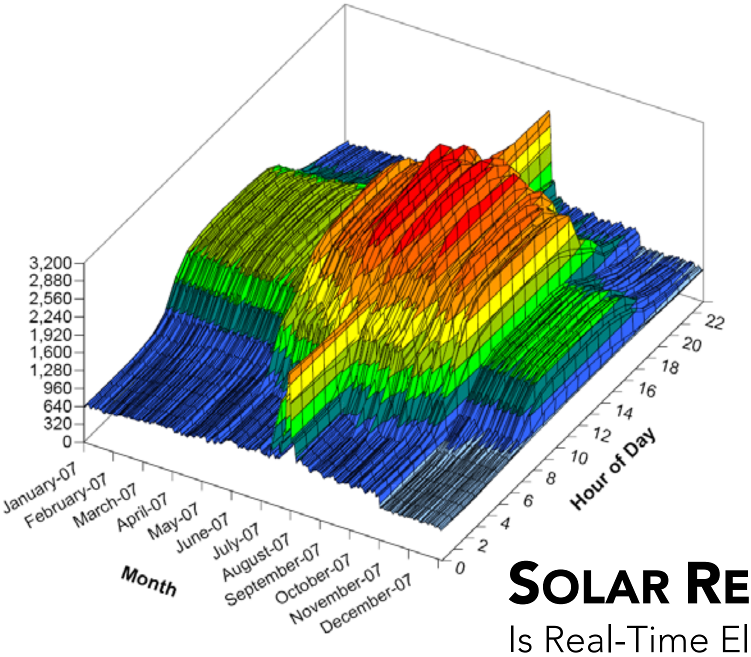

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SOLAR REAL-TIME PRICING

Is Real-Time Electricity Pricing Beneficial to Solar PV in New York City?

Final Report

Prepared for:
New York City Economic Development Corporation

July 16, 2009

Study Prepared by:
Bright Power, Inc.
Energywiz, Inc.
The Association for Energy Affordability, Inc.

SOLAR REAL-TIME PRICING

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Bright Power, Inc. (principal author) is a renewable energy and energy efficiency consulting firm. Based in New York, the company consults locally, nationally and internationally with organizations such as the New York State Energy Research and Development Authority (NYSERDA), the Jonathan Rose Companies, Stewards of Affordable Housing for the Future (SAHF), and Emirates Trading Agency (Abu Dhabi, UAE). One of Bright Power's key strengths is the ability to assess the technical feasibility of a wide range of renewable energy technologies and efficiency measures, model their performance, and combine this information with knowledge of financing and available incentive programs to deliver a maximally beneficial package for the customer. Andrew McNamara, CEM, (amcnamara@brightpower.biz) is a senior consultant at Bright Power. He consults with design teams and owners regarding energy saving opportunities and has co-authored reports to NYSERDA and technical articles published by Solar Today, the American Solar Energy Society (ASES), the International Building Performance and Simulation Association (IBPSA). Jeffrey Perlman, CEM, (jperlman@brightpower.biz) is President and Founder of Bright Power. He has presented nationally on the performance, economics, and risks of solar energy and energy efficiency and has worked on the development, design and/or installation of solar projects in NYC, nationally and in the Middle East. Sam Pilling, MBA, (spilling@brightpower.biz) previously worked in wholesale and retail energy markets at Citadel Investment Group and Accenture. Sam has worked with some of the US's largest utilities on billing, trading, and risk management.

Energywiz, Inc. is an energy consulting firm serving large energy users, suppliers, agencies, and other consultants, both in the U.S. and abroad. During its 13 years, it has also served the US EPA, various utilities, and (via its web-based training seminars) the Association of Energy Engineers (AEE). Its founder, Lindsay Audin (energywiz@aol.com), was formerly the energy manager for Columbia University (1988-96), and has won over a dozen awards (including induction into the AEE Energy Managers Hall of Fame) during his 35 years in the energy services business.

The Association for Energy Affordability, Inc. (AEA) is a not-for-profit technical and training services organization that analyzes building performance data, performs energy audits, and develops work scopes for energy efficiency measures to be installed in specific buildings by Weatherization programs in their communities. In addition to these direct services, AEA's continued NYSERDA-funded buildings research and demonstration activities provide support for new energy management technologies, promote health, safety and comfort in residential properties, from small homes to large multifamily apartment buildings. Da-Wei Huang (dhuang@aeanyc.org), MSME, is a lead engineer with AEA where he specializes in designing and supporting energy management system development and has significant experience in analyzing Con Ed utility rates.

Acknowledgements

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We are also grateful to Fat Spaniel Technologies for providing the hourly load data for this study. Fat Spaniel is one of the foremost providers of solar monitoring solutions and without their technology, the quality of solar data of the quality in this report would not have been possible.

We would like to thank Intech 21, NYSERDA, and two private office buildings for the hourly data used in this study.

Special thanks to Sabrina Hawkins, Amalia Cuadra, Phil Vos, Ann Shi, and Ari Frankel of Bright Power for their detail-oriented and thorough work in helping to craft this report.

Executive Summary

The goal of this study is to evaluate the validity of the following statement: "the coincidence of high electric energy prices and peak solar electric photovoltaic (PV) output can improve the economics of PV installations, and can also facilitate the wider use of hourly pricing." The study is focused on Con Edison electric service territory in New York City. Key conclusions that emerge from this analysis are:

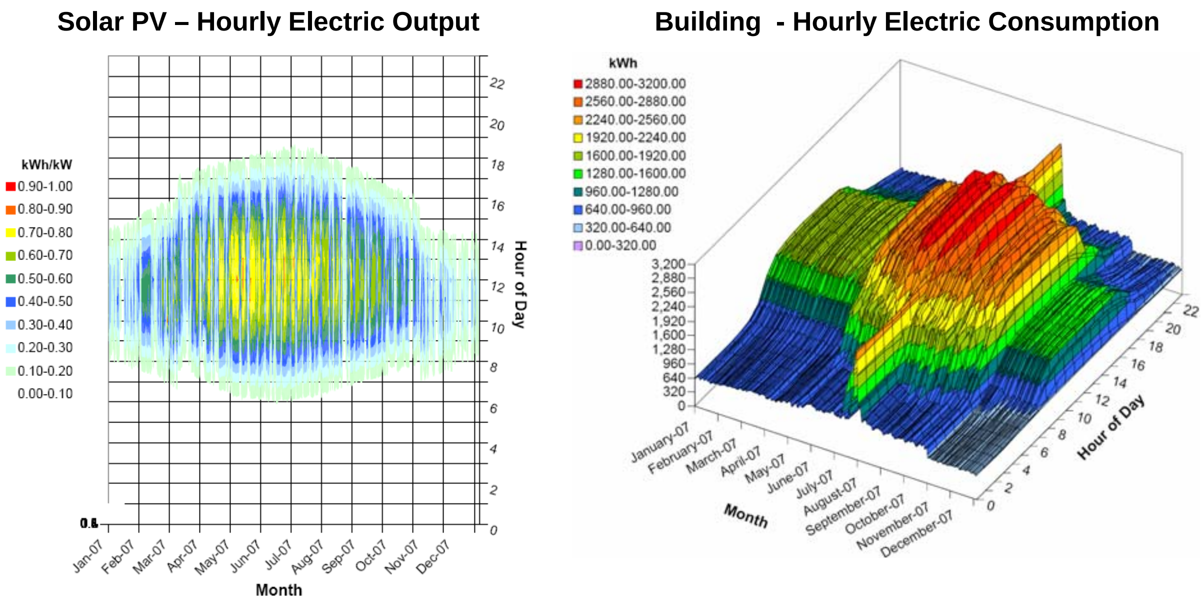
1. There is an historical correlation between hourly electricity price and solar electricity generation in New York City – solar PV output is highest when hourly electricity prices are highest. Said another way, solar PV electricity is undervalued by traditional electricity pricing structures.
2. a. Solar generated electricity is generally more valuable under Rider M, Con Edison's hourly pricing tariff, than under a standard Con Edison tariff.
   b. But, the overall cost of electricity is higher under Con Edison's hourly pricing tariff than under a standard Con Edison tariff, for four of six buildings evaluated in this study. Consequently, any efforts to improve solar economics through hourly pricing should be careful to avoid negatively impacting the overall cost of power for solar customers.
3. a. A building's load profile plays a significant role in determining the value of solar PV output under available standard and hourly tariffs.
   b. Solar PV's ability to save on demand charges is less consistent than its ability to save on energy charges. The cause is the building's electric load, which is not perfectly tracked by PV output. One way to mitigate this inconsistency is to compensate PV output purely on energy savings, with no demand component.
4. Government incentives currently available in New York City have a much greater effect on the payback and cost-effectiveness of solar PV than changing from the standard rate to the available hourly rate. Despite the small increase in the value of PV under hourly pricing, up-front incentives remain the dominant factor in the economic analysis.

As a basis for the analysis, this report uses the following data:

- Hourly solar electric production for four solar PV systems within 70 miles of New York City, from 2007.
- Hourly electric consumption for six New York City buildings – two industrial buildings, two office buildings, two multifamily residential buildings – from 2007.
- Con Edison standard tariffs from 2007 (SC-04, SC-08, SC-09)
- Con Edison's hourly pricing tariff, Rider M, from 2007
- City, State and Federal incentives for installation of solar PV systems, available and current as of June 2009.

The following charts are representative of the graphical displays of hourly solar PV output and hourly electric consumption data that can be found in the report.

Hourly Solar PV Performance (Left) and Hourly Building Electric Consumption (Right) for 2007



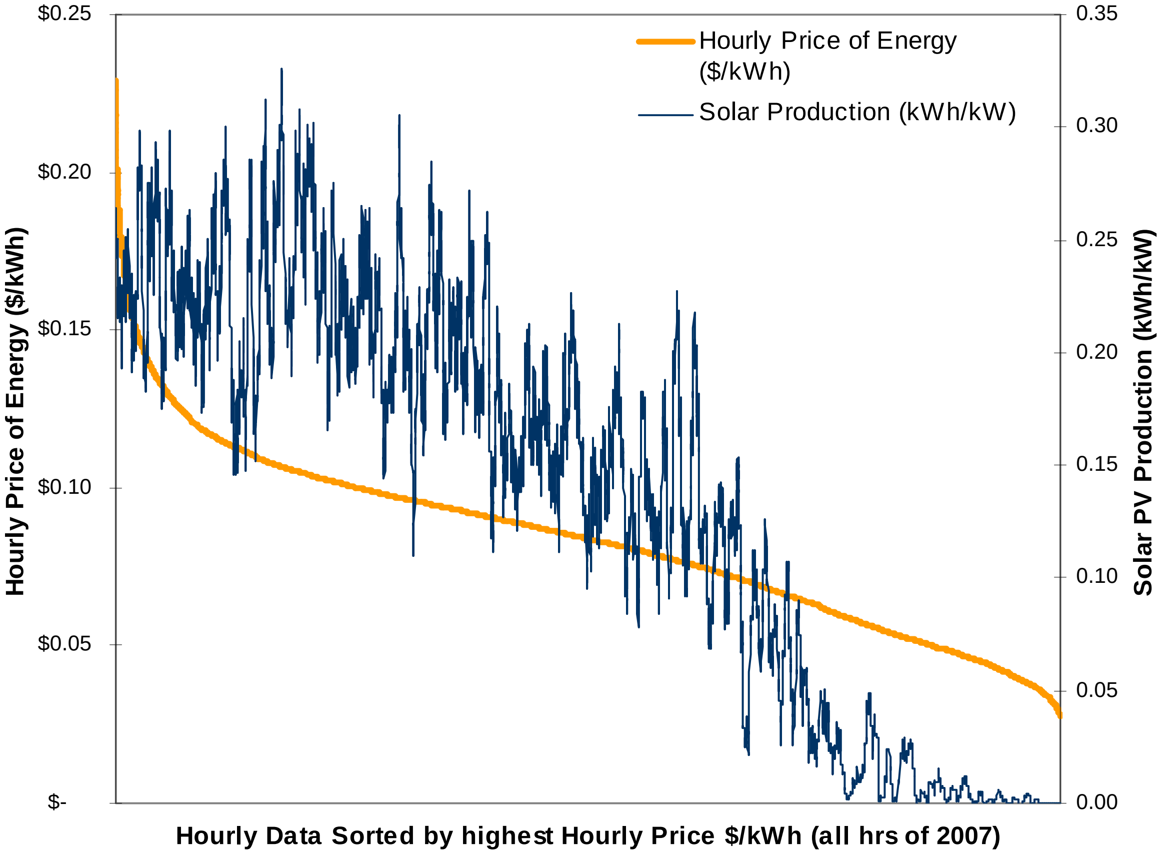
Solar PV – Hourly Electric Output

Building - Hourly Electric Consumption

1. There is a Correlation Between Hourly Electricity Price and Solar Electric Generation

The chart below shows that when the price of energy is high, solar PV production tends to be high; when the price of energy is low the opposite is true. The same correlation is not present under a standard Con Edison tariff.

Hourly Price of Electricity and Normalized Solar PV Production (50 hour moving average)



2. a. Solar generated electricity is generally more valuable under Con Edison's hourly pricing tariff.

b. But, the overall cost of electricity is often higher under Con Edison's hourly pricing tariff than under a standard Con Edison tariff.

The cost of electricity was calculated for each of six buildings under the applicable Con Edison standard tariff, as well as under Rider M, Con Edison's hourly pricing tariff, both with and without solar. The value of solar PV output for a building is the difference in electricity cost with and without solar. The percent difference in the value of solar is presented in the table below (positive number indicates increased value under hourly pricing). B1 – B6 indicate the six buildings analyzed in the study.

Value of PV and Building Electricity Cost under Standard Tariff and Hourly (PV System S1)

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%

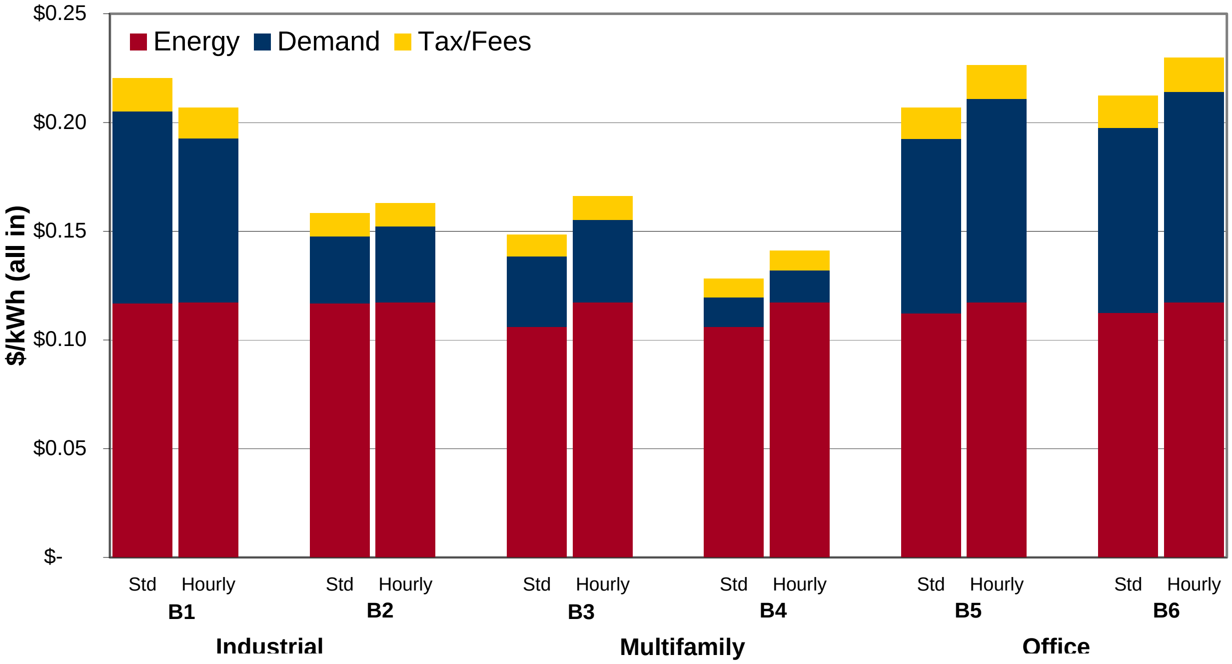
The result, as seen in the above table, is that hourly pricing adds value for solar in five of the six tested buildings. However, hourly pricing would result in a significantly higher overall electric bill for four out of the six analyzed buildings. The two industrial buildings would see an electricity cost decrease by switching to hourly pricing, while the multifamily and office buildings would see a substantial cost increase that more than outweighs any additional solar value from hourly pricing.

