%	65%	57%	45%
Capital	SLC Horizontal	70%	63%	60%	45%	41%
Long Island	SLC South 30	55%	53%	52%	48%	46%
Long Island	SLC Southwest 30	72%	71%	60%	55%	53%
Long Island	SLC Horizontal	55%	54%	53%	49%	45%
West	SLC South 30	87%	85%	74%	55%	33%
West	SLC Southwest 30	88%	88%	75%	57%	34%
West	SLC Horizontal	83%	82%	69%	52%	32%
Capital	MWh DR South 30	26	86	573	2,508	9,035
Capital	MWh DR Southwest 30	12	42	355	1,510	7,081
Capital	MWh DR Horizontal	29	100	585	2,376	8,839
Long Island	MWh DR South 30	63	246	1,028	2,711	7,330
Long Island	MWh DR Southwest 30	32	120	645	1,705	4,639
Long Island	MWh DR Horizontal	70	258	1,058	2,713	7,065
West	MWh DR South 30	15	51	476	4,931	32,095
West	MWh DR Southwest 30	10	39	459	4,755	31,906
West	MWh DR Horizontal	28	90	646	5,233	32,330
Capital	MWh DR No PV	117	828	5,566	18,949	44,901
Long Island	MWh DR No PV	198	1,100	6,602	22,264	51,941
West	MWh DR No PV	278	2,481	13,684	40,590	109,465

Results in Table 5 and Figure 2 show that the capacity credit of PV in the State of New York is high. The capacity credit decreases with penetration[3], but remains significantly higher than the resource's capacity factor at high penetration (note that 20% penetration represents well over 6,000 MW of PV in New York). The amount of demand response necessary to guaranty firm peak reduction with PV is a small fraction of the amount that would be necessary to achieve the same without PV – e.g., for Long Island at 10% penetration the DR requirement with southwest facing PV would be 645 MWh; achieving the same objective without PV would require 10 times more DR.

Interestingly the capacity credit extracted from the 2007 load and PV output data is found to be higher for the upstate regions than downstate, at least a low penetration. At high

[3] The reason for this decrease is that, as PV penetration exceeds the size required to shave the highest demand peaks which are highly correlated with the solar resource, PV must meet secondary peaks and non peak loads which are less correlated with solar gain.

penetration Long Island retains a higher capacity credit. This upstate trend is consistent with a previous observation by the authors that compared the evolution of effective capacity nationwide from the late 1980's to the early 2000's [8]. A general increase in PV capacity for northern utilities had been noted possibly traceable to increased cooling demand from higher technology use, as well as a gradual winter and summer temperature increase likely linked to intensifying global warming. The West and Capital regions are solidly summer peaking with 2007 summer to winter peak ratios of 1.15 and 1.20 respectively. The Long Island region is highly summer peaking with a 2007 summer-winter ratio of 1.50 -- explaining the greater resilience of capacity credit at high penetration (see note 2 above).

