

# Is Real-Time Pricing Right for Solar PV?

*Jeffrey Perlman and Andrew McNamara*

**D**oes the coincidence of high hourly energy prices and peak photovoltaic (PV) output improve the economics of PV installations under real-time pricing (RTP)? Could PV facilitate the wider use of hourly RTP?

To answer these questions, we performed an analysis using hourly solar production data from PV systems and hourly electric load data from buildings within New York City, and hourly and standard pricing information from Con Edison and the New York Independent System Operator (NYISO).<sup>1</sup> (See the subhead “Data Sources” at the end of the article for more-detailed information.)

### RTP VERSUS STANDARD TARIFFS, WITH AND WITHOUT SOLAR PV

Solar production data and building load data were not taken from the same buildings: no building in New York City was identified that had both hourly PV and hourly electric load data available for all of 2007. PV production and hourly load data were analyzed and correlated as if the PV systems were mounted on the buildings for which hourly load data was available. This approach does not reduce the accuracy of the data or the final pricing assessment. Actual PV system production is independent of building usage, and

impacts on pricing are neutral as long as a building is eligible for net metering and the solar system is correctly sized (all buildings selected for this study were eligible for net metering).

### Basic Cost-Reduction Calculation

Before addressing the value of solar, we calculated the costs of electricity for each building without solar, under both standard and RTP rate structures. To estimate the hourly energy output of a PV system for each building, we took the PV output data from the monitored systems and scaled it to reflect the projected output from an appropriately sized system based on the building’s roof area. We calculated a PV performance factor (kilowatt-hours per kilowatt of rated DC output of the solar array) for each hour of the year, and multiplied the estimated solar array size by this factor. For example, an industrial building with an available roof area that allows for an 80-kilowatt PV system had the annual normalized hourly solar output (kilowatt-hours per kilowatt) scaled up by a factor of 80. The solar PV systems for the buildings in this study met three criteria that made estimating the value of solar-generated electricity relatively straightforward: the systems (a) were sized to produce less than building load, (b) qualified for net metering,<sup>2</sup> and (c) generated less electricity than total building consumption over an annual period.

To calculate the annual value of the PV-generated electricity, we first subtracted the projected hourly PV system output for each building from the hourly building load profile for that building to determine a building load profile with PV. We then applied the appropriate electric tariff to the load profile to obtain the electricity cost with PV. Subtracting this result from the hourly electricity cost without PV yields the annual cost

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reduction generated by the installation of a solar PV system.

### PV Costs and Government Incentives

We estimated the cost for PV systems to be \$10 per DC watt of installed capacity.<sup>3</sup> A 50-kilowatt system would then have an installed cost of \$500,000.<sup>4</sup> Because the installed costs of PV systems are intrinsically tied to government incentives, the value of incentives was included in the analysis. However, because incentives change often, we used incentives available in 2009 rather than historical incentives from 2007.

For 2009, the available incentives for PV systems in New York City included federal incentives, such as the 30 percent energy investment tax credit<sup>5</sup> and MACRS accelerated depreciation,<sup>6</sup> as well as state and local incentives, including New York State Research and Development Authority Cash Incentive, sales tax exemption, state tax credit (only for residential customers), and New York City property tax abatement (35 percent of system cost, divided over four years).

## RESULTS

Our study came to a number of conclusions.

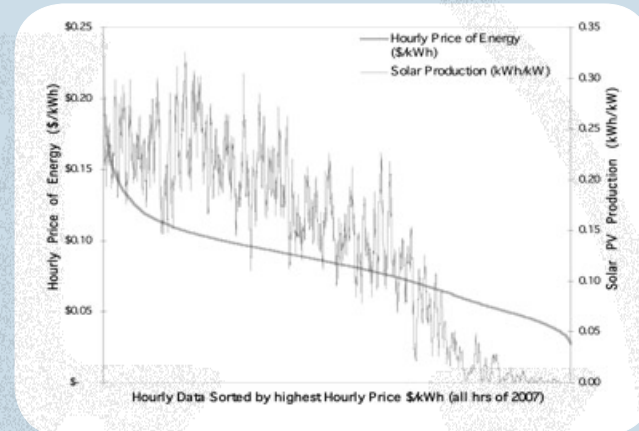
### Hourly Electricity Price Correlates With Solar Electric Generation