3. a. A building's load profile plays a significant role in determining the value of solar PV output under available standard and hourly tariffs.

b. Solar PV's ability to save on demand charges is less consistent than its ability to save on energy charges.

The following chart shows the value of solar PV output for all six buildings under the available standard and hourly Con Edison tariffs. It is clear that, under either tariff, the value of solar electricity can vary substantially based on building use.

Value of Solar PV by component of electric bill for Standard Tariff (Std.) and Hourly Pricing



A large electric bill can be divided into two primary components – *energy* ($/kWh) and *demand* ($/kW). It is the values of the demand components that fluctuate the most between buildings and between standard and hourly tariffs (see blue bars in previous chart). The demand value of solar is dependent on the coincidence of PV generation with building peak loads. It only takes a single non-sunny but high use half-hour period in a month to erase any solar demand savings for an entire month. Building B4 is a multifamily building with a peak in the evening, when the sun is not strong, so solar demand savings are minimal. Buildings B5 and B6 are office buildings with mid-day peaks, and those show fairly strong solar demand savings.

The conclusion of the previous chart 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 the more consistent energy portion of the bill, rather than the less consistent demand savings. 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.[1]

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[1] Wiser, Ryan et.al. "The Impact of Retail Rate Structures on the Economics of Commercial PV systems in California." Lawrence Berkeley National Lab. July 2007.

4. Government incentives currently available in NYC have a much greater effect on the payback and cost-effectiveness of solar PV than changing from the standard rate to the available hourly rate.

At the time of this report, the incentives for solar PV in New York City are higher than ever before for the "right" customer. The available incentives include:

- Federal 30% investment tax credit or grant.
- Federal accelerated depreciation (MACRS)
- State PV cash incentive (often referred to as a "rebate") from the New York State Research and Development Authority (NYSERDA)
- City property tax abatement for 35% of system cost over 4 years.

It is important to understand that many electric customers are not able to make use of all incentives. The incentives take up to five years to accrue and many are contingent on the tax appetite of the building and building owner. Also, the different incentives have complicated tax consequences on each other, and many are available for only a limited time.

If, however, a building owner is able to allocate the required cash or credit towards purchase of a solar PV system, and can take all of the incentives, the payback of PV will be less than five years, as shown in the chart below.

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
	B4	3.3 Yrs	3.3 Yrs
Office	B5	3.2 Yrs	3.1 Yrs
	B6	3.0 Yrs	2.9 Yrs

The chart above also shows that the economic payback for PV occurs in less time under hourly pricing 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 non-profit that is ineligible for two of the four tax-based incentives, realizes 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.

Other Rate Structures and Incentives

In order to realize true real-time value of solar PV output, it is important that electric customers have real-time pricing structures that are compelling to them. There are several possible rate structures that might be more compelling to a solar owner than the existing Con Edison Rider M tariff, such as:

- *Two-Part RTP tariff (regulated) or a "block and index" ESCO contract (unregulated).* In either of these cases, the customer purchases a portion of their 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, but as of the writing of this report are not available through Con Edison. Block and index tariffs are already common for large facilities purchasing through a third-party supplier (ESCO).

- *Feed-In Tariff.* A feed-in tariff pays a PV system owner for the system's output independently of the building's electric consumption. It therefore removes the effect of building demand from the equation. Feed-in tariffs, which are employed in several European countries, typically use a separate utility meter to monitor the output of the PV system. Isolating the PV system in this way allows it to be metered according to a special solar tariff, which could be an hourly tariff, without affecting the rest of the building's electric bill. Germany, the largest solar market in the world, has employed a system whereby the solar energy is separately metered and paid at a fixed rate (not an hourly rate) several times higher the market price for electricity.

Any change in electric tariff needs to be done with great care and cognizance of potential unintended consequences. For example, for the scenarios analyzed in this assessment, solar PV electricity tends to be more valuable under Con Ed's available hourly pricing tariff, but hourly pricing also often results in higher electric costs to the customer. Also, history has shown that when customers are subjected to mandatory hourly pricing, the majority will engage with a third-party power marketer (ESCO) that can offer them a non-hourly fixed price contract, which would typically result in less value to a solar PV system.

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. Adding a preferred rate option for PV has the potential to further complicate the installation of PV. Rate design should be undertaken with care to ensure that it is clear and well understood by potential customers. Since PV is a long term investment, 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.

Recommendations

Recommendations regarding rate design and potential topics for future research are covered in detail in Section 5 of the report.

Introduction

This report sets out to assess the validity of the following statement: "the coincidence of high electric prices and peak solar electric photovoltaic (PV) output can improve the economics of PV installations, and can also facilitate the wider use of hourly pricing." To evaluate the cost-effectiveness of solar electricity under an hourly pricing scenario, the following data sources were used: the best available hourly solar production data from PV systems around New York City, hourly electric load data from buildings within New York City, and hourly pricing information from Con Edison and the New York Independent System Operator (NYISO).

Methodology and Scope

Hourly PV system output data is from remotely monitored solar arrays at four locations within 70 miles of New York City: two public schools in Kearny, New Jersey, approximately 7 miles west of the city; a riverside warehouse complex, also in Kearny; a high school in Rockland County, approximately 25 miles north of the city; and an office building in Fairfield, Connecticut, approximately 63 miles northeast of the city. These 4 "representative" systems were selected from among 10 PV systems originally studied for calendar year 2007, and include a range of different PV components and system orientations.

Hourly electric load data is from three different types of buildings: two industrial, two multifamily apartment buildings and two private office buildings. Data on these buildings came from a publicly available NYSERDA[2] database, from an advanced metering company[3], and from interval meters installed in the office buildings. Standard Tariff Pricing was calculated from tariff rates published under Con Edison PSC Nos. 4, 8, and 9. - Electric (Full Service)[4]. Day-Ahead Market Location-Based Marginal Pricing (DAM-LBMP) data from the New York Independent System Operator (NYISO) together with Con Edison Rider M tariff information was used to calculate the monetary value of the PV power under hourly pricing scenarios. This report includes an analysis of curtailment benefits, and the impact of available incentives on the cost of PV systems.

It should be noted that for this study, solar production data and building load data do not come from the same buildings; no building in NYC was identified that had both hourly PV and hourly electric load data available for all of 2007. PV production and hourly load data have been analyzed and correlated *as if* the PV systems were mounted on the buildings for which hourly load data was available. The PV output data obtained from monitored systems was first scaled to an appropriate size for each building with load data, based on the building's roof area; the PV data was then combined with the electric load data into matrices to calculate the real-time effect of a PV system on the amount of power purchased by these buildings. For example, where the output of a 2 kilowatt (kW) PV system on a school had been paired with the electric load data for a multifamily building with capacity for a 20 kW PV system, the school's PV production data was scaled up by a factor of ten to match the output of a hypothetical system installed on the multifamily building's available roof area.

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 are eligible for net metering. Also, the PV system analysis in this

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[2] New York State Energy Research and Development Authority

[3] Intech21, Inc.

[4] Con Ed rates and tariffs can be found at: http://www.coned.com/rates/

report uses performance data for all of calendar 2007, which provides for more valuable analysis than data from a single system, which may experience production glitches. The effect of PV on a single building's load data is also analyzed on a mix-and-match basis, using different PV system types, configurations, and orientations. This study does not analyze PV systems with battery storage, because such a configuration is rare in an urban environment. However, electric energy storage could help PV to more consistently address peak demand reduction.

It should also be noted that sub-hourly (e.g., 15 minute) building load data would allow a more accurate level of analysis regarding the cost of demand in this study. For the study, peak electric demand is calculated as the peak hour consumption during the billing period. In actuality, Con Edison peak electric demand is defined as the "integrated demand" occurring during the two highest consecutive 15-minute intervals in a billing period. The integrated demand is the average of the kW use occurring in a 15 minute period, which if used continuously for 15 minutes, would produce the kWh actually consumed. Given the critical role that demand played in the cost-benefit analysis of Real-Time Pricing, a follow on study using 15 minute data could substantially increase the level of accuracy of this report.

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

Notation

All-In – The all-in price of electricity is the ratio of all of the costs accrued to the overall electric energy use, given in $/kWh. All-in costs take into account electric energy, demand, and fee costs.

Annual Normalized Solar Output – The annual AC output of a PV system in kWh divided by the system capacity in kW. This is equivalent to the sum of all **performance factors** throughout the course of a year for a given PV system. It corresponds to the annual production of an equivalently configured and oriented 1 kW PV system.

Array – A collection of photovoltaic modules electrically structured to produce a specific amount of power.

Azimuth – Defined as the cardinal direction which a solar panel is facing. For this study, North is 0 degrees, East is 90 degrees, South is 180 degrees and West is 270 degrees. Azimuth affects hourly solar performance through the course of a day.

Capacity Factor – Defined as the ratio of the capacity of a PV system in kW to the peak load of a facility in kW.

Demand Weight – The proportion of total customer electric bills (pre-PV) that is made up of demand charges[5].

Hourly Pricing (Real Time Pricing, Day Ahead Market Pricing) – Hourly pricing reflects real time cost, on an hourly basis. For purposes of this study Hourly Pricing, Real-Time Pricing, and Day Ahead Market Pricing all refer to the same thing – the Con Edison Rider M tariff which is based on the Day Ahead Market NYISO Zone J Location Based Marginal Price.[6]

Load Factor – The ratio of a building's average load to its peak load (kW). Average load is calculated as annual electric energy usage (kWh) divided by 8760, the number of hours in the year.

Peak Load (Peak Demand) – The maximum power requirement of a building or system during a given time period. For a standard tariff this means the maximum hourly load during a given month.

Performance Factor – Ratio of solar electric energy produced (kWh) to the rated array capacity (kW). On an hourly basis, this ratio is usually between 0 and 1 kWh/kW. On an annual basis, this ratio is usually between 1000 and 1400 kWh/kW.

Photovoltaic (PV) System – A system that can generate electricity from sunlight through solid-state semiconductor devices. Typically consists of PV modules that generate DC electricity, one or more inverters to convert DC to AC electricity, and all the necessary conduits, wires, disconnect switches, meters, and other components to ensure a safe, code-compliant installation.

Rider M – Term used by Con Edison to define its hourly pricing tariff.

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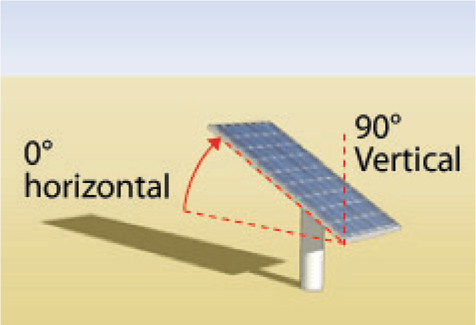
[5] Wiser, Ryan et.al. "The Impact of Retail Rate Structures on the Economics of Commercial PV systems in California." Lawrence Berkeley National Lab. July 2007.

[6] Note that in fact there are many different potential methods for calculating real-time pricing that would result in different hourly electric prices: Con Edison Rider M was chosen for its current availability in the marketplace.

Tilt – Defined as the angle between the horizontal and the solar plane. The red arrow in the following figure demonstrates this concept.[7]



Tilt affects the seasonal performance of a PV system – lower angles perform better in the summer and higher angles better in the winter.

Time-of-Day Peak Demand Charge – A special kind of peak demand charge that In the case of time-of-day demand charges, it may also be defined as time or during a certain hour-of-the-day window during a given month.

Value of PV – The value of PV is difference in the cost of electricity of a building without and with solar power generation. The value of PV can also be calculated on a $/kWh basis by dividing the value of PV by the overall energy (kWh) generated by the PV system.

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[7] http://www.energy.iastate.edu/renewable/solar/calculator/

1. Solar Electric Output and Building Load Data for NYC Metro Area

In order to analyze the economics of solar electric power under an hourly pricing scenario, hourly solar electric production and hourly electric loads were analyzed. Hourly solar electric production data was collected from four different PV sites during the 2007 calendar year. For the same time period, the electric load of six buildings was also collected and their hourly load profile was analyzed. The year 2007 was selected because it is a recent full calendar year that had less volatility in price than 2008.

1-1. Hourly Solar Output Data

Four PV arrays were selected for this analysis out of an initial five systems. The arrays are located between 7 and 63 miles from New York City. The solar production of each array is monitored by Fat Spaniel, an independent provider of monitoring services. Of the ten PV systems first identified for this study, four owners agreed to share the data collected by their monitoring system. The following table describes each array location, azimuth, tilt, and rated power output.

Table 1. Description of Solar Arrays Used in this Study

Array ID	Array Owner	Approx. Distance NYC (Columbus Circle)	Array Azimuth	Array Tilt	Array Power Rating
S1	Kearny HS Kearny, NJ	7	205°	50% @ 0°, 50% @ 10°	210 kW
S2	EXCLUDED FROM STUDY[8]	N/A	N/A	N/A	N/A
S3	River Terminal Development Kearny, NJ	7	210°	5°	607 kW
S4	Barrett Outdoor Communications West Haven, CT	63	194°	19°	16.4 kW
S5	Rockland BOCES H.S. Nyack NY	22	180°	22°	5.06 kW

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[8] Solar System S2 was excluded from the study due to incomplete data.

The following map shows the location of the PV systems relative to New York City.

Figure 1. Locations of Solar Systems S1, S3, S4, and S5.[9]

Solar Data Normalization

The solar production of each array was collected in an hourly format containing 8760 unique data points, one data point for each hour of the year. To compare the arrays in this study, each was normalized by its rated power. The ratio of solar power produced (kWh) to the rated array power (kW) is known as the **performance factor** (kWh/kW). The performance factor is the amount of output that an equivalent 1 kW system would have produced. When calculated on an hourly basis, this metric typically produces a value between 0 and 1 kWh/kW, and it is a valuable tool in describing the performance of solar arrays. If a system produces 10 kWh in one hour, but is rated to produce as much as 30 kW, then its performance factor for that hour is 0.33 kWh/kW. Similarly, if a 300 kW solar array produces 100 kWh in one hour, its performance factor for that hour is also 0.33 kWh/kW. The sum of each hourly performance factor determines the annual normalized solar output for any given solar system – typically 1000 to 1400 kWh/kW per year in New York City.

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[9] Note S2 is excluded from the study due to insufficient data.

Solar Data Error Correction

Solar production data used in this study was between 95% and 98% complete due to problems with the remote data collection system. In order to improve the quality of the data used in this study, error correction was performed on data gaps larger than 24 hours. The solar data correction methodology averages the production of the same hour of the day for the seven days before and seven days after the missing data point. For example: a data gap at 14:00 would be filled using an average of every 14:00 for one week before and one week after. The following table outlines the annual normalized solar output before and after error correction.

Table 2. Annual Normalized Solar Output Corrected for Data Errors[10]

	Error Correction		
	Pre (kWh/kW)	Post (kWh/kW)	% Diff
S1	1,169	1,188	2%
S3	1,183	1,242	5%
S4	1,404	1,442	3%
S5	1,188	1,225	3%

In order to discern the quality of the data collected, the annual normalized solar output was compared to PV Watts V1, which is a performance calculator for grid connected PV systems.[11] Solar data was compared against modeled AC solar output from PV Watts, using a factor of 0.85 for the conversion from DC to AC. This ratio accounts for conversion losses. The results of the PV Watts model are shown for each PV system in the following table.