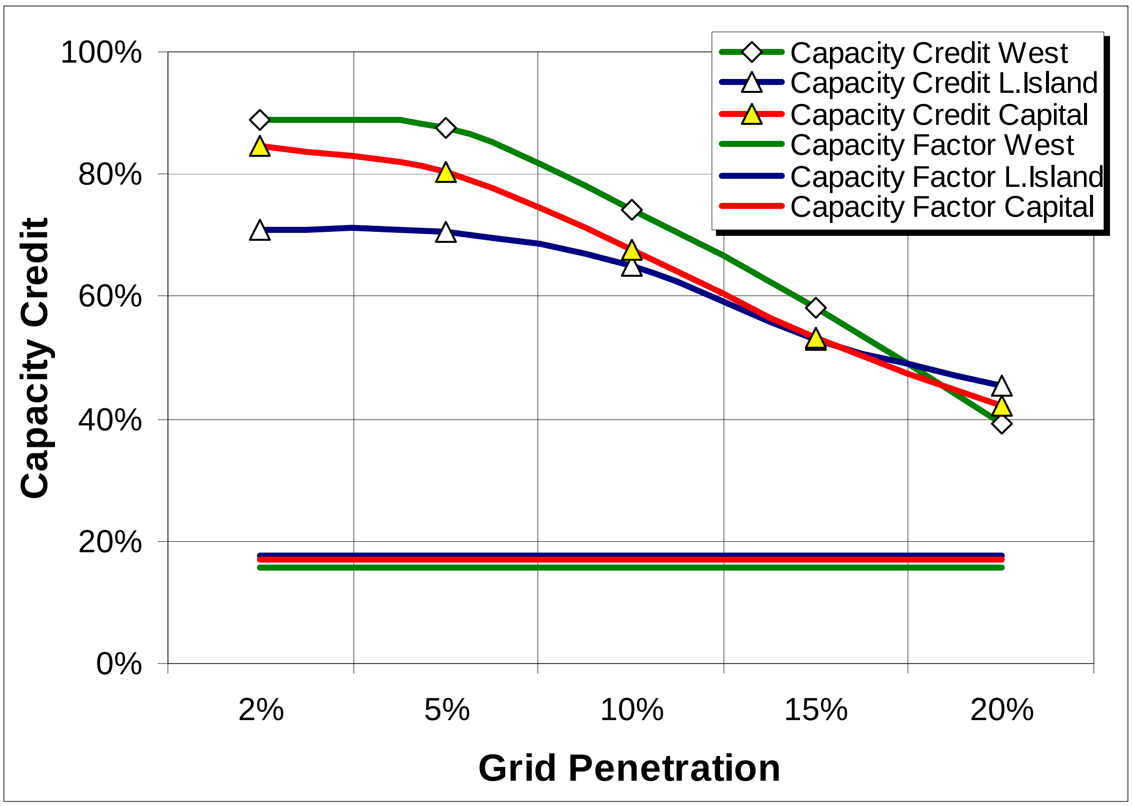

Figure 2: Composite capacity Credit[4] for the southwest-facing tilted PV configuration, compared to the resource's capacity factor[5]

The main reasons for the upstate downstate difference, however, are the demand load shapes and peak-day solar conditions. Figures 3, 4 and 5 display the solar resource for all PV configurations and load shape on peak day for the West, Capital and Long Island regions respectively. The figures also show the load impact of a 10% PV penetration for southwest facing installations. The upstate peaks occur earlier in the day and have less of an evening shoulder (i.e., more commercial cooling relative to residential cooling). Also,

[4] The composite capacity credit is the mean of the ELCC and SLC metrics
[5] The capacity factor is the mean output divided by the rated capacity

while the solar resource was significant during the downstate peak day (August 8), it was ideal during the upstate peak day (August 2).