**Exhibit 1** shows that under RTP, when the price of energy is high, solar PV production tends to be high; when the price of energy is low, PV production is low. As the real-time price of electricity reflects the demand across the entire electricity grid, the graph shows that PV production is well correlated with the times of higher gridwide demand. **Exhibit 2** shows that the same correlation is not present under a standard Con Edison tariff.

### Under Con Edison Tariff, Solar More Valuable but Total Cost More

**Exhibits 3** and **4** show the value of solar under the applicable Con Edison standard tariff, as well as under Con Edison's hourly pricing tariff, where B1–B6 indicate the six buildings analyzed in the study. Hourly pricing adds value for solar in five of the six tested buildings. However, hourly pricing would result in a significantly higher overall electric bill for four out of the six analyzed buildings. The two industrial buildings would see an electricity cost decrease by switching to hourly pricing, while the multi-

**Exhibit 1.** Hourly Price of Electricity and Normalized Solar PV Production (50-Hour Moving Average)

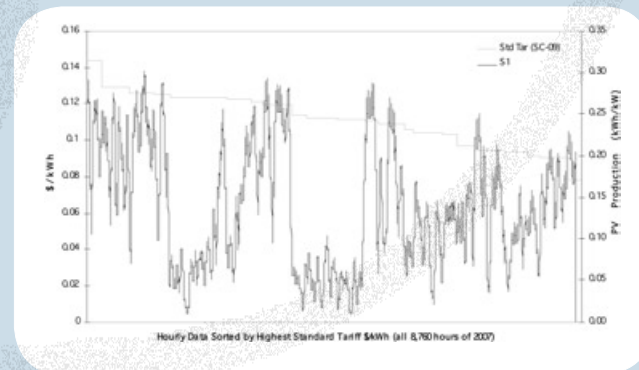


family and office buildings would see a substantial cost increase that more than outweighs any additional solar value from hourly pricing.

### Building Profile Affects Solar Savings; and Effect of Demand Cost

A large electric bill can be divided into two primary components: energy (dollars per kilowatt-hour) and demand (dollars per kilowatt). Exhibit 4 shows that, under either the standard or hourly tariff, the value of solar electricity can vary substantially based on building use. However, the values of the demand components fluctuate the most between buildings and between standard and hourly tariffs (see the “Demand”

**Exhibit 2.** Standard Price of Electricity and Normalized Solar PV Production (50-Hour Moving Average)



**Exhibit 3. Value of PV and Building Electricity Cost Under Standard Tariff and Hourly Tariff**

Building Type	ID #	Value of PV (Annual \$ Savings)				Building Electricity Cost (Annual \$ Cost)			
		Std.	Hourly	Diff	% Diff	Std.	Hourly	Diff	% Diff
Industrial	B1	\$20,948	\$19,661	-\$1,287	-6%	\$291,461	\$277,081	-\$14,381	-5%
	B2	\$10,915	\$11,221	\$306	3%	\$300,870	\$285,045	-\$15,825	-5%
Multifamily	B3	\$1,588	\$1,778	\$190	11%	\$182,823	\$191,425	\$8,602	5%
	B4	\$1,982	\$2,179	\$197	9%	\$288,139	\$299,830	\$11,691	4%
Office	B5	\$18,429	\$20,176	\$1,747	9%	\$5,226,816	\$5,530,157	\$303,341	6%
	B6	\$2,272	\$2,458	\$186	8%	\$2,045,505	\$2,219,808	\$174,303	8%