Table 3. Comparison of PV Watts Model of Annual Normalized Solar Output and Error Corrected Data[10]

	Model		
	Model (kWh/kW)	Corrected (kWh/kW)	% Dif
S1	1,210	1,188	-2%
S3	1,210	1,242	3%
S4	1,313	1,442	9%

As it can be seen from Table 3, there is a difference between the performance of each model and data collected for this study. It is not surprising to see a difference between modeled and actual data. The difference could be the result of a variety of factors. Shading, balance of system equipment, and wiring methods could all affect performance. Additionally, PV Watts uses 30-year typical meteorological data to calculate the annual normalized solar output, whereas the solar data for this study is from the 2007 calendar year.

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[10] Note S2 is excluded from the study due to insufficient data.

[11] PV Watts is an online tool published by the Renewable Resource Data Center, part of the National Renewable Energy Laboratory, a government entity. PV Watts uses local historical temperature, irradiance, and inputted data to model solar output for a 30-year period. PV Watts V1 can be found at: http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/

The monthly model output and the error-corrected actual output can be presented graphically. For PV system S5, where the modeled performance is 9% higher than actual performance, the monthly model versus the error-corrected performance is presented the following graph. Since the PV Watts model uses 30 year average weather data, it is not surprising to see that it is much smoother than the actual data from the calendar year 2007.

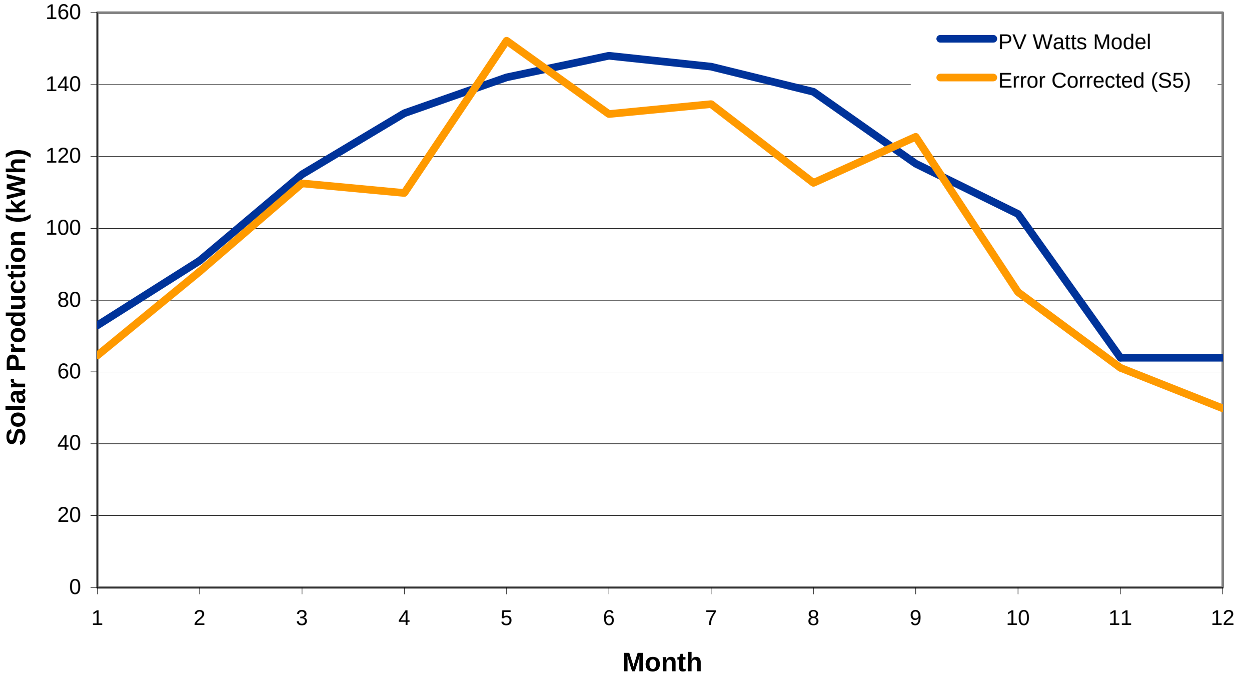

Figure 2. Monthly Modeled Performance vs. Actual (Error Corrected) Performance, PV system S5

Hourly and Seasonal Solar PV Performance

In order to evaluate the hourly and seasonal performance of each solar PV system, their performance was plotted hourly throughout the course of 2007. The following graphs show the seasonal and hourly performance for all four PV systems.[12]

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[12] High resolution graphs of performance for each system can be found in the Appendix.

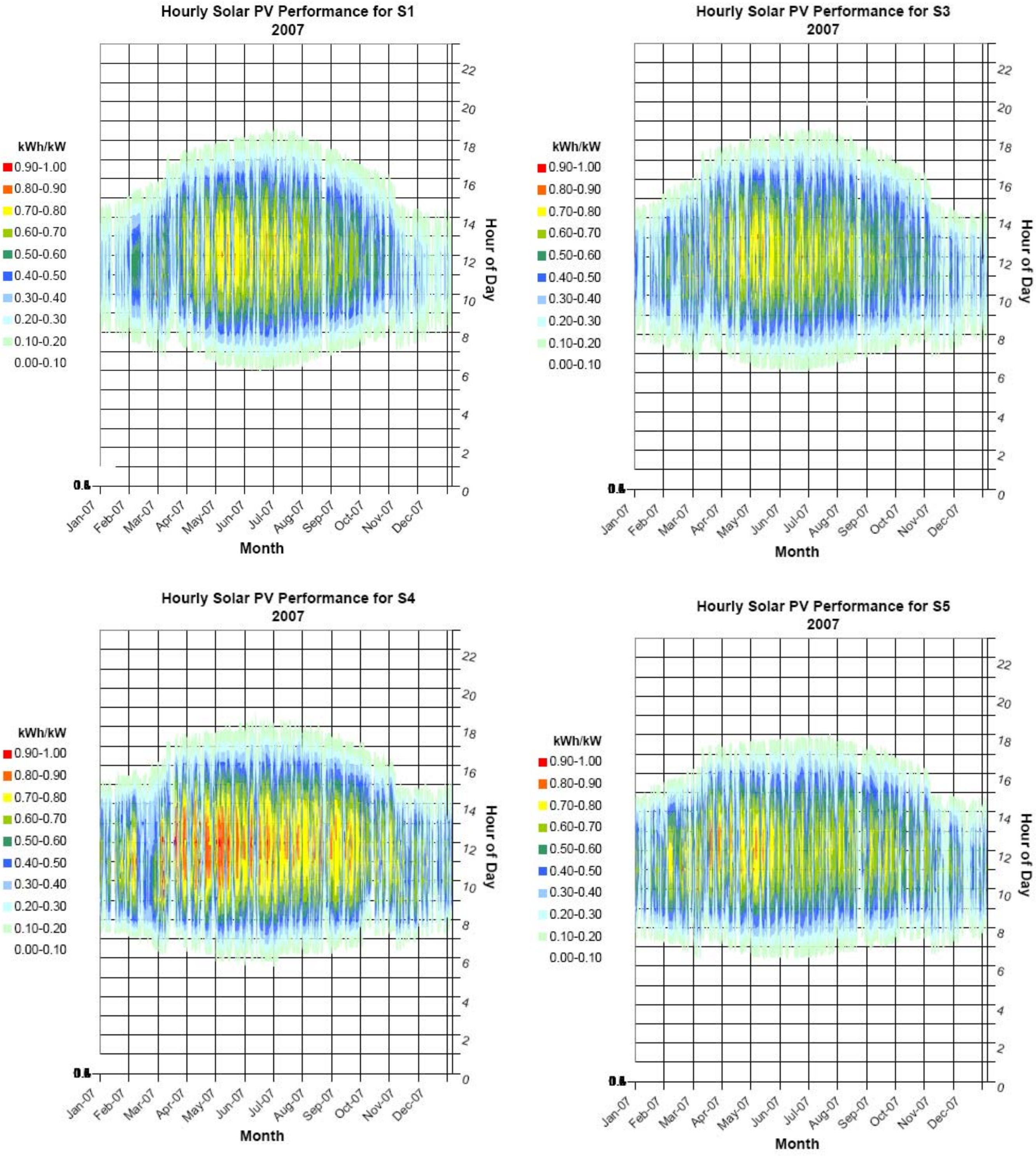

Figure 3. Hourly Solar PV Performance for Solar Arrays S1, S3, S4, and S5

Figure 3 shows that all the systems are performing similarly. Greatest output is in April through June, which makes sense because these are the months with the most sunlight and the lowest temperatures[13] , although building peaks tend to be in August, when temperatures are hotter. System S4 demonstrates the greatest peak performance. S4 and S5 demonstrate slightly flatter output curves, attributable to the greater tilt angle of the modules which improves non-summer performance. The benefit of this graphical analysis is two-fold. These graphs allow for visual correlation of the solar and building profiles – that correlation plays a role in the ability of PV to reduce demand charges for a building.

The following figure shows the entire year average daily performance of each solar system in this study.

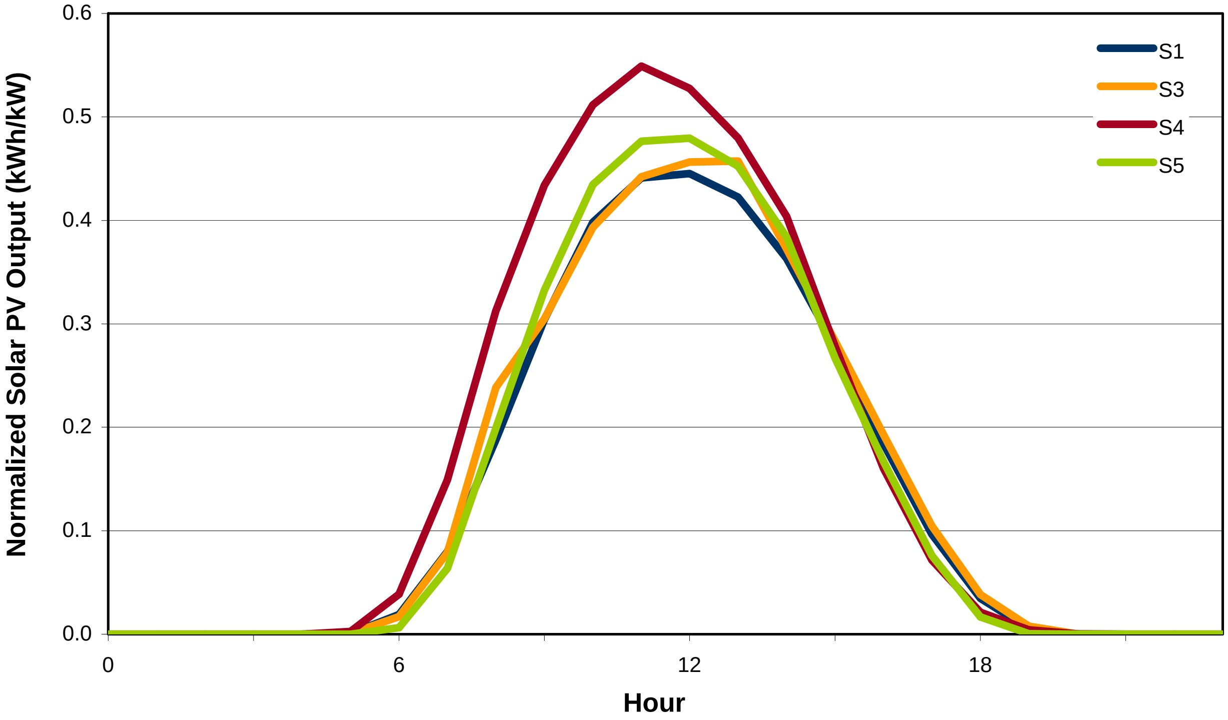

Figure 4. Average Hourly Performance of PV Systems

This figure reveals that electricity production for all four systems is from 6 AM to 6 PM. As with Figure 3, the peak production occurs between 10 AM and 1 PM. A system oriented more towards the east will typically peak in production earlier in the day, while a system oriented to the west will peak later in the day. This is potentially important for real-time pricing analysis, due to the variability in price throughout the course of the day. The same analysis can be performed on seasonal variation. The following graph compares the four PV systems in this study and how their performance varied throughout the course of the year.

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[13] PV operates more efficiently at colder temperatures.

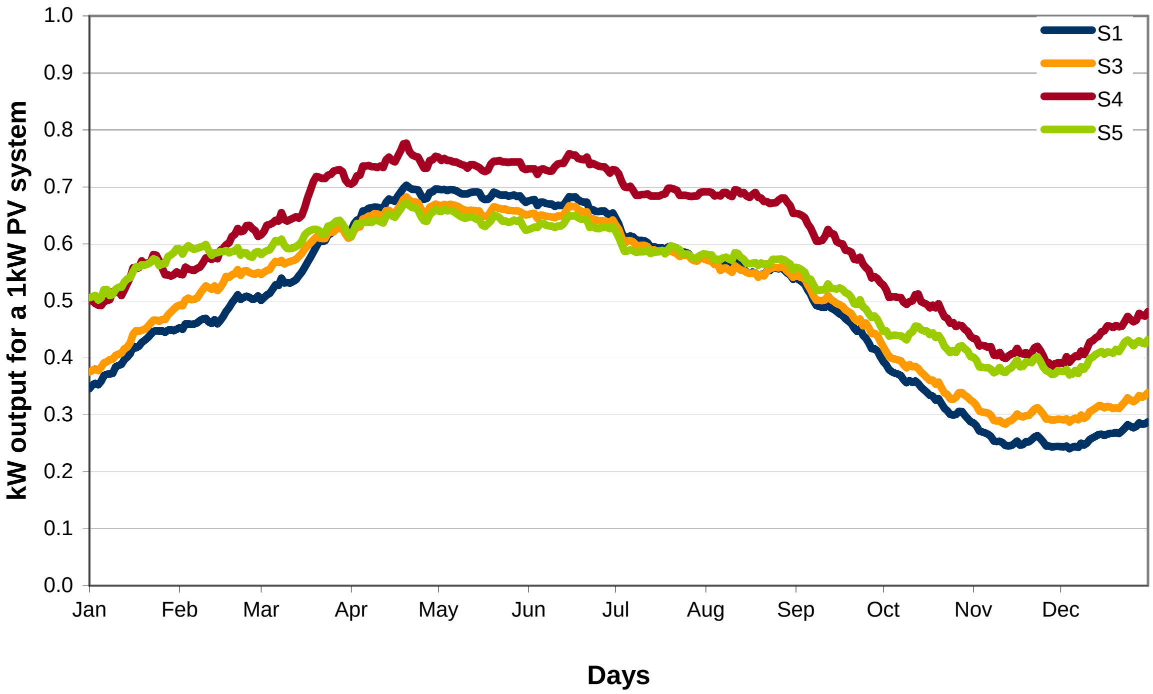

Figure 5. Average Seasonal Performance of PV Systems. 10-day moving average of daily peak performance factor. [14]

The performance of all four PV systems is higher during the months of April, May, and June than any other period during 2007. Note the relative difference in seasonal performance, S1 produces the second highest output during the summer, but the lowest during the winter. This is likely due to the low tilt angle, which causes the system to perform better during the summer months when the sun is higher in the sky. For purpose of comparison of the effect tilt angle on the value of PV energy output, systems S1 and S5 will be used throughout this study.

1-2. Hourly Building Electric Load Data

Six buildings were selected for this study. Among the six buildings, there are three different types of buildings – two industrial buildings, two multifamily buildings, and two office buildings. The following table describes each building and the source for building hourly load data.

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[14] Note S2 is excluded from the study due to insufficient data.

Table 4. Description of Buildings Analyzed and Source for Hourly Electric Load Data[15]

Building Type	ID #	Data Source	Building Type	Location
Industrial	B1	NYSERDA CHP[16]	Food Processing	Brooklyn
	B2	NYSERDA CHP	Laundry	Brooklyn
Multifamily	B3	Intech21[17]	Multifamily	Manhattan
	B4	Intech21	Multifamily	Brooklyn
Office	B5	Private Building, Con Edison Interval meter[18]	Office Building	Manhattan
	B6	Private Building, Con Edison Interval meter	Office Building	Manhattan

These buildings were selected because are a diverse sample and they have hourly electric load data for 2007.