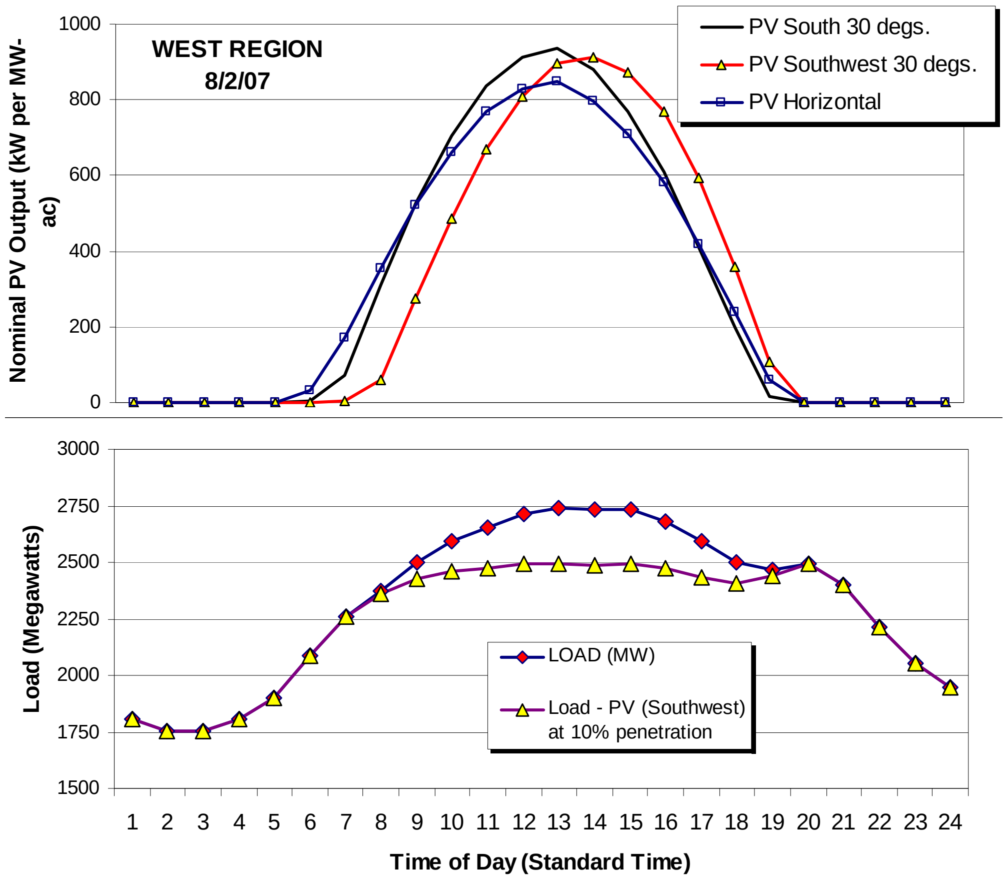

Figure 3: Peak day PV resource and load in the West region

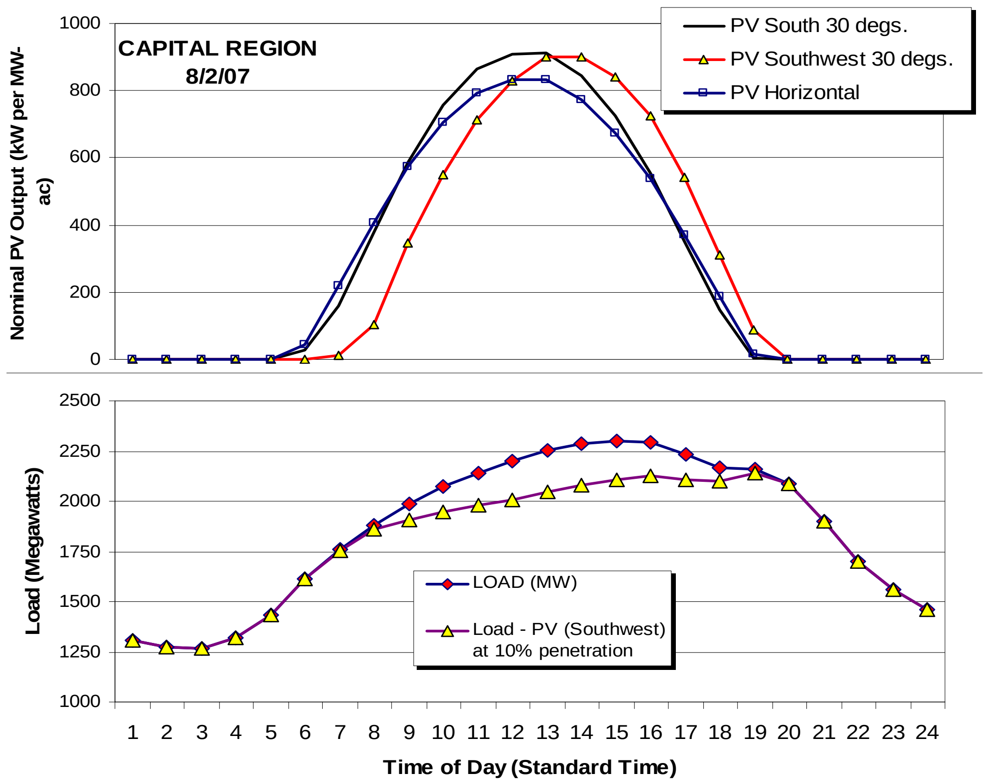

Figure 3: Peak day PV resource and load in the Capital region

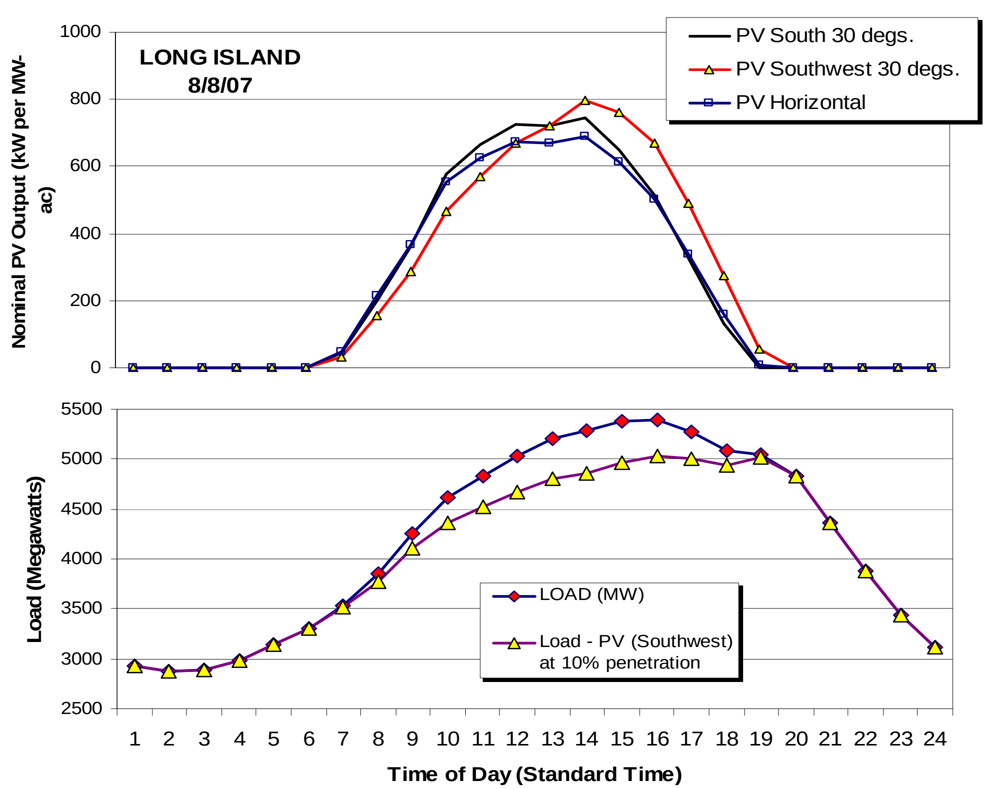

Figure 4: Peak day PV resource and load in the Long Island region

Capacity value: While capacity is not a directly traded commodity, its value is quantifiable trough DR programs, that, in effect provide up to $100 per kW per year for stand-by capacity [e.g., 6] that may, or may not be called upon. Another gauge of capacity is demand-based tarrification offered to large utility customers that is valued at $180/kW per year upstate (National Grid) and as high as $250/kW per year downstate (ConEdison).

In the case of DR, it as been demonstrated that the addition of PV on the grid firmly diminishes the need for DR and saves money to the DR program administrator, commensurately with the capacity credit of the solar resource -- a windfall that PV does not currently capture. The 2007 data analyzed in this study and presented in Table 5 fully confirm this assertion.

Taking the smaller DR number of $100/kW as a gauge of regional capacity value downstate, the 70% capacity credit of PV would be worth an additional $45 for each PV-generated MWh – a value the wholesale level that is not currently captured by PV but directly benefits the utilities.

Conclusion