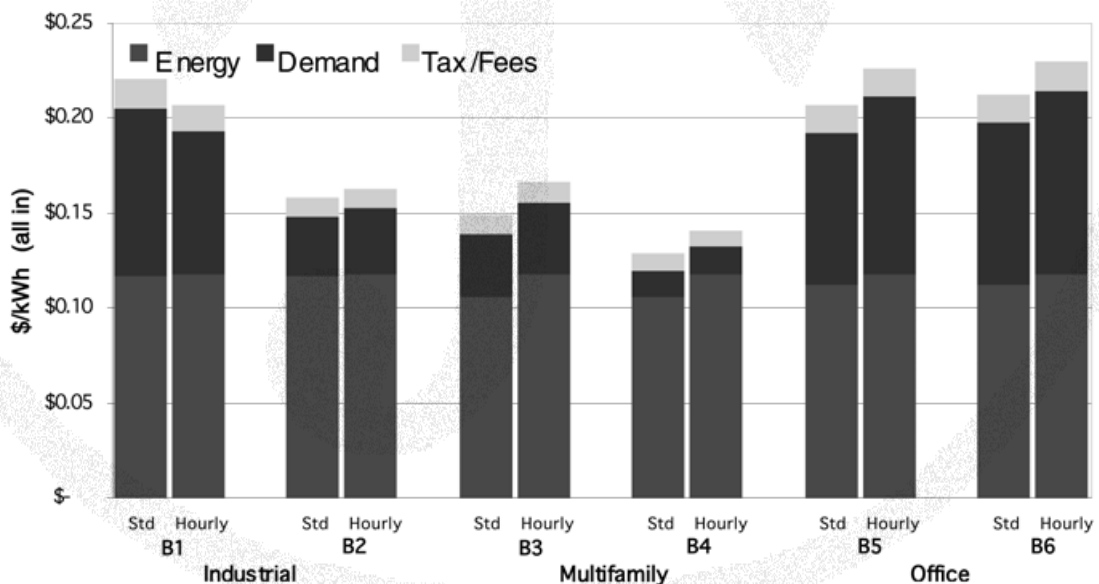
bars). The demand value of solar is dependent on the coincidence of PV generation with building peak loads. It only takes a single nonsunny but high-use half-hour period in a month to erase any solar demand savings for an entire month.

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**Exhibit 5** displays the peak demand setting day for two buildings analyzed in the study.

Building B2 is an industrial building with a midday peak and shows fairly strong solar demand savings. Building B4 is a multifamily building with a peak in the evening, when the sun is not strong, thus solar demand savings are minimal. The conclusion of Exhibits 4 and 5 is that the actual value of solar electricity under either standard or hourly rates varies widely, and that this variation is primarily attributable to the demand portion of the electric bill. Thus, if there is a desire to compensate solar electricity equitably across buildings, it might be logical to base solar electric compensation on energy

**Exhibit 4. Value of Solar PV by Component of Electric Bill for Standard Tariff (Std.) and Hourly Pricing**



production (kilowatt-hours) rather than savings to a building's peak demand (kilowatts). These findings are consistent with a Lawrence Berkeley National Labs study, which found that an electricity rate that limits demand-based charges provides the most value to PV systems across a wide array of circumstances.<sup>7</sup>

### Government Incentives More Important Financially Than Hourly-Versus-Standard Rate

At the time of this study, the incentives for solar PV in New York City were higher than ever before for the "right" customer. It is important to understand that many electric customers are not able to make use of all incentives. The incentives take up to six years to accrue, many are contingent on the tax appetite of the building owner, and incentives are often available for only a limited time.