Electric Load Data Error Correction

As with the solar data, error correction was performed with the electric load data in order to correct for data gaps. Incomplete data is attributed to loss of communication between data loggers and the central data collection server. Where data was missing or incomplete, the gaps were filled by substituting the specific hourly data from one week prior. In no cases was this carried out on more than 2% of the total data collected.

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[15] Building B4 is market rate building and Building B3 is affordable housing.

[16] Data from the NYSERDA CHP website is publicly available and accessible at http://chp.nyserda.org. These datasets consists of hourly electric data for sites that have combined heat and power (CHP), or cogeneration, systems installed. For the purposes of this study, the hourly building load data was the primary point of focus. To accurately reflect the total electric load at each building, the "Total Facility Purchased Energy" was added to the "DG/CHP Generator Output." Since the average NYC building does not have a CHP system, adding the purchased Energy and the Generator Output data together and analyzing the PV system's effect on this combined load provides a more widely applicable result than using only the Purchased Energy load data.

[17] Hourly load data for multifamily buildings was obtained from Intech21, Inc. Intech21 is a NY-based company that designs, manufactures, and provides service on advanced electric metering and submetering systems.

[18] The Con Edison interval meter provided quarter-hourly load data, which was converted to hourly load data for purposes of consistency of analysis.

Electric Load Data Analysis

The following graph shows the average and peak load for each of the buildings in this analysis.

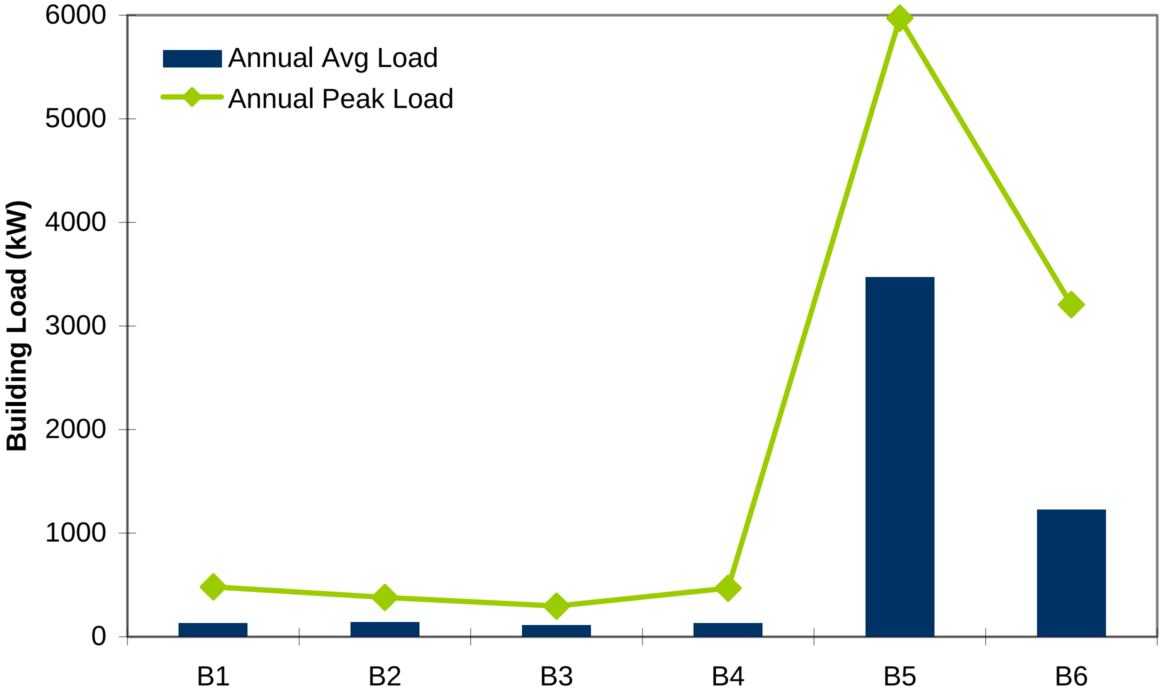

Figure 6. 2007 Average Load compared to Peak Load, by building

A building's **load factor** is the ratio of a building's average power load to its peak power load. This factor is a measure of how steady an electrical load is over time. The load factor of each building is presented in the table below. B5 has the highest load factor indicating that it's load profile is the most consistent.

The office buildings, B5 and B6, were the biggest consumers of electricity. The average load (kW), peak load (kW), and load factor for the buildings in this study are outlined in the following table. Building B5 has the highest load factor indicating that its load is the most consistent throughout the course of the day.

Table 5. Average Load, Peak Load, and Load Factor for Each Building.

	Industrial		**Multifamily**		**Office**	
	B1	B2	B3	B4	B5	B6
Avg Load (kW)	134	144	112	134	3,472	1,227
Peak Load (kW)	482	380	296	470	5,972	3,206
Load Factor	0.28	0.38	0.38	0.29	0.58	0.38

In order to evaluate the hourly and seasonal load profiles, daily and annual load averages were performed for each building. The following graph shows the hourly load profile for each of the six buildings.

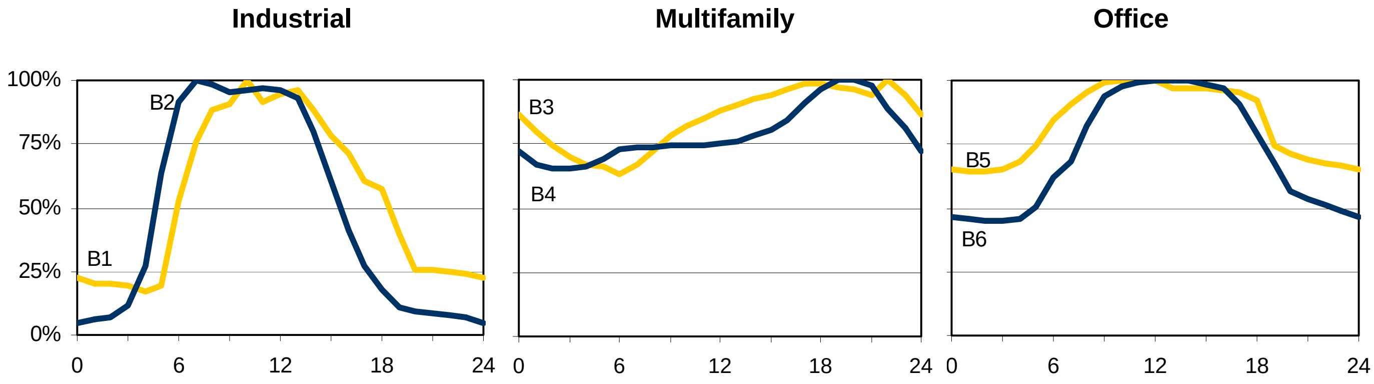

Figure 7. Normalized Annual Average Hourly Building Load Profiles

The comparison of the normalized annual load profile for all the sets of buildings reveal the following:

- The industrial buildings (B1 and B2), have load profiles with sharp mid-day peaks.
- The multifamily buildings (B3 and B4) have load profiles that peak in the evening.
- The office buildings, (B5 and B6) have broader peak profiles during daylight hours.

By comparing the normalized annual load profile of each set of buildings, the potential for PV integration and the benefits of hourly pricing can be incorporated with the results from the solar output analysis. For example, peak solar power output tends to occur in the early mid-day hours, so those buildings with mid-day peak loads (B1 and B2) are more likely to benefit from solar power because of a greater probability of demand reduction.

Monthly peak load profile analysis is another interesting way to view the data, as it allows for comparison of solar power output variation with seasonal solar performance. The following graph shows a 10-day moving average[19] daily peak to annual peak load profile.

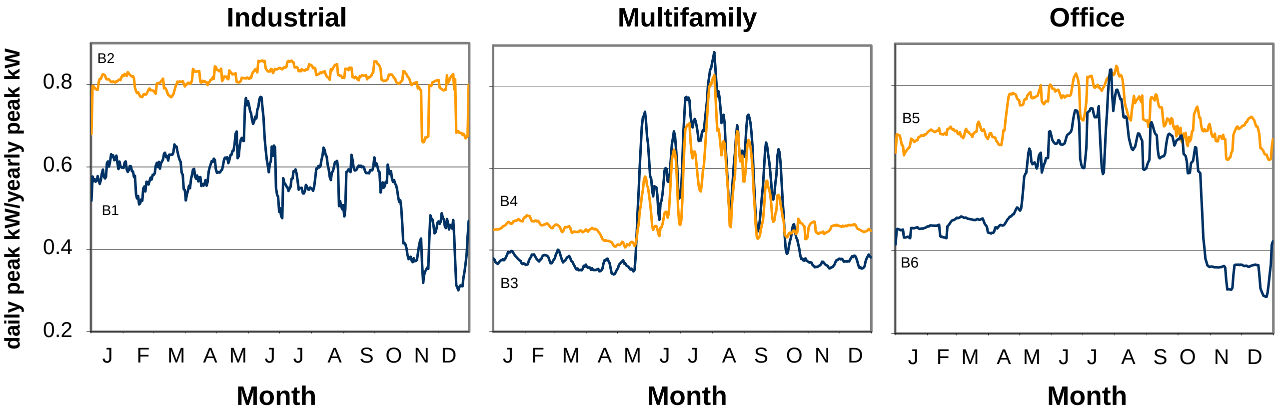

Figure 8 . Normalized Monthly Building Load Profiles.

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[19] This 10-day moving average is used to smooth out short-term fluctuations and highlight the longer-term trends over the course of the entire year. In this case the average of ten consecutive peak daily demand values forms a single data point, that process is repeated for the entire year to form the trendline.

As it can be seen from Figure 8, the load profiles of the multifamily and office buildings increase during the summer months as there is an increased cooling load. Industrial buildings do demonstrate the same seasonal variations multifamily and office buildings, but do demonstrate drop-offs in November and December, presumably attributable to decreased production hours during the Thanksgiving and winter holidays.

1-3. Solar Output Performance for Buildings Analyzed

The buildings selected for this study were treated as hypothetical hosts for solar PV. To estimate a reasonable array size for each building, available roof area was estimated using the satellite online tool Google Earth^{TM}; a power density of 10 W per square foot of usable area was assumed. Roof top area images and calculations can be found in the Appendix. The following table shows estimated array size for each of the buildings in this study.

Table 6. Estimated PV array size for Buildings 1 - 6.

Building Type	ID #	Building Type	Gross Roof Area (sq. ft.)	% Free Area	Potential PV Array Size (kW)
Industrial	B1	Food Processing	50,670	60	80
	B2	Industrial Laundry	7200	80	58
Multifamily	B3	Multi Family	1500	60	9
	B4	Multi Family	3740	35	13
Office	B5	Office Building	14,964	50	75
	B6	Office Building	1564	60	9

It should be noted that array sizes were capped at 80 kW. This size corresponds to the present maximum NYSERDA incentive for PV installations.

The **PV capacity factor** is the ratio of the rated capacity of a PV system to the peak annual load of the building. The PV capacity factor for each building given its estimated solar system size is presented in the following table.

Table 7. PV Capacity Factor for Each Building.

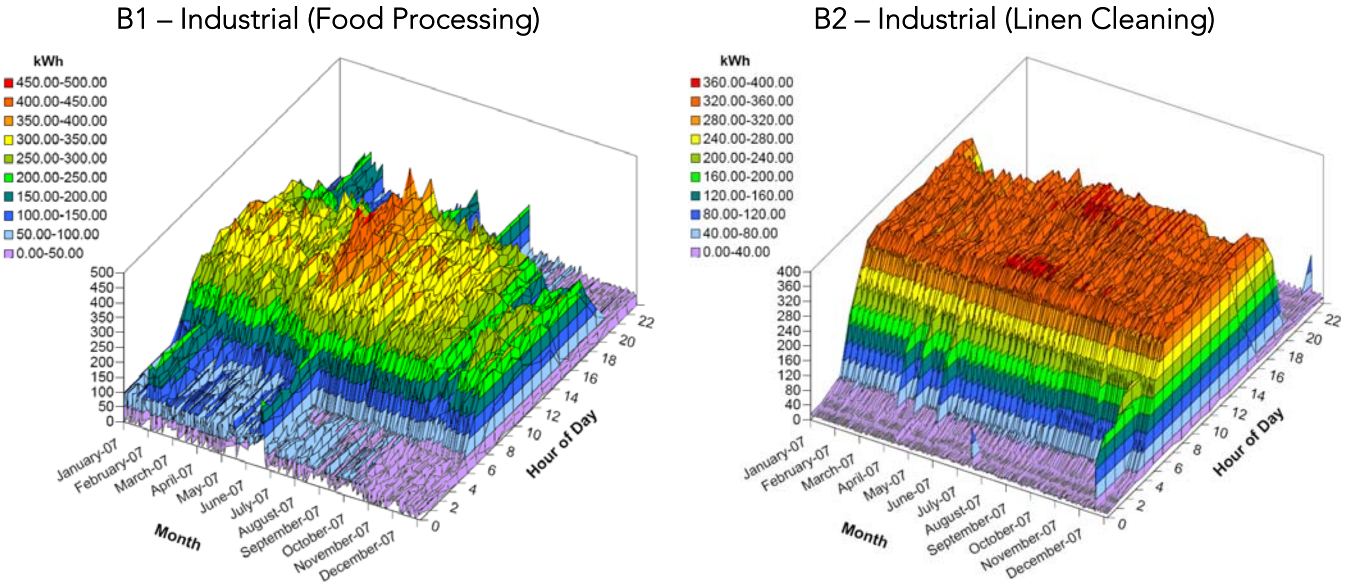
	Industrial		Multifamily		Office	
	B1	B2	B3	B4	B5	B6
PV Capacity (kW)	80	58	9	13	75	9
Max Bld. Load (kW)	481.79	379.8	296.16	469.6	5936	3194
PV Capacity Factor	16.6%	15.3%	3.0%	2.8%	1.3%	0.3%

1-4. Analysis of Building Loads and Hourly Solar Production

The PV Performance data for each site and the hourly building load data for each building were rendered graphically to help analyze hourly correlations and potential impacts of PV output on building load.

Load Profiles

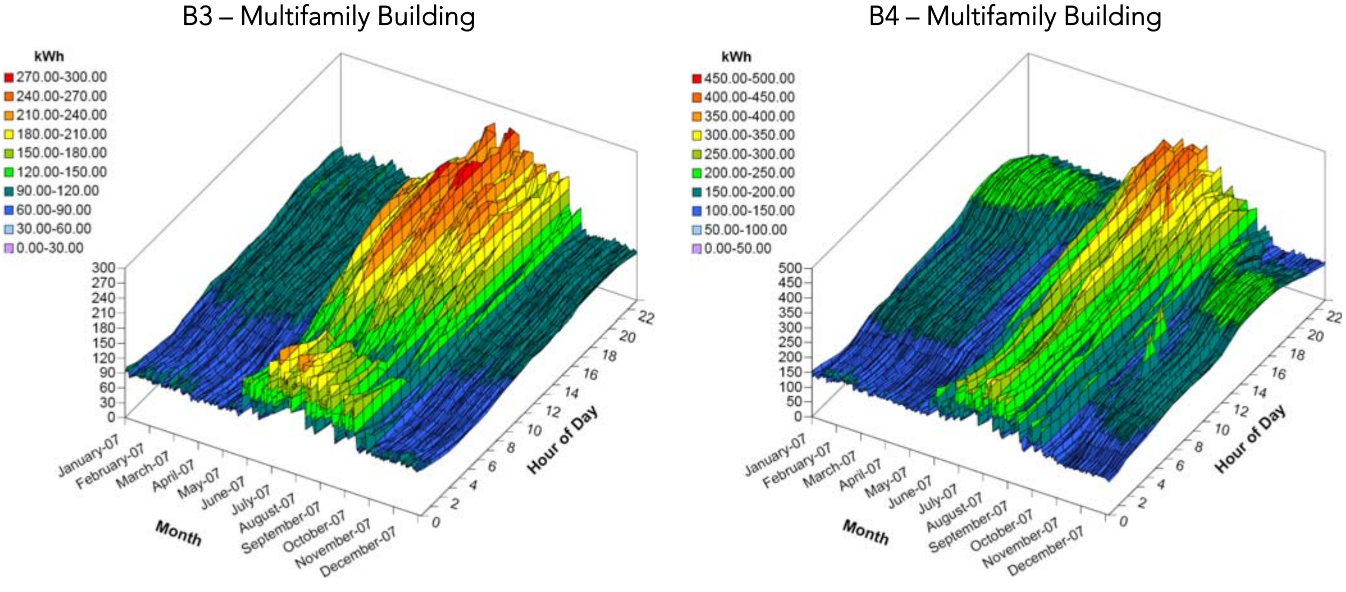
The following three dimensional graphs show the intensity of hourly electric energy consumption over a year for the six analyzed buildings.