The sum of the wholesale energy and capacity value of PV equals $0.109/kWh energy + $0.045/kWh capacity = $0.154/kWh in the Long Island region. The net metered-residential customer retail rates in that region currently equals about $0.20/kWh. As a result, these two values alone amount to over three-quarters of the net metered-residential customer retail rates in that region. The addition of loss savings, T&D system benefits, environmental compliance value, and fuel risk mitigation benefits unique to PV will result in additional cost-savings to the utility and thus increase the value from the utility's perspective.

Thus, the answer to the question, "What is the value of PV," from the utility perspective is likely to be that **New York's utilities will have a net benefit from the net-metered deployment of PV in their service territories.**

Next Steps

The next steps in addressing the comprehensive value of PV include (1) calculating the other benefits to the utility, (2) evaluating the economics from the system owner's perspective, and (3) calculating the benefits to all the ratepayers.

References

1. Hoff, T. E. and R. M. Margolis (2003) "Distributed Photovoltaics in New Jersey", Prepared Under NREL Contract AAD-2-31904-03, October 2003. http://www.clean-power.com/research/distributedgeneration/DistributedPVInNewJersey.pdf.

2. Hoff, T. E. and R. M. Margolis (2005) "Moving Towards a More Comprehensive Framework to Evaluate Distributed Photovoltaics", Prepared Under NREL Contract AAD-2-31904-03, June 6, 2005. http://www.clean-power.com/research/customerPV/EvaluationFramework.pdf.