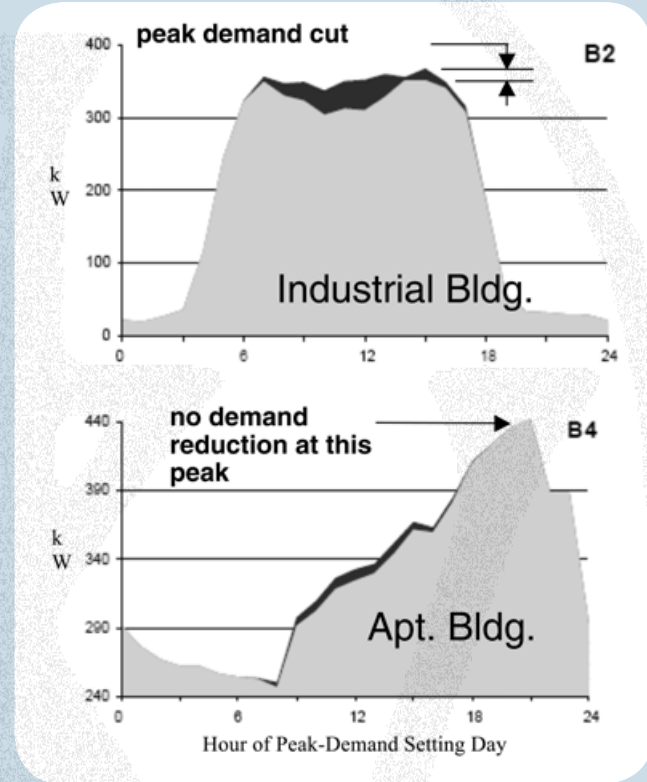
However, if a building owner were able to take all of the incentives available in 2009, the payback of PV would have been less than five years, as shown in **Exhibit 6**. Furthermore, the economic payback for PV would occur in less time under RTP than under a standard tariff for five of the six analyzed buildings. Notice that B3\*\*, an affordable housing building assumed to be owned by a nonprofit that is ineligible for two of the four tax-based incentives, would realize a much longer payback in both scenarios. This indicates the great sensitivity of PV economics to the ability of a particular building to access particular incentives.

### SUGGESTIONS TO MORE CONSISTENTLY AND EQUITABLY COMPENSATE SOLAR ELECTRICITY

There are a number of other ways to reward solar PV.

1. *Reduce demand weight of RTP tariff.* Because solar PV systems are more consistent at saving energy than at reducing an individual building's demand, a tariff that allows an electric utility to recoup costs with increased real-time energy rates and decreased demand rates would benefit solar PV economics. Doing so would reward PV system owners for generating power at times of greater gridwide demand while not penalizing them if their particular

**Exhibit 5.** Peak-Demand Day Profiles for August 2007 (Scale Is Adjusted to Illustrate Peak-Load Reduction)



building peak load profiles do not match up perfectly with the electricity production of their PV systems.

2. *Narrow the time-of-day demand window.* Solar PV would be more likely to show significant demand savings if the time-of-day demand window were more narrow.

**Exhibit 6.** Payback of Solar PV Installation Costs for Analyzed Building

Building Type	ID #	Simple Payback Period	
		Std	Hourly
Industrial	B1	3.1 Yrs	3.2 Yrs
	B2	3.3 Yrs	3.3 Yrs
Multifamily	B3	3.2 Yrs	3.2 Yrs
	B3**	33.8 Yrs	31.0 Yrs
Office	B4	3.3 Yrs	3.3 Yrs
	B5	3.2 Yrs	3.1 Yrs
	B6	3.0 Yrs	2.9 Yrs

Demand charges under the analyzed RTP rate were based on the the peak demand in three windows: 8:00 a.m.–6:00 p.m., 8:00 a.m.–10:00 p.m., and at all hours. A more narrow window of 8:00 a.m.–4:00 p.m. or even 10:00 a.m.–2:00 p.m. would be more likely to benefit solar PV.

3. *Use a feed-in tariff.* Under a “feed-in tariff,” the electricity that is generated by a PV system is bought by the utility at above-market prices. One of the key findings of this study is that PV produces power when it is most valuable, but that the added value often does not translate to savings on the PV system owner’s electric bill. Feed-in tariffs provide a higher retail rate for PV on the basis of energy (dollars a kilowatt-hour), not demand (dollars a kilowatt), and have been used extensively and with great success in Europe.
4. *Consider two-part RTP tariffs or block and index contracts.* The “two-part RTP tariff” (regulated) or a “block and index” (unregulated) energy service company (ESCO) contract are rate structures that might be more compelling to a solar owner than the existing Con Edison Rider M tariff. In either of these cases, the customer purchases a portion of its electricity at a fixed rate and a portion at an hourly price. These pricing structures offer the stability of a fixed-price contract while also allowing PV to capture increased value

under hourly pricing. Two-part RTP tariffs have existed for a decade or more through utilities such as Georgia Power. Block and index tariffs are already common for large facilities purchasing through an ESCO.