B1 – Industrial (Food Processing)

B2 – Industrial (Linen Cleaning)

Figure 9. Hourly Electric Consumption (kWh) for Industrial Buildings.

Figure 9 displays the load profile of the two industrial buildings at every hour of the year. Building 1 exhibits peak loads in June, between the hours of 7AM and 6PM. Building 2 exhibits a load profile that is more consistent over the course of the year, displaying a year round peak period across similar hours of the day. The sharp drop off in electricity consumption outside of the daytime period is typical of an industrial building without a night shift.

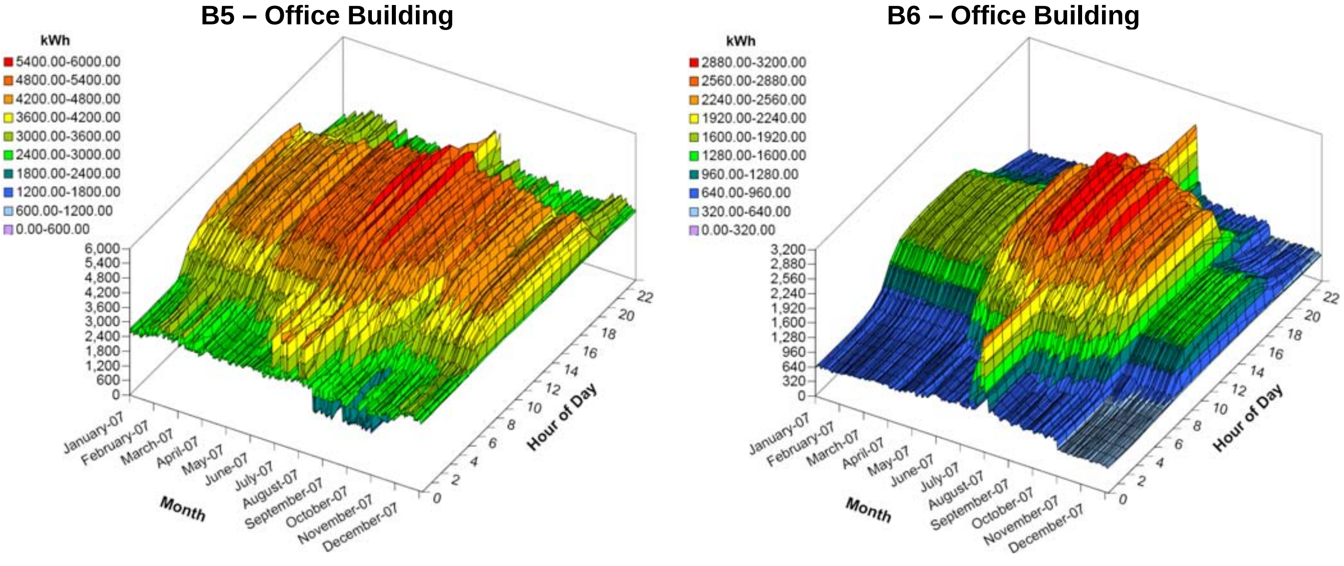


B3 – Multifamily Building

B4 – Multifamily Building

Figure 10. Hourly Electric Consumption (kWh) for Multifamily Buildings.

Figure 10 displays the load profile of two multifamily residences at every hour of the year. Both multifamily buildings exhibit peak loads in summer evenings. Building B4 exhibits a particularly late peak from 8 to 11PM.



B5 – Office Building

B6 – Office Building

Figure 11. Hourly Electric Consumption (kWh) for Office Buildings.

Figure 11 displays the load profile of two office buildings at every hour of the year. Both buildings show fairly flat mid-day peaks, the result of relatively consistent daytime electric consumption: the amount of electric energy used by servers, computers, office equipment and lights that do not vary much throughout the day. In B6, the significantly higher daytime usage in May through September is indicative of a substantial electric cooling load. Also note the one day in July when building staff apparently left the cooling on all night, causing a “stripe” of higher night-time electricity consumption. The load profile in B5 is typical of office buildings with 24-hour server operations, which have relatively higher night-time loads. Also note that both buildings exhibit occasional high night-time loads, perhaps due to cooling or other equipment operating overnight.

Of the building types analyzed, the industrial and office buildings display load profiles which best correlate with solar energy output; those buildings have mid-day peaks that could be potentially be reduced by coincidence with greatest solar output. The late-day peak of multifamily buildings correlates less with peak load solar output. This effect is visible in Figure 12, which displays the August peak demand day profile for each building type. The peak shaving ability of solar is visible in the blue "cap" on top of each graph.

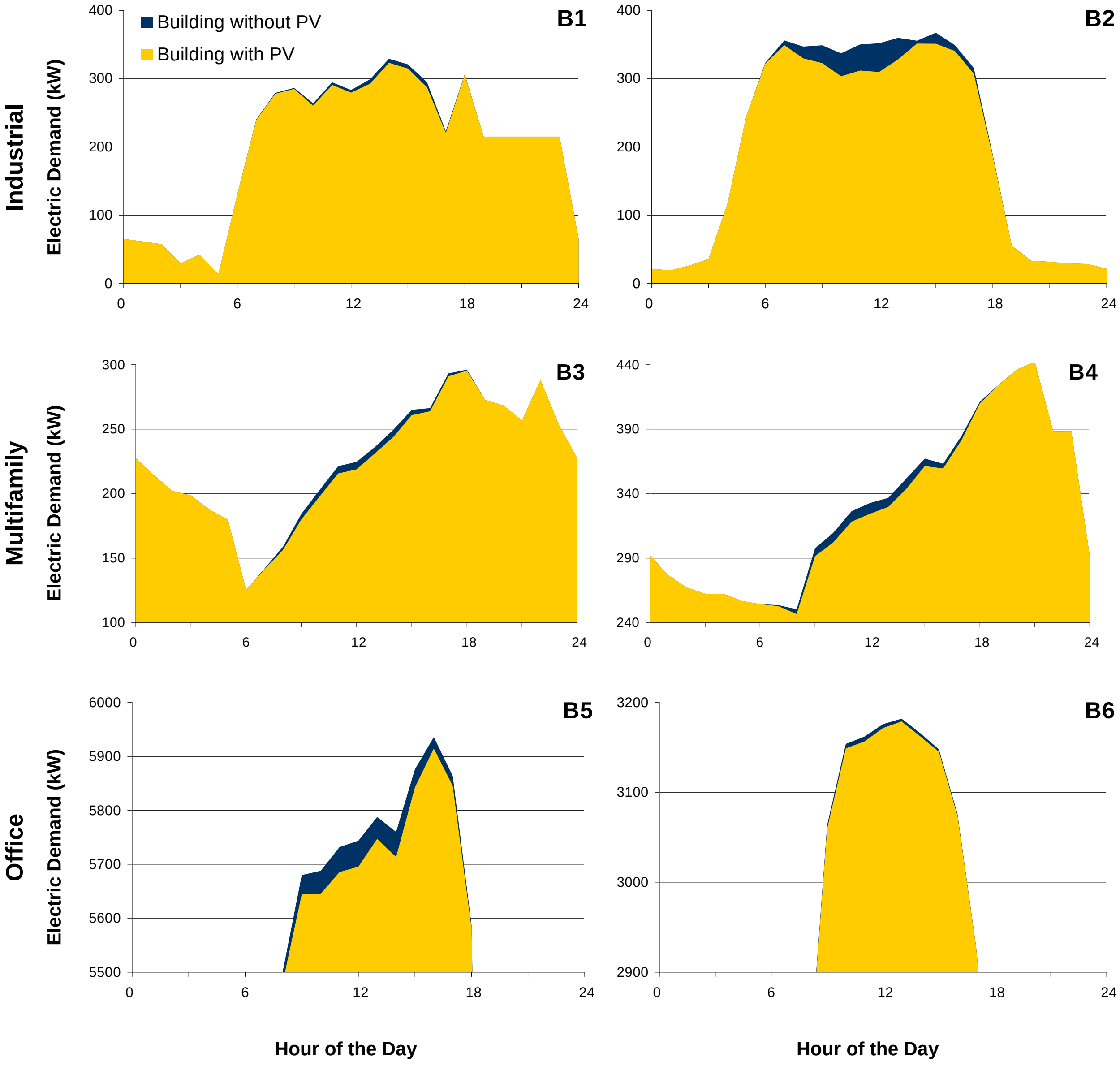


Figure 12. Peak Demand Day Profiles for August 2007. Scale is adjusted to illustrate peak load reduction.

Note: The peak demand setting days shown in the charts above during the month of August 2007 for buildings B1 through B6 were the 21st, 28th, 8th, 8th, 8th, and 7th of the month, respectively.

Even if the building load profile correlates with solar PV output, it is easy to imagine from the above graphs why it is difficult for PV to accrue demand savings. A brief period of reduction in PV output could easily coincide with a peak demand event. At around 3PM in the Industrial B2 graph, one such moment is visible, where the pink cap on the graph becomes thin and the blue demand is close to maximum. PV is more well-suited to save energy than demand; electric tariff structures that reward energy savings more and demand savings less will benefit PV.[20]

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[20] Note that battery storage could improve PV's peak demand saving ability, but it is rare to see an on-grid PV system include batteries, especially in the New York area.

2. Value of PV under Standard Tariff Pricing

The value of a PV system for a given building is evaluated as the annual electric utility bill cost savings attributable to the installation of a PV system. This section addresses the value generated by PV under Standard Tariff Pricing. The value of PV under an hourly pricing scenario will be evaluated in Section 3 and compared to the value of PV under a standard tariff in Section 4 of this report.

2-1. Standard Tariff Electricity Pricing

The Con Edison Standard Tariff is defined in this study as Rate I of each service classification. As of the writing of this report, a building in Con Edison service territory is automatically assigned to Rate I unless its monthly peak demand (kW) is greater than 500 kW. Under the Standard Tariff, as under hourly pricing, each building is assigned to a Service Classification. This study focuses on common service classifications for large buildings SC-09 (General - Large), SC-08 (Multiple Dwelling - Redistribution), and SC-04 (Office and Industrial - Redistribution).[21]

The Standard Tariff is calculated by adding the published supply charge plus adjustments, the Renewable Portfolio Standard and System Benefits Charge, Demand and Energy delivery, fixed Bill Processing and Meter Fees, and taxes. The tariff is illustrated graphically in the following figure.

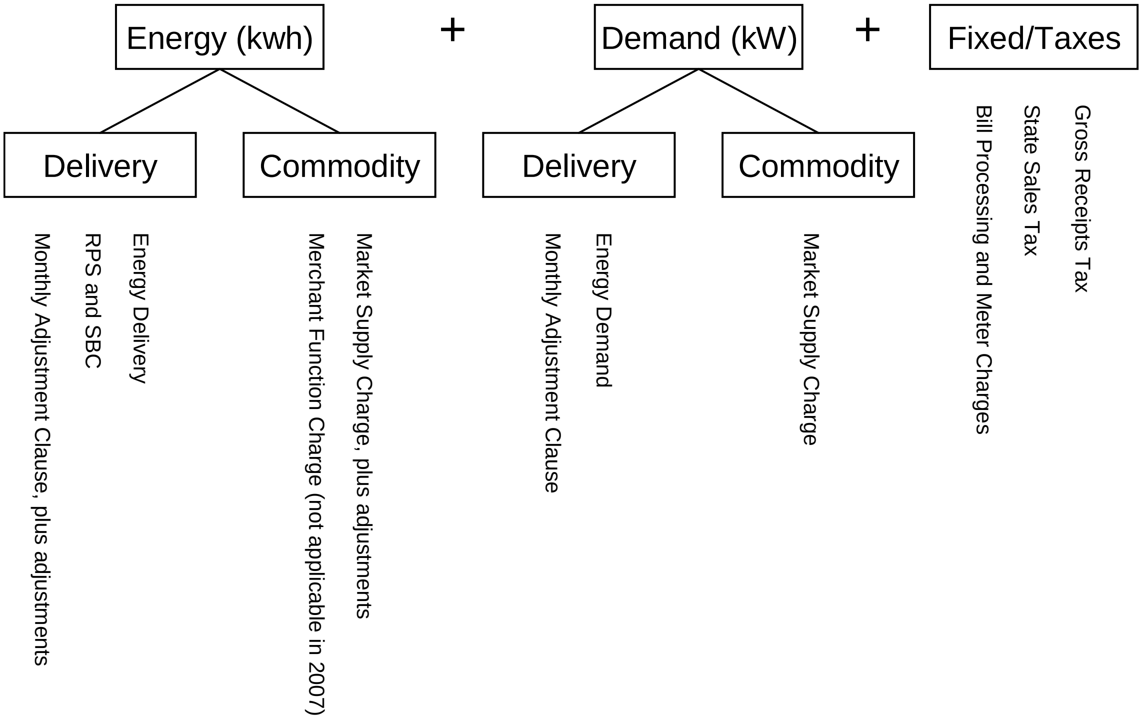

Figure 13. Rate Structure of Standard Tariff Pricing

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[21] For purposes of consistency, all buildings are assumed to purchase the electric commodity through Con Edison and not through an Energy Services Company (ESCO)

In Con Edison territory, the *demand* and *energy* components of the bill vary by month, hour, and service classification. The chart below represents the monthly charge by Con Edison for Service Classification 09 (SC-09).

Table 8 . Con Edison Standard Tariff (SC-09) published monthly pricing.[22,23]

	Energy					Demand				Fixed/Taxes			
	MSC	**RPS**	**SBC**	**Energy Delivery**	**MAC**	**Energy Demand**		**MSC**	**MAC**	**Bill Process**	**Meter**	**Tax**	**Gross Receipts Tax**
	all hours $/kwh	*$/kwh*	*$/kwh*	*$/kwh*	*all hours* $/kwh	*0-900kW* $/kw	*>900kW* $/kw	*$/kw*	*$/kw*	*$/bill*	*$/bill*	*%*	*%*
January	$0.1010	$0.0004	$0.0017	$0.0142	$0.0079	$10.66	$9.36	$6.02	$1.80	$0.94	$2.72	8.38%	2.52%
February	$0.0770	$0.0004	$0.0017	$0.0142	$0.0120	$10.66	$9.36	$7.23	$2.72	$0.94	$2.72	8.38%	2.52%
March	$0.0808	$0.0004	$0.0017	$0.0142	$0.0119	$10.66	$9.36	$7.23	$2.64	$0.94	$2.72	8.38%	2.52%
April	$0.0813	$0.0004	$0.0017	$0.0152	$0.0114	$11.36	$9.97	$7.23	$2.31	$0.94	$2.72	8.38%	2.41%
May	$0.0852	$0.0004	$0.0017	$0.0152	$0.0096	$11.36	$9.97	$13.50	$1.85	$0.94	$2.72	8.38%	2.41%
June	$0.0935	$0.0004	$0.0017	$0.0152	$0.0075	$14.21	$12.83	$13.50	$1.47	$0.94	$2.72	8.38%	2.41%
July	$0.1182	$0.0004	$0.0017	$0.0152	$0.0006	$14.21	$12.83	$13.50	$0.14	$0.94	$2.72	8.38%	2.41%
August	$0.1050	$0.0004	$0.0017	$0.0152	$0.0062	$14.21	$12.83	$13.06	$1.35	$0.94	$2.72	8.38%	2.41%
September	$0.0856	$0.0004	$0.0017	$0.0152	$0.0096	$14.21	$12.83	$13.06	$2.03	$0.94	$2.72	8.38%	2.41%
October	$0.0871	$0.0006	$0.0017	$0.0152	$0.0085	$11.36	$9.97	$13.06	$1.72	$0.94	$2.72	8.38%	2.41%
November	$0.0836	$0.0006	$0.0017	$0.0152	$0.0131	$11.36	$9.97	$7.12	$2.67	$0.94	$2.72	8.38%	2.41%
December	$0.0859	$0.0006	$0.0017	$0.0152	$0.0128	$11.36	$9.97	$7.12	$2.83	$0.94	$2.72	8.38%	2.41%

It is important to note that electricity costs contain two primary components. One is the *energy* component, where cost is per kWh consumed. The second is *demand* component, where cost is per peak kW reached. The demand (kW) component of the electricity price is calculated monthly based on actual hourly peak demand for the month multiplied by the Con Edison published dollars per kW for that month. Con Edison calculates peak demand from the highest two rolling 15 minute periods each month. The table below shows the results of the calculation of electricity costs for each of the six buildings analyzed under the standard tariff.