3. Hoff, T. E, et. al. (2006). The Value of Distributed Photovoltaics to Austin Energy and the City of Austin. SOLICITATION NUMBER: SL04300013.March 17, 2006. http://www.austinenergy.com/About%20Us/Newsroom/Reports/PV-ValueReport.pdf

4. Hoff, T. E., (2006) "How to Incorporate Perspective When Performing a Solar Value Analysis", SolarPower 2006. http://www.clean-power.com/research/customerPV/IncorporatingPerspectiveInValueAnalysis.pdf

5. PV Value Clearinghouse. http://www.nrel.gov/analysis/pvclearinghouse.

6. Brown, S. R., (2007): DR, DG and Storage. Comments To NYISO Symposium. The Future Is Now: Energy Efficiency, Demand Response and Advanced Metering. June 27, 2007.

7. Perez, R., M. Taylor, T. Hoff, and J. P. Ross, (2008): Moving Toward Consensus on a Photovoltaic Generation Capacity Valuation Methodology. USDOE Technical Report on Contract DE-FC36-07GO17036

8. Perez, R., R. Margolis, M. Kmiecik, M. Schwab and M. Perez, (2006): Update: Effective Load Carrying Capability of Photovoltaics in the United States. Proc. ASES Annual Conference, Denver, CO

APPENDIX 1 -- EFFECTIVE CAPACITY METRICS

Effective Load Carrying Capability (ELCC)

The ELCC metric was introduced by Garver in 1966[6] and has been used mainly by "island" utilities before the strengthening of continental/regional interconnectivity. The method was applied at Pacific Gas and Electric Company[7]. The ELCC of a power plant represents its ability to increase the total generation capacity of a local grid (e.g., a contiguous utility's service territory) without increasing its loss of load probability. The ELCC is determined by calculating the loss of load probability (LOLP) for two resources. The first resource is the actual resource with its time-varying output. The second resource is an "equivalent" resource with a constant output. The ELCC may be graphically visualized on a load duration curve plot. The example presented in figure 1 -- using load data from Rochester Gas and Electric and a PV penetration X/L = 20% (see case studies below) -- shows the utility load duration curve with and without PV, and also shows the load duration curve obtained with a constant output generator with an ELCC capacity calculated at 145 MW for this case study (see quantitative case studies below).

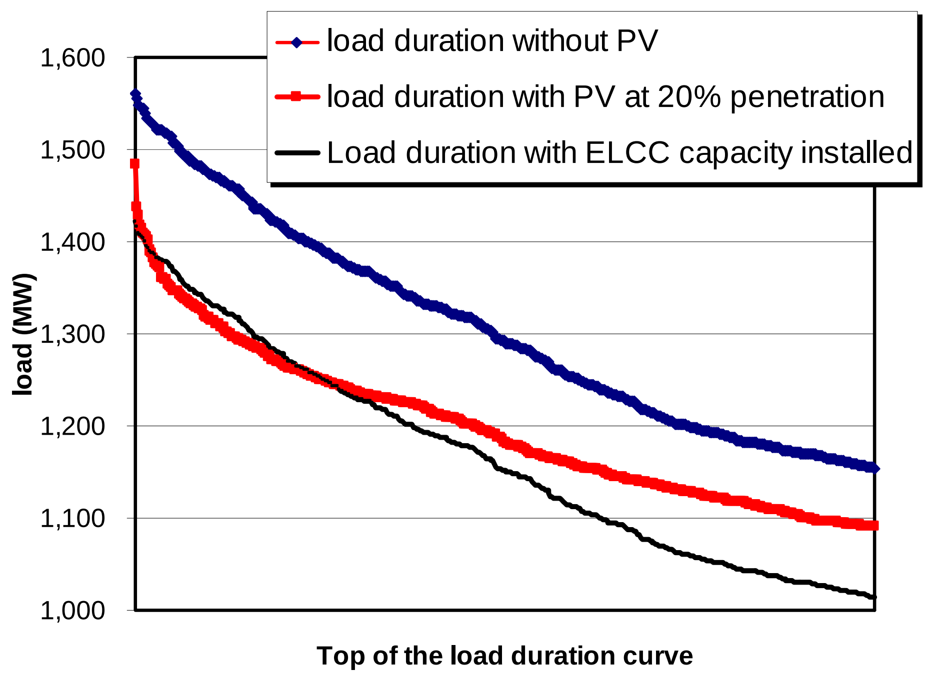

Figure 1. Comparing Load duration curves with and without PV to equivalent load duration curve assuming a constant output generator with an ELCC capacity. The above example is given for Rochester Gas and Electric (peak load = 1561 MW) and a PV penetration of 20% (312 MW). The ELCC calculated for this case figure is 47% (146 MW).