#### A NOTE ON SOLAR INCENTIVES

Current solar incentives vary widely by state and municipality. The economics of solar in each locale can require detailed study and change often as incentive allocations are used up or changed. Adding a preferred electricity rate option for PV has the potential to further complicate the decision-making process for customers considering the installation of PV. With a design-system life of 40 years or more, ensuring the long-term stability of any special PV electric rates is of the utmost importance. Many models have been tried globally to incentivize PV; the most successful have stable structures and incentive levels that make PV an attractive long-term investment.

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#### CONCLUSION

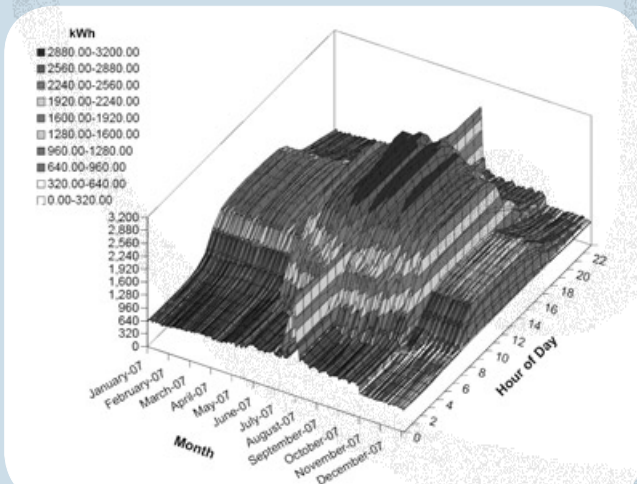
The way in which hourly pricing affects PV economics depends on the shape of a building’s hourly load profile and the details of the RTP tariff. Applying hourly pricing may increase or decrease PV’s value. But, in four of six studied cases in New York City, it caused overall electric bills to rise. Such a result would discourage electricity customers from switching to hourly pricing, merely to improve the economics of PV.

There are ways, however, to secure the best of both worlds: a higher value for PV-generated electricity more closely corresponding to the real-time value of that electricity and stable electric bills for the building. These include block and index pricing or two-part RTP tariffs.