Table 9. Annual Cost of Electricity Use under Con Edison Standard Tariffs (2007)

Building Type	**ID #**	**Cost**	**Con Edison Rate Class**
Industrial	B1	$ 312,409	SC-04, Rate I
	B2	$ 311,785	SC-04, Rate I
Multifamily	B3	$ 184,411	SC-08, Rate I
	B4	$ 290,121	SC-08, Rate I
Office	B5	$ 5,245,244	SC-09, Rate I
	B6	$ 2,047,776	SC-09, Rate I

This analysis does not include the New York City ECSP/LMEP Adjustments, the Business Incentive Rate, or any other Rider or Incentive program which could affect the value of solar under standard tariff pricing in NYC.[24]

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[22] This table does not include MSC and MAC adjustment charges which are published on an irregular mid-month schedule. These charges are, however, included in all calculations.

[23] This table reflects published pricing for Standard Tariff (SC-09) only. Standard Tariff (SC-04) has a similar structure, but individual numbers vary.

[24] Energy Cost Savings Program (ECSP) / Lower Manhattan Energy Program (LMEP) are city programs that reduce Con Edison electric costs for certain customers of Con Edison.

2-2. Economic Performance of PV Systems under Standard Tariffs.

Determining the value of solar generated electricity is relatively straightforward if the solar system (a) is sized to produce less than building load, (b) qualifies for net metering[25], and (c) generates less electricity than total building consumption over an annual period.

The first step in determining the value of PV systems under standard pricing is to determine the energy output (kWh) of each PV system for each building on an hourly basis. Hourly solar electricity generation is calculated by multiplying the estimated PV array size for each building (Table 6) by the hourly performance factors (kWh/kW) of each PV system (see Appendix for results).

Consider Building B1, an industrial building. The available area for PV allows for an 80 kW system. The annual normalized solar output for S1 is scaled up by a factor of 80, which corresponds to the output of S1 as an 80 kW PV system. This output is then applied to the hourly building load profile to obtain the predicted building load profile after the PV electricity is accounted for. The electric tariff is then applied to the load profile to obtain the cost after PV. The result is subtracted from the values in Table 9 without PV electricity to calculate the energy cost reduction generated by the integration of solar PV systems under standard pricing.

The following table shows the results of these calculations for two solar PV systems hypothetically placed on each of the six buildings. The key difference between the two solar systems is that one is tilted more closely to horizontal and optimized for summer production (S1) and the other is tilted at a higher angle better for year-round production (S5).

Table 10. Annual PV Electric Output and Value for Solar Systems S1 (low tilt) and S5 (higher tilt) for Each Building (Standard Tariff).

		PV Energy Output (kWh)			**Value of PV ($)**		
Building Type	**ID #**	**S1**	**S5**	**% Diff**	**S1**	**S5**	**% Diff**
Industrial	B1	95,059	97,980	**3%**	$ 20,948	$ 21,224	**1%**
	B2	68,918	71,036	**3%**	$ 10,915	$ 10,710	**-2%**
Multifamily	B3	10,694	11,023	**3%**	$ 1,588	$ 1,539	**-3%**
	B4	15,447	15,922	**3%**	$ 1,982	$ 1,913	**-4%**
Office	B5	89,118	91,857	**3%**	$ 18,429	$ 19,236	**4%**
	B6	10,694	11,023	**3%**	$ 2,272	$ 2,428	**7%**

PV System S5 out-produces S1 by 3% in terms of raw electric output (kWh), but for three of the six buildings, S1 is more valuable. Traditionally, a system installed at a tilt equal to latitude, or 41 degrees for New York City, has been considered to be optimal because it has the greatest energy output. The key finding in this chart is this: while a lower tilt angle system does output less energy, it is possible for it to be more valuable than higher tilt angle system.

The reason for this higher value is that electric rates are higher during the summer (see Table 8). PV system S1 has higher electric output during the summer (see Figure 5) when electric energy and demand charges are higher; for some of the buildings this low-tilt system is able to derive

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[25] Net metering is important to allow a building access to 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.

enough additional value from the high summer electric prices to more than make up for its lower year-round energy output[26].

The average all-in value of PV for 2007 is then calculated by dividing the total savings from solar generated output by the kWh produced by each solar system (both found in Table 10). The result is a normalized price for one kWh of solar, including all components of the Standard Tariff – demand, energy and fees/taxes. The average all-in value of PV for each building across each solar array can be found in the following table.

Table 11. Annual Average all-in Value of PV Generated Electricity ($/kwh), by Building (Standard Tariff)

		Value of PV (all-in $/kWh)	
Building	**ID #**	**S1**	**S5**
Industrial	B1	$0.22	$0.22
	B2	$0.16	$0.15
Multifamily	B3	$0.15	$0.14
	B4	$0.13	$0.12
Office	B5	$0.21	$0.21
	B6	$0.21	$0.22

Table 11 displays that the office and industrial buildings extract more value from solar energy than multifamily buildings. It is interesting to note that there is much greater fluctuation in the all-in value of solar as building load profile varies ($0.10/kWh difference between B1 and B4) than as solar production profile varies ($0.01/kWh difference between S1 and S5). This indicates that building load profile plays a much stronger role than the solar production profile in determining the value of PV.

Table 11 represents the average all-in value of PV generated electricity for an entire year. But the real time price of electricity, as a function of NYISO Zone J, is constantly fluctuating. The following figure displays normalized solar output (50 hour moving average of hourly PV Performance Factors) and the fluctuating price of electricity sorted by highest real-time price.

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[26] Why might PV system S5 be more valuable for B1, but S1 is more valuable for B2? That is likely due to the interaction of each solar system with each building – if by chance one PV system is producing during an hour when the other is not, and that hour happens to be a peak demand setting hour for the building, then that would cause one solar PV system production profile to be more valuable than the other.

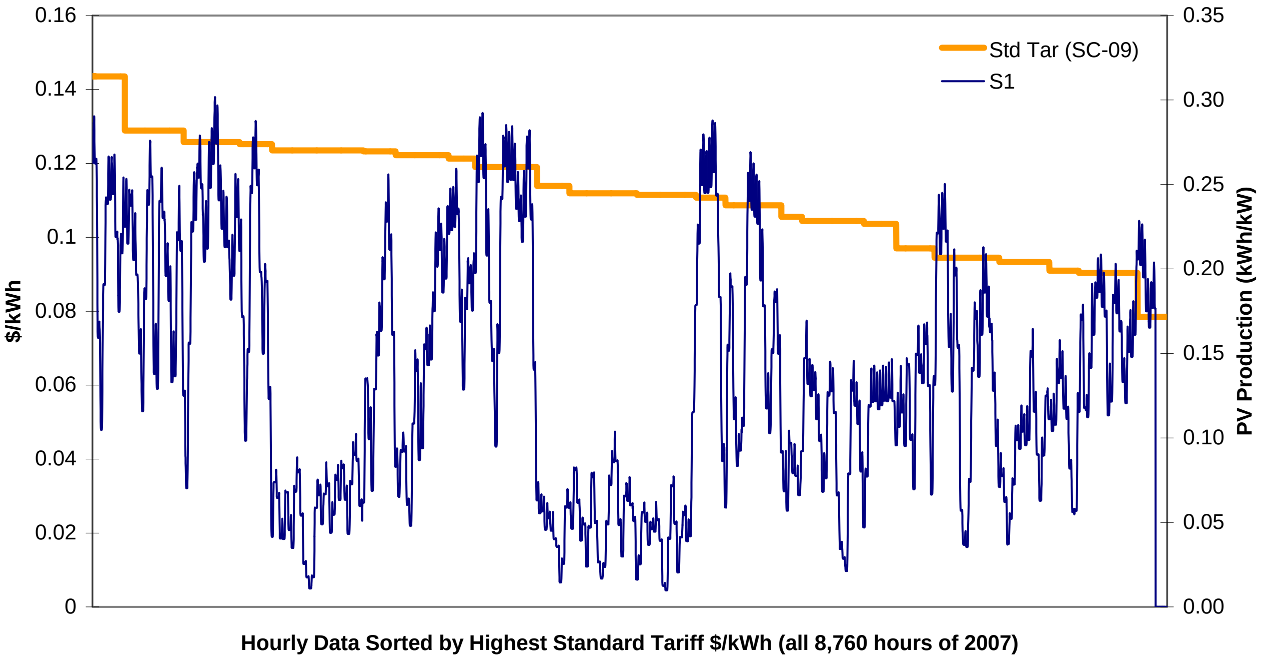

Figure 14. Standard Tariff Price of Electricity ($/kWh) and 50-hour Moving Average Performance Factor for S1 (kWh/kW).

Under the Standard Tariff, solar performance output does not correlate with the all-in price, as shown in Figure 14. This result is expected: for 2007, the standard tariff shows slightly higher prices in the summer, but prices are also relatively high in winter (Table 8). April and May are two of the best months for solar production (Figure 3, Figure 5) and also have some of the lowest prices under the Standard Tariff (Table 8). Also, the Standard Tariff has no time-of-day variation in electric price, so summer nights have relatively high electric prices with no solar production.

3. Value of PV Under Real Time Pricing Scenarios

The value added by the installation a PV system for a given building under real-time pricing is evaluated by comparing electric utility costs both with and without a PV system installed. The method employed in this section is similar to that of the Standard Tariff in Section 2, except with a real-time tariff. The value of PV under a real time pricing scenario will be evaluated and compared to the value of PV under a standard tariff in Section 4.

3-1. Real-Time Pricing Tariff

In this study, Real Time Pricing (RTP) is defined as Con Edison's hourly pricing tariff, Rider M. While Rider M may not be the optimal RTP rate for solar, it was selected for pragmatic reasons – it is the RTP rate currently available to Con Edison customers. Rider M is a mandatory program for buildings in Con Edison territory with peak demand over 500 kW[27]. Under the current Con Edison rules for Rider M, only two buildings in this study (B5 and B6) are subject to mandatory Real-Time Pricing. For the purposes of the study, these buildings will be treated like all other buildings and evaluated under both RTP and the Standard Tariff Pricing for Office Buildings.

The Rider M Tariff is calculated as the New York Independent System Operator (NYISO) day-ahead market price for energy in Zone J (NYC) adjusted for line losses of 7.9%, plus ancillary services and adjustments, the System Benefits Charge and Renewable Portfolio Standard, delivery and demand, supply charges and adjustments, fixed billing and metering fees, and taxes. The tariff is illustrated graphically in the following chart.

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[27] Rider M is also available on a voluntary basis, that rate is similar, but was not evaluated for this study. The voluntary Rider M rate is similar to the mandatory rate, except that does not have time-of-day demand charges; time-of-day demand charges are favorable to solar, it is likely that the mandatory rate is somewhat more favorable than the voluntary for PV.

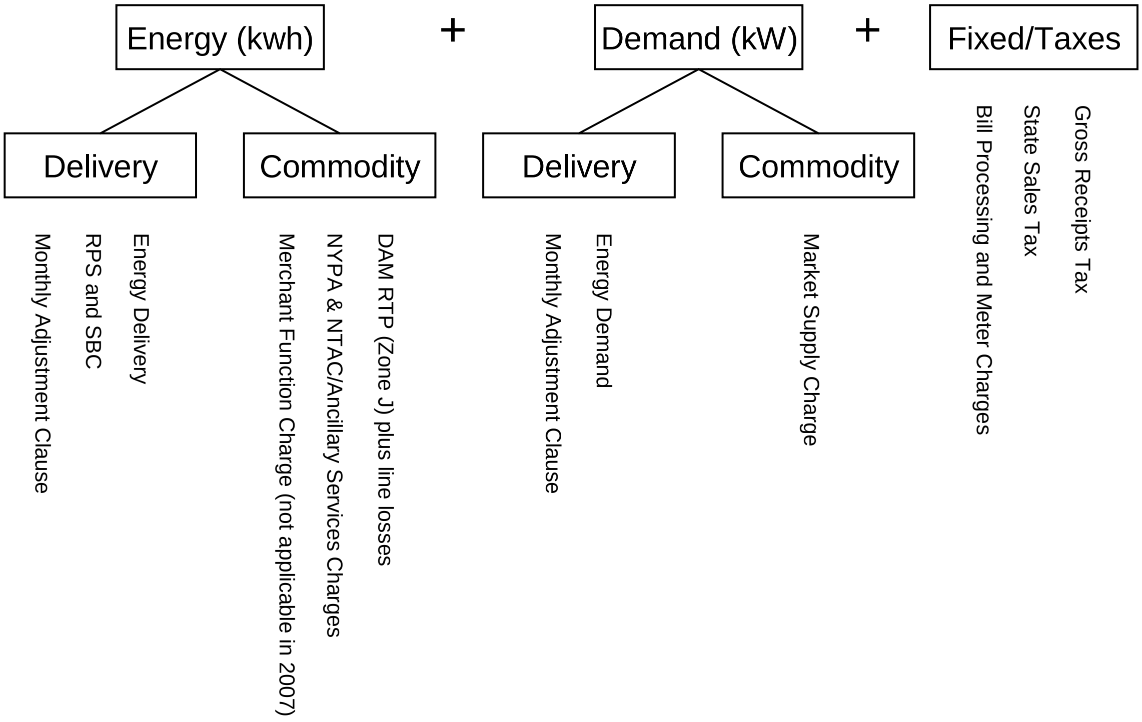

Figure 15. Rate Structure of Hourly Real-Time Pricing

The cost per component for the tariff outlined in Figure 15 is shown in the following table. This table shows how the price of each element varies on a monthly basis.