---

[6] Garver, L. L., (1966): Effective Load carrying Capability of Generating Units. IEEE Transactions, Power Apparatus and Systems. Vol. Pas-85, no. 8

[7] T. Hoff, "Calculating Photovoltaics' Value: A Utility Perspective," IEEE Transactions on Energy Conversion 3: 491-495 (September 1988).

It has also been shown that ELCC could be estimated from simple proxy measurements of local characteristics, such as a utility's summer-to-winter peak load ratio (see Fig. 2).

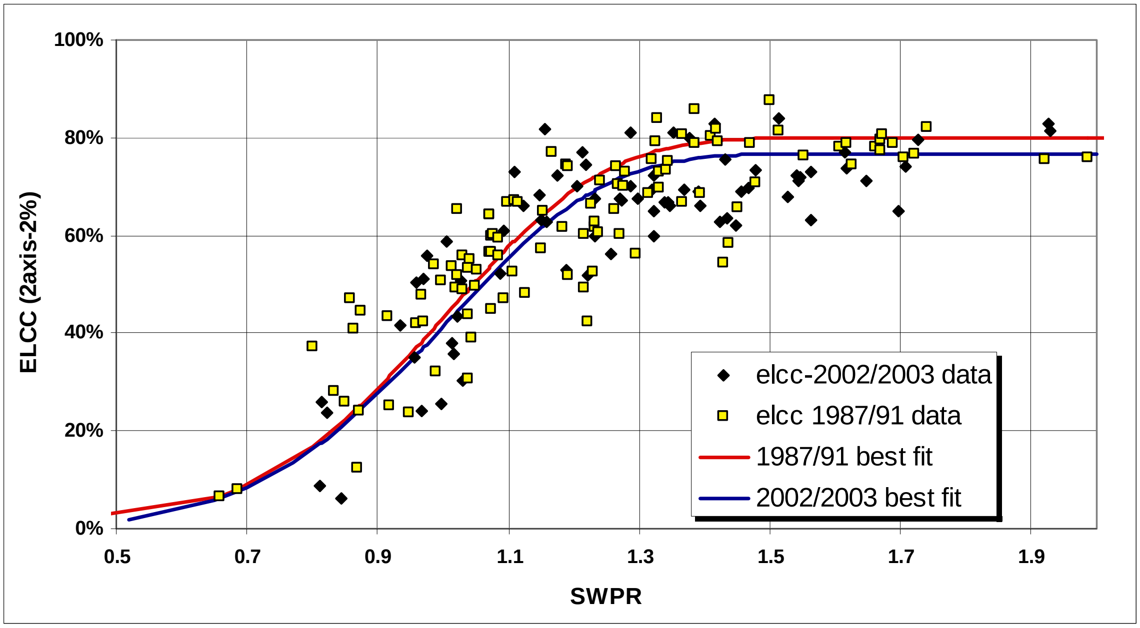

Figure 2. Relationship between ELCC and a utility's (or substation's) summer-to-winter peak load ratio.

Solar-Load-Control-based Capacity (SLC)

This metric answers the question: Given a certain amount of demand response available to a utility, how much more guaranteed load reduction is possible if PV is deployed?

It is illustrated in Figure 5.

Given a penetration p = X / L, the effective capacity is given by

$$SLC = (X - Y) / X \quad (6)$$

Where Y is the amount of load reduction achieved in the absence of PV with the same cumulative amount load control needed to guaranty a load reduction equal to X with PV

As above, this metric accounts directly for grid penetration.