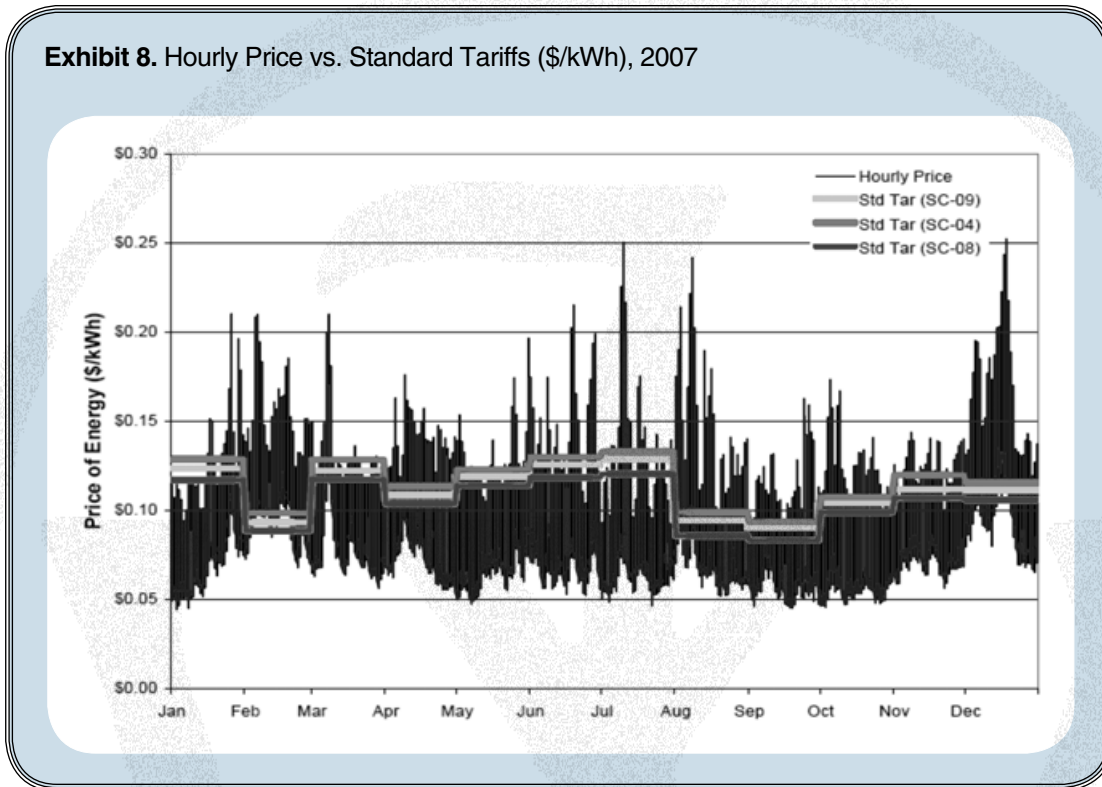
Nonetheless, the bottom line for PV is that the structure and value of government incentives play a larger role in determining the value of PV than does the utility tariff.

The findings of this report can only be treated as case studies. In order to draw statistically significant conclusions, a study of many

**Exhibit 7. Building—Hourly Electric Consumption**



**Exhibit 8. Hourly Price vs. Standard Tariffs (\$/kWh), 2007**



more buildings would need to be conducted. Although interesting conclusions can be drawn from the analysis in this report, in many ways, the authors view this study as a first step in understanding the benefit of real-time pricing to solar PV systems.


### DATA SOURCES

All data are measurements taken in the year 2007.

Hourly PV system output data was taken from remotely monitored solar arrays at four locations within 70 miles of New York City. These four “representative” systems include a range of different PV components and system orientations.

Hourly electric load data was taken from six different buildings: two industrial buildings, two multifamily apartment buildings, and two private office buildings. The hourly electricity load for one of the buildings is shown in **Exhibit 7**.

Day-ahead market location-based marginal pricing data from the NYISO together with Con Edison Rider M tariff information was used to calculate the monetary costs and savings under hourly scenarios. Standard Tariff Pricing was calculated from Rate I under Con Edison PSC

Nos. 4, 8, and 9—Electric (Full Service).<sup>8</sup> The average price of energy is generally lower under hourly pricing (RTP), but it is also more volatile, as shown in **Exhibit 8**. 

### NOTES

1. This article is based on a longer study conducted under contract to the New York City Economic Development Corporation, and funded by the U.S. Department of Energy Solar America Cities partnership. The full report is available at <http://www.brightpower.biz/projects/reports>.
2. Net metering allows a building to sell power back to the utility at the full retail price during those hours when the building produces more electricity than it uses. All buildings in this study use more electricity than what is produced by the solar PV system on an annual basis.
3. In reality, there are often economies of scale: larger PV systems are able to capture a lower price. This study does not take such economies into account. There are a number of other site-specific cost factors that would further affect the price.
4. This is intended only to give a very rough estimate of installed costs. Actual costs may vary on site-specific conditions, market-based factors, and other cost elements.
5. Note the federal investment tax credit may also be taken as a grant, which has tax consequences on the remaining incentives.
6. Modified Accelerated Cost Recovery System.
7. Wiser, Ryan et al. (2007, July). *The impact of retail rate structures on the economics of commercial PV systems in California*. Berkeley, CA: Lawrence Berkeley National Lab.
8. Con Ed rates and tariffs can be found at <http://www.coned.com/rates/>.