Table 12. Con Edision Real-Time Pricing under SC-09 (as published) .[28],[29]

	Energy					Demand					Fixed / Taxes			
	RPS	**SBC**	**Energy Delivery**	**MAC**	**MAC**	**Energy Demand**			**MSC**	**MAC**	**Bill Process**	**Meter**	**Tax**	**Gross Receipts Tax**
	$/kwh	*$/kwh*	*$/kwh*	*Mon/Fri 8am-10pm* $/kwh	*all other* $/kwh	*Mon/Fri 8am-6pm* $/kw	*Mon/Fri 8am-10pm* $/kw	*all hours* $/kw	*$/kwh*	*$/kwh*	*$/bill*	*$/bill*	*%*	*%*
January	$0.0004	$0.0017	$0.0052	$0.0084	$0.0057		$7.55	$3.27	$8.06	$ 2.34	$0.94	272.00%	8.38%	2.52%
February	$0.0004	$0.0017	$0.0052	$0.0097	$0.0066		$7.55	$3.27	$9.58	$ 2.77	$0.94	272.00%	8.38%	2.52%
March	$0.0004	$0.0017	$0.0052	$0.0090	$0.0061		$7.55	$3.27	$9.58	$ 2.59	$0.94	272.00%	8.38%	2.52%
April	$0.0004	$0.0017	$0.0055	$0.0100	$0.0068		$7.93	$3.45	$9.58	$ 2.60	$0.94	272.00%	8.38%	2.41%
May	$0.0004	$0.0017	$0.0055	$0.0081	$0.0054		$7.93	$3.45	$14.92	$ 1.69	$0.94	272.00%	8.38%	2.41%
June	$0.0004	$0.0017	$0.0055	$0.0068	$0.0047	$5.71	$10.80	$10.66	$14.92	$ 1.47	$0.94	272.00%	8.38%	2.41%
July	$0.0004	$0.0017	$0.0055	$0.0012	$0.0008	$5.71	$10.80	$10.66	$14.92	$ 0.31	$0.94	272.00%	8.38%	2.41%
August	$0.0004	$0.0017	$0.0055	$0.0051	$0.0036	$5.71	$10.80	$10.66	$14.70	$ 1.13	$0.94	272.00%	8.38%	2.41%
September	$0.0004	$0.0017	$0.0055	$0.0082	$0.0058	$5.71	$10.80	$10.66	$14.70	$ 2.00	$0.94	272.00%	8.38%	2.41%
October	$0.0006	$0.0017	$0.0055	$0.0076	$0.0053		$7.93	$3.45	$14.70	$ 1.71	$0.94	272.00%	8.38%	2.41%
November	$0.0006	$0.0017	$0.0055	$0.0107	$0.0073		$7.93	$3.45	$8.29	$ 2.50	$0.94	272.00%	8.38%	2.41%
December	$0.0006	$0.0017	$0.0055	$0.0116	$0.0079		$7.93	$3.45	$8.29	$ 3.37	$0.94	272.00%	8.38%	2.41%

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[28] Note that this table does not include RTP (Zone J) adjusted for losses which is priced hourly or NYPA and NTAC/Ancillary services charges which become effective on mid month schedule. However, all calculations include both RTP and NYPA and NTAC/Ancillary Services Charges.

[29] This table reflects published pricing for Standard Tariff (SC-09) only. Standard Tariff (SC-04) may vary on several components of this table.

The same caveats apply to this table as to Table 8 which showed the breakdown of the Standard Tariff. Additionally, it is important to note that Table 14 does not show the portion of the tariff that varies on an hourly basis: the aforementioned NYISO day-ahead market hourly pricing in Zone J adjusted for line losses. A graph of the hourly price for all 8,760 hours of 2007 is displayed below.

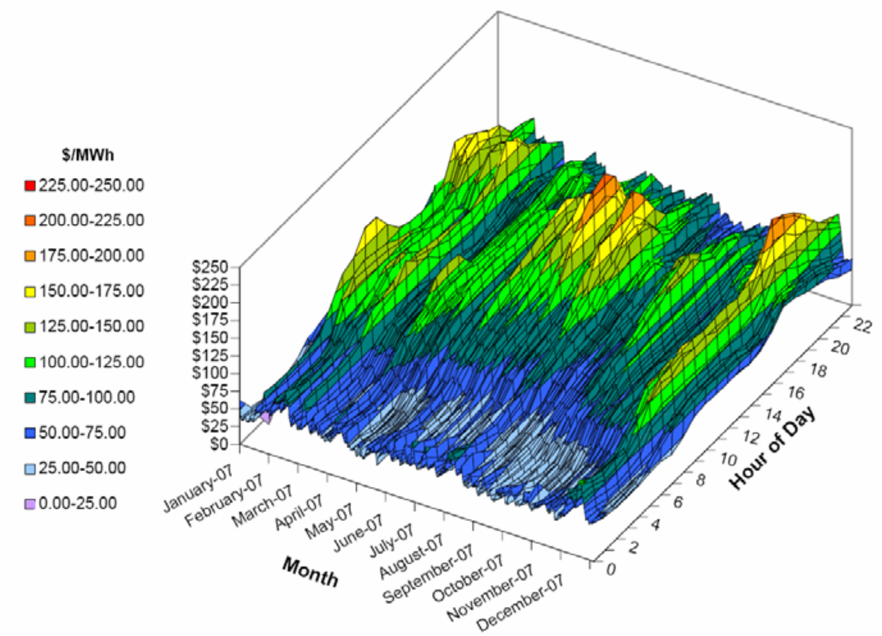

Figure 16. Hourly[30] NYISO Zone J Price per MWh adjusted for losses, 2007

To demonstrate the impact of hourly pricing, the electric consumption of each building is multiplied by the hourly price shown in Figure 16. The following figure shows the hourly cost of electricity for Building 1 (without solar power) during 2007 under hourly pricing.

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[30] Hourly Day Ahead Real Time Price.

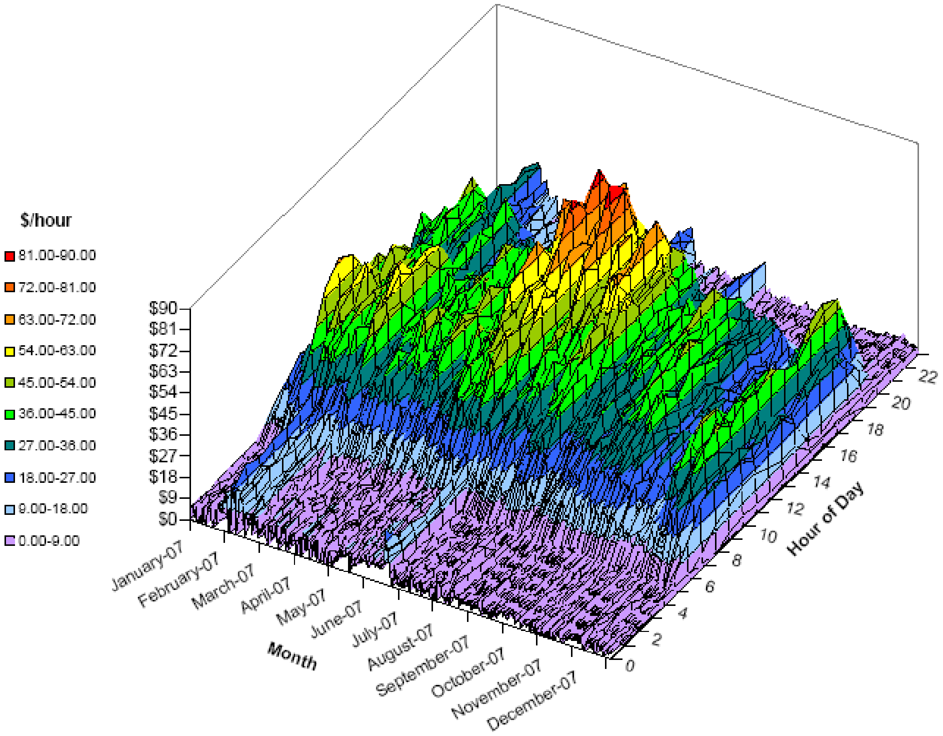


Figure 17. Hourly Component of Electric Energy Cost ($/hr) – Industrial Building B1 without Solar, 2007 (PV System S1).

When the hourly component is combined with the other components of the electric bill shown in Table 13, the annual cost of electricity under for each building can be calculated. The following table presents the annual cost of electricity for each building under hourly pricing, inclusive of demand, energy, and fees.

Table 13. Annual Cost of Electricity under hourly pricing.

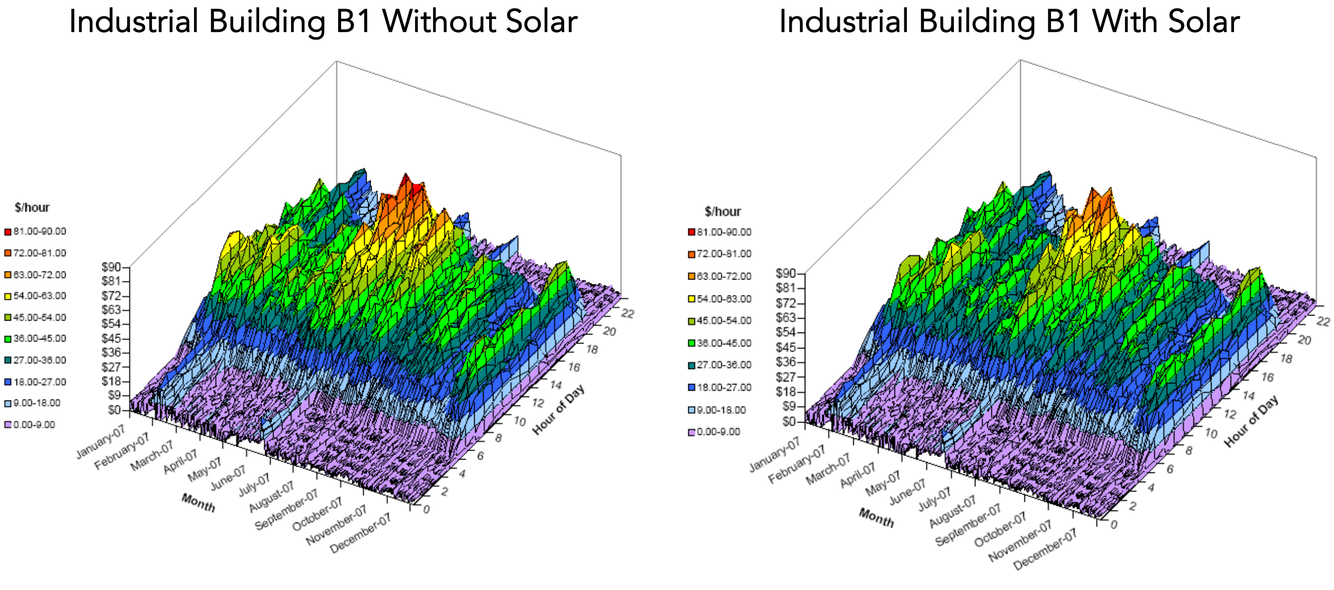
Building Type	ID #	Cost	Con Edison Rate Class
Industrial	B1	$ 296,742	SC-04, Rider M
	B2	$ 296,266	SC-04, Rider M
Multifamily	B3	$ 193,204	SC-08, Rider M
	B4	$ 302,009	SC-08, Rider M
Office	B5	$ 5,550,333	SC-09, Rider M
	B6	$ 2,222,266	SC-09, Rider M

3-2. Economic Performance of PV Systems under hourly pricing

As mentioned in Section 2-2, determining the value of solar generated electricity is relatively straightforward if the solar system (a) is sized to produce less than building load, (b) qualifies for net metering[31], and (c) generates less electricity than total building consumption over an annual period.

The method for evaluating the economic performance of the PV systems under real-time pricing is similar to the method employed for the standard tariff. Generated hourly solar electricity is subtracted from building consumption on an hourly basis, run through the pricing outlined above (see Table 12 and Figure 16), and subtracted, on an hourly basis, from the data for the building without solar. The following table shows the energy cost reduction generated by the integration of solar systems under real time pricing.

Again consider Building B1, the same industrial building used as an example in Section 2-2 on the Standard Tariff. The available area for PV allows for an 80 kW system, the output of which is applied to the hourly building load profile to obtain the predicted building load profile with solar. The energy component of the electric tariff is then applied to the load profile to obtain the hourly cost of the energy component. The hourly cost of energy, with and without solar, respectively, are displayed in Figure 18 below.



Industrial Building B1 Without Solar

Industrial Building B1 With Solar

Figure 18. Hourly Component of Electric Energy Cost ($/hr) – Industrial Building B1 without Solar and with Solar Integration, 2007 (PV System S1).

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[31] Net metering is important to allow a building access to the full retail price during those hours when the building produces more than it uses. All buildings in this study use more electricity than what is produced by the solar PV system on an annual basis.

Note in the above graphs that the "peaks" on the left are diminished on the right, indicating that solar has reduced the peak load of the building. The graphs in Figure 18 can be reconciled into one graph by calculating the difference in energy cost. The following figure shows the difference in energy (kWh) costs for Building 1 with and without solar integration.

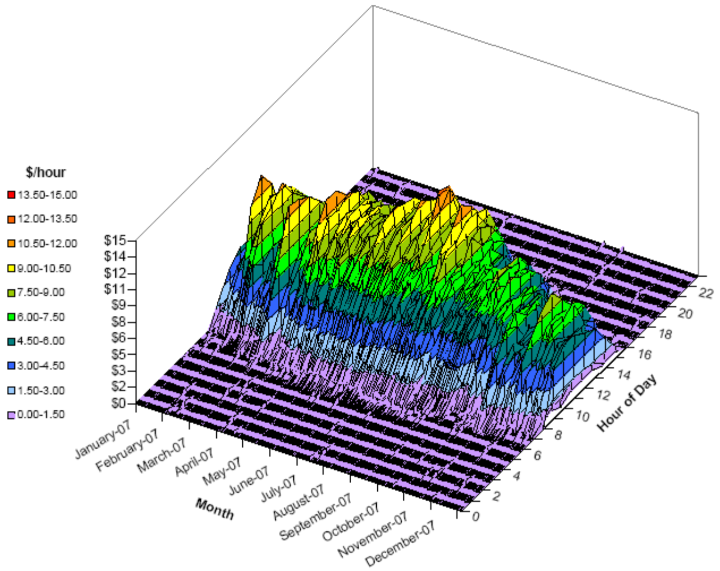

Figure 19. Hourly Value of Solar for Building B1 (PV System S1).

While the hourly value of PV to the energy component (kWh) of the electric bill is independent of building load profile, the total value of PV on a monthly and annual basis is dependent on the interaction of the building load profile with the PV production profile. If the PV system produces power coincident with the peak load, then the demand charge is reduced. As such, the full value of solar energy under hourly pricing includes savings on energy, demand, taxes and fees. The following table shows the annual energy output and value of that output for two solar PV systems hypothetically placed on each of the six buildings. The same two systems appear here as in Section 2-2 on Standard Tariff pricing, one is tilted more closely to horizontal and optimized for summer production (S1) and the other is tilted at a higher angle better for year-round production (S5).

Table 14. Annual PV Energy Output and Value for Solar Systems S1 (low tilt) and S5 (higher tilt) for Each Building (Hourly Pricing).

		PV Energy Output (kWh)			**Value of PV ($)**		
Building Type	**ID #**	**S1**	**S5**	**% Diff**	**S1**	**S5**	**% Diff**
Industrial	B1	95,059	97,980	**3%**	$ 19,661	$ 19,803	**1%**
	B2	68,918	71,036	**3%**	$ 11,221	$ 11,028	**-2%**
Multifamily	B3	10,694	11,023	**3%**	$ 1,778	$ 1,731	**-3%**
	B4	15,447	15,922	**3%**	$ 2,179	$ 2,148	**-1%**
Office	B5	89,118	91,857	**3%**	$ 20,176	$ 20,936	**4%**
	B6	10,694	11,023	**3%**	$ 2,458	$ 2,602	**6%**

The results here are similar to those seen in Section 2-2 on standard pricing: PV System S5 out-produces S1 by 3% in terms of raw energy output, but for three of the six buildings, lower tilt PV system S1 is more valuable. The reason for this higher value is that electric rates are higher during the summer (see Table 12). PV system S1 has higher electric output during the summer (see Figure 5) when electric energy and demand charges are higher; for some of the buildings this low-tilt system is able to derive enough additional value from the high summer electric prices to more than make up for its lower year-round energy output.

The average all-in value of PV for 2007 is then calculated by dividing the total savings from solar generated output by the kWh produced by each solar system (both found in Table 14). The result is a normalized price for one kWh of solar, including all components of the Hourly Pricing Tariff – demand, energy and fees/taxes. The average all-in value of PV for each building across each solar array can be found in the following table.

Table 15. Annual Average all-in Value of PV Generated Electricity ($/kwh), by Building (Hourly Tariff).