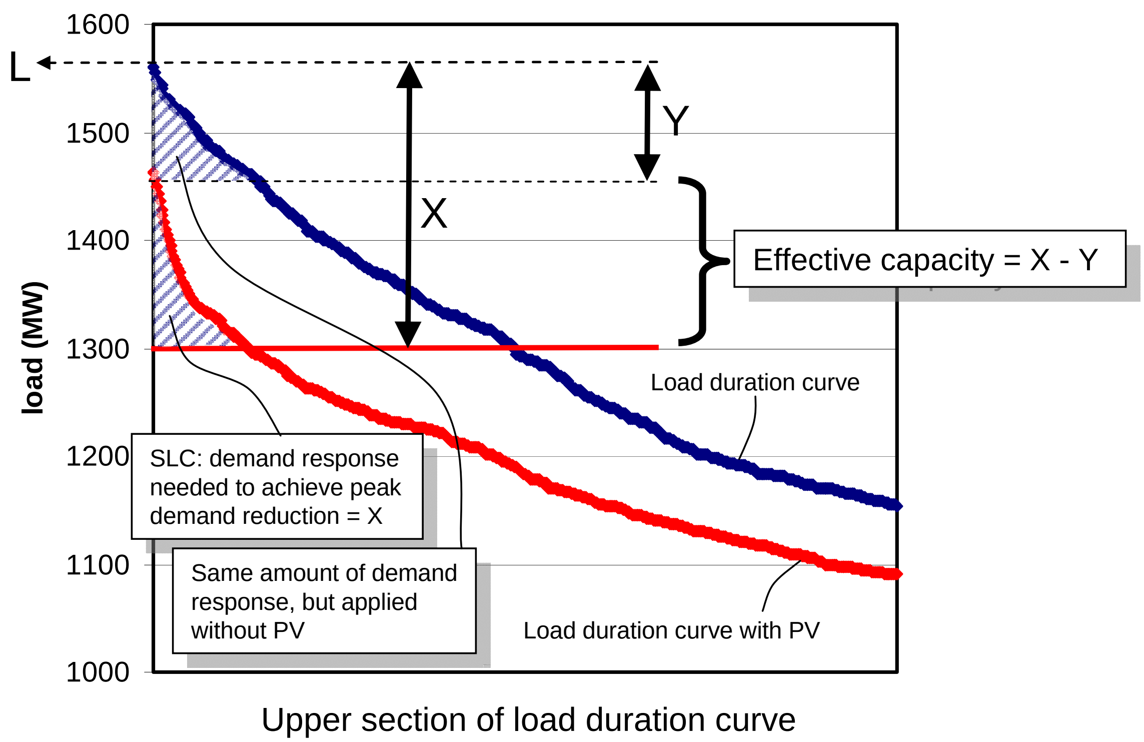

Figure 3. The same amount of demand response load management can be added to mitigate peak load with or without PV present, resulting respectively in load reduction to the Y' and X threshold lines. The effective capacity of PV is measured by its ability to reduce peak loading from the blue to the red threshold. The above illustration is for Rochester gas and Electric with a 260 MW installed PV capacity (SW facing).

APPENDIX 2 -- preliminary discussion of other utility/ratepayer PV values

Prepared by Fred Zalcman, SunEdison

There are many other ways that solar PV can hold utility costs in check:

- *Avoiding the purchase of electricity during system peaks.* Increased deployment of PV and other customer-sited generation can be a powerful tool to mitigate price spikes experienced during peak demand periods. In today's competitive electricity marketplace, where the market clearing price paid to all generators is set by the most expensive plant needed to run in order to satisfy consumer demand, increased deployment of PV can help utilities avoid costly purchases during peak hours. A recent study found that about 1 GW of solar PV deployed across New England would save ratepayers there from $130 to $280 million in power costs.

- *Fuel price hedge protection.* New York currently derives well over half of its electric generation from natural gas, coal and other fossil-fired generation. Because PV is a renewable resource that requires no purchased fuel to operate, they are not subject to the considerable volatility and risk of future price increases commonly associated with more conventional generation. These cost increases are passed through to all consumers through the utility fuel adjustment clause that appears on the monthly electric bill. By "locking in" a percentage of its electric supply from customer-sited renewable resources, New York can insulate itself against the very real risks of a future run-up in the price of primary fuels.

- *Transmission loss savings.* As much as 15% of the useful energy that is paid for by the utility (and ultimately ratepayers) can be lost when the energy that is generated by large centralized power plants and shipped to area homes, business and factories through the transmission and distribution network. Losses are most significant (and also most expensive) when the grid is under the greatest stress during hot, humid conditions – precisely when PV output is at its highest. These losses are avoided by placing generation closer to the point of consumption.

- *Avoided environmental compliance costs.* Conventional fossil generators must comply with stringent regulations to limit the release of pollutants into the air and water that cause environmental degradation and impair public health. New York's coal-, natural gas-, and oil-fired generators incur significant costs in meeting current regulations governing pollutants associated with a range of environmental concerns including acid rain, ozone, fine particle pollution, and air toxics. Power plant contribution to global climate change is emerging as the most significant environmental issues of our generation. As regulations addressing global warming pollution are phased-in, owners of carbon-intensive generating plants will face mounting compliance costs. Since solar PV emits no pollutants, increasing the proportion of electricity supply from this clean energy option will result in the avoidance of environmental compliance costs that are passed on to New York consumers in the price of electricity.

- *Investment in distribution system upgrades and expansion.* As demonstrated by the recent Consolidated Edison rate case, utility customers are shouldering an enormous economic burden to maintain, replace and expand local facilities needed to reliably distribute power. While efforts to modernize this infrastructure are essential, distributed resources such as solar PV that can often serve as a cost-effective alternative to more traditional "poles and wires" have largely been ignored. Since the need for distribution system investment is often demand-driven, when strategically located in overstrained areas of the grid, PV's strong coincidence with peak demand could help defer or avoid the need for such investments.

- *Avoided payment for ancillary services.* Utilities and other load serving entities are responsible for compensating providers of "ancillary services", defined by FERC as encompassing "those services necessary to support the transmission of electric power from seller to purchaser given the obligations of control areas and transmitting utilities within those control areas to maintain reliable operations of the interconnected transmission system." In principle, owners of PV can work collaboratively with the distribution utility to configure their system to provide certain ancillary services, such as voltage support, allowing the utility to avoid payment for such services through the grid operator.[8]

In addition to these direct, cost-savings to utilities and their customers, PV offers a host of benefits to the people of New York. These societal benefits include but are not limited to:

- *Economic development and job creation.* As a distributed resource, solar generates more jobs per MWh than any other renewable energy technology.[9] These are high-skilled, high-paying jobs throughout the PV value chain, including wafer, cell and module manufacturers, integrators of cells into systems, power electronics manufacturers, distributors, designers and system installers. Were New York to establish a large-scale, long-term incentive program, the state can expect to capture a high portion of the manufacturing jobs (that tend to be located in close proximity to major markets) and virtually all of the permanent construction jobs. Moreover, given the multiplier effect, additional jobs are created in industries that support the solar industry. According to the NY Solar Industry Roadmap, a 2000 MW program delivered over the next decade could produce as many as 3,000 permanent construction jobs and 10,000 manufacturing and integration jobs. [cite to Roadmap]

- *Avoided environmental and public health impacts.* Even with strict emission controls, residual power plant pollution continues to exact a significant toll in terms of impaired public health and ecosystem degradation. A recent Abt study attributed

---

[8] Hoff, T.E., Perez, R., Braun, G., Kuhn, M., Norris, B., The Value of Distributed Photovoltaics to Austin Energy and the City of Austin, Clean Power Research LLC, (March 17, 2006); *see generally*, U.S. Department of Energy, The Potential Benefits of Distributed Generation and Rate-Related Issues that May Impede their Expansion (February 2007).
26 Navigant Consulting Inc., Distributed Generation and Distribution Planning: An
[9] *US Senate Hearing on Environment and Public Works*, Prof. Dan Kammen of UC Berkeley, Sep 25 2007)

1,200 premature deaths and 2,500 heart attacks a year in New York to fine particle emissions (soot) from power plants. [check cite] Mercury emissions, over one-third of which come from coal-fired generation, is a bio-accumulative neurotoxin (i.e., it increases in toxicity as it moves up the food chain) and is said to affect cognitive and motor skill development in children; in fish and wildlife, mercury contamination results in reproduction, neurological and behavioral disorders.[10] The New York State Department of Health has issued a health advisory warning against the consumption of fish from 87 water bodies located throughout New York State. As a non-emitting renewable energy technology, these public health and wildlife impacts are mitigated as solar displaces fossil generation and represents a bigger share of New York's overall resource mix.

- *Avoided risk of blackouts.* The economic losses to business and the general public due to power outages of even short duration are staggering. The 2003 blackout which affected much of the Northeast is reported to have resulted in economic losses of $6 to $10 billion. Large scale deployment of solar PV can reduce the risk of blackouts and brownouts by providing load relief that matches up well with system peak demand. During outages, facilities equipped permitted to operate in an "islanded" mode can continue to power essential on-site load, reducing economic losses and maintaining services essential to the health and welfare of the public. Moreover, deployment of PV can expedite and facilitate the restoration of the grid by effectively removing load that would otherwise need to be served after a disruption in service.

---

[10] *See, e.g.,* U.S. Environmental Protection Agency's *Mercury White Paper* http://www.eoa.gov/ttn/oarpg/t3/memoranda/whtpaper.pdf