Building Type	**ID #**	**Value of PV (all-in $/kWh)** **S1**	**S5**
Industrial	B1	$0.21	$0.20
	B2	$0.16	$0.16
Multifamily	B3	$0.17	$0.16
	B4	$0.14	$0.13
Office	B5	$0.23	$0.23
	B6	$0.23	$0.24

Table 15 displays that the office and industrial buildings extract more value from solar energy than multifamily buildings, as in Section 2-2. There is much greater fluctuation in the all-in value of solar as building load profile varies ($0.11/kWh difference between B4 and B6) than as solar production profile varies ($0.01/kWh difference between S1 and S5). This indicates that under hourly pricing as under the Standard Tariff, building load profile plays a much stronger role than the solar production profile in determining the value of PV.

Table 15 represents the average all-in value of PV generated electricity for an entire year. But the real time price of electricity, as a function of NYISO Zone J, is constantly fluctuating. The following figure displays normalized solar output (50 hour moving average of hourly PV Performance Factors) and the fluctuating price of electricity sorted by highest real-time price.

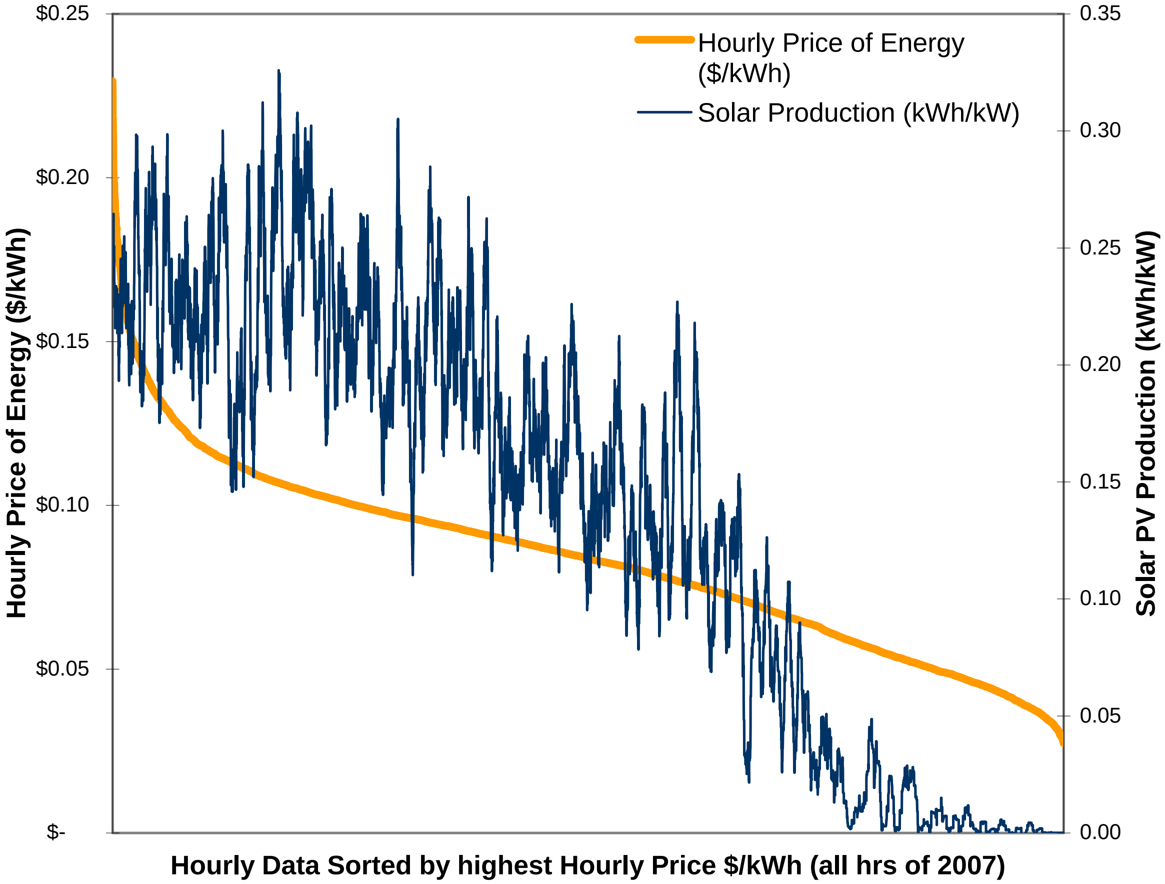

Figure 20. Real Time Price of Electricity ($/kWh) and Normalized Solar Output for S1 (kWh/kW).

PV Production is typically highest when the hourly price is most valuable, indicating that the hourly price tends to be high in the middle of the day when solar arrays have peak output. This represents a key finding of the report: there is a correlation between solar production and the price of electricity in New York City. This is in contrast to Standard Tariff pricing, where the price of electricity does not correlate with solar output.

However, while high PV output to correlates overall with high hourly price, during the most valuable periods of hourly price this correlation becomes slightly inverted, as shown in the following figure.

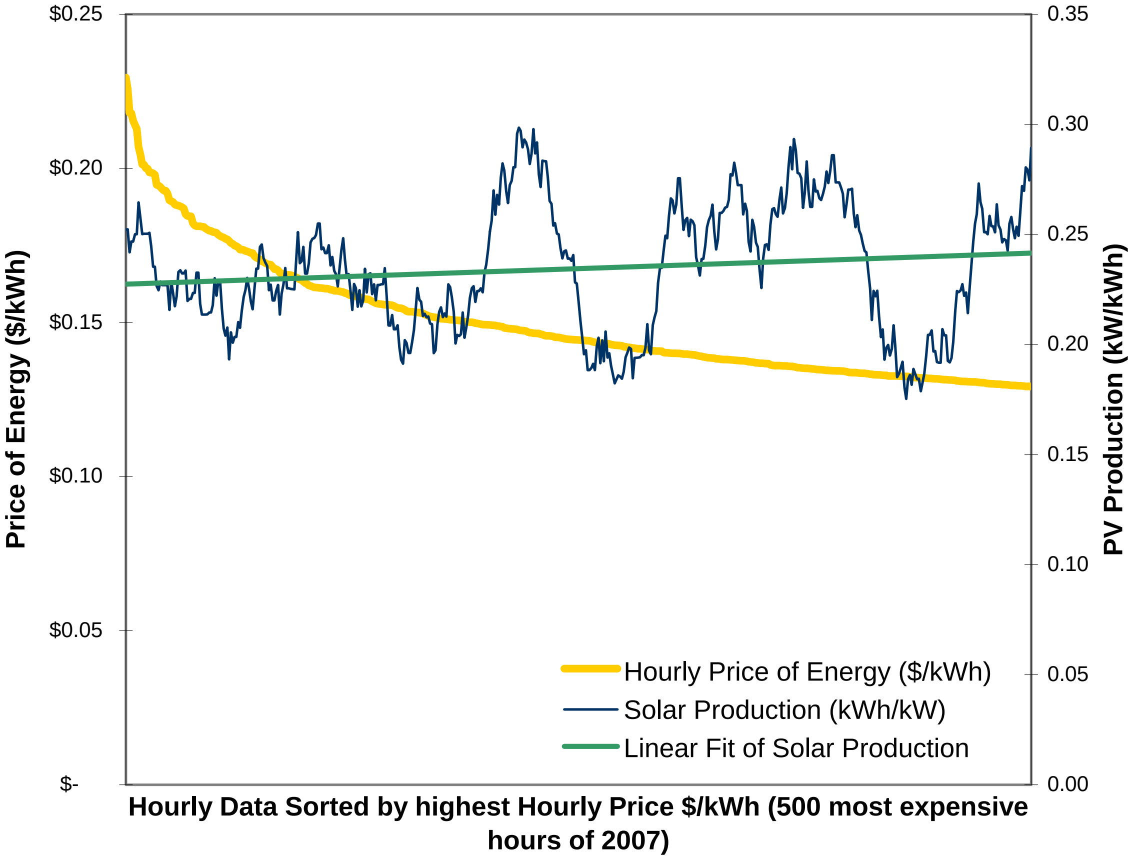

Figure 21. Real Time Price of Electricity ($/kWh) and Normalized Solar Output for S1 (kWh/kW) during the most expensive 500 Real Time Pricing Hours.

During the 500 most expensive hours under hourly pricing, solar production correlates negatively to price. This is likely because the periods of highest PV output (11:00 to 14:00, April - June) are not entirely coincident with the periods of highest NYISO Zone J electricity price (14:00-17:00, June-August) for the majority of New York City buildings.

Historical statistical analysis of Zone J Day Ahead Hourly Real Time Price

Since May 2005, the NYISO Zone J real time price has been volatile – if 2005, 2006, or 2008 were analyzed in place of 2007, the real time pricing may have been more or less attractive. Small peaks (up to around $200/MWh) occur throughout the year and larger peaks (up to $400-$500/MWh) tend to be concentrated largely in the summer months. The hourly price dating back to May 2005 is included in the following figure.

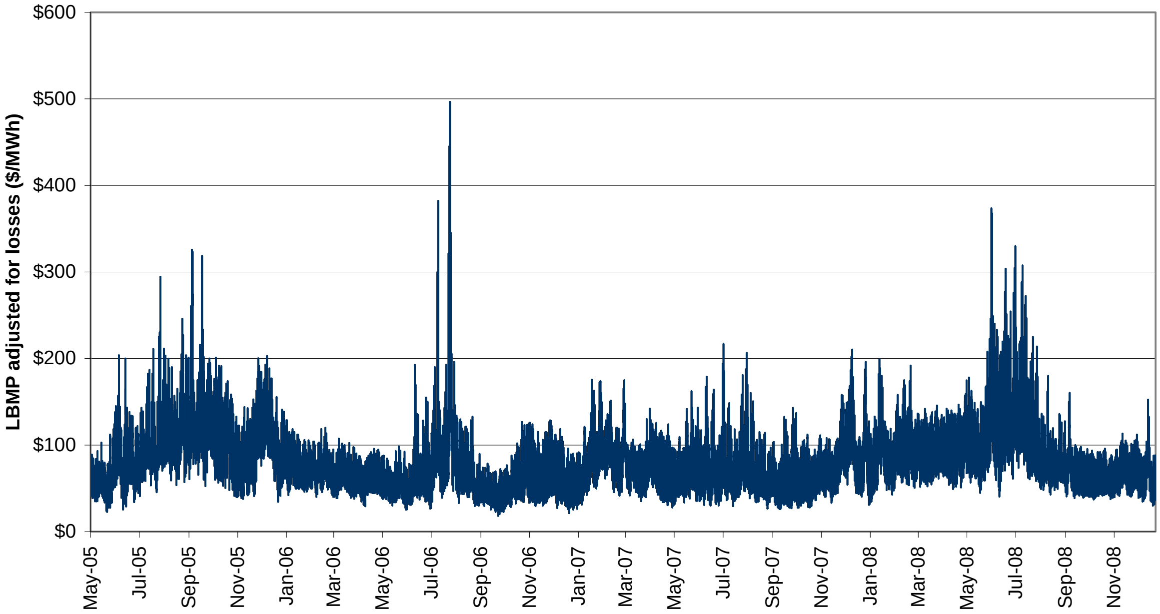

Figure 22. NYISO Zone J Day Ahead Hourly Real-Time price, May 2005 – December 2008

The average price per month over the period from May 2005 to December 2008 is shown in the following figure. This figure better illustrates the Zone J pricing peaks during the summer months.

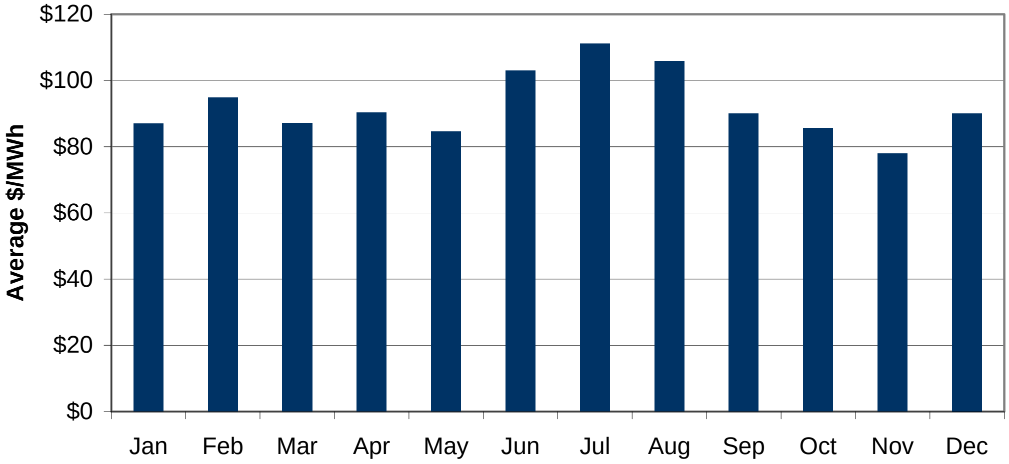

Figure 23. Average Hourly Price ($/MWh) by month May 2005 – Dec 2008, NYISO Zone J

Another way of presenting the hourly price of electricity, is to count the number of occurrences at various price thresholds to give a sense for the frequency of different price ranges. The average $/MWh for NYISO Zone J Hourly Price from May 2005 to December 2008 was $92.53. The price was $100 or less 67% of the time, $200 or less 98% of the time $300 or less 99.8% of the time. In 32,000 hours there were only 10 hours when the price exceeded $400.

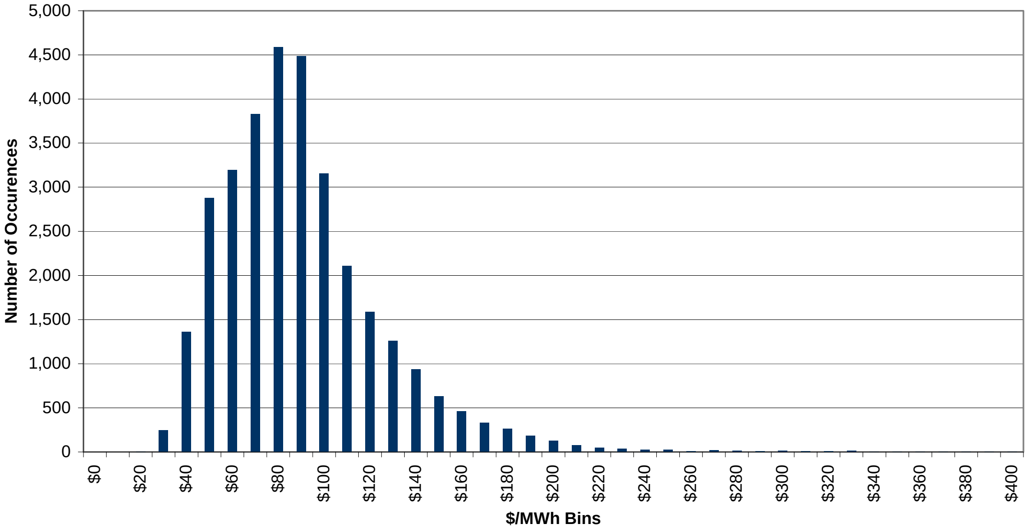

Figure 24. Histogram of NYISO Zone J Day Ahead Hourly Price ($/MWh), May 2005 – Dec 2008.

4. Economic Comparison of RTP and Standard Tariff Pricing

In this section, the value of PV under Con Edison's Rider M hourly real time pricing (see Section 3) is compared with Standard Tariff pricing (see Section 2).

4-1. Energy and Demand Cost Components

In order to compare the economics of RTP and Standard Tariff Pricing, it is critical to understand the distinction between *energy* (kWh) and *demand* (kW). As explained previously, each component plays a significant role in the value of PV under both RTP and Standard Pricing.

Electric Energy Component

For 2007, the energy component of the hourly price is generally lower than the energy component for the Standard Tariff. The Standard Tariff (SC-09) energy component ($/kWh) price is greater than the Real-Time Energy component ($/kWh) price in 61% of all instances. This holds true. The following figure displays energy cost data for 2007 for the Hourly and Standard Tariff Pricing (Con Edison tariffs SC-09, SC-08, and SC-04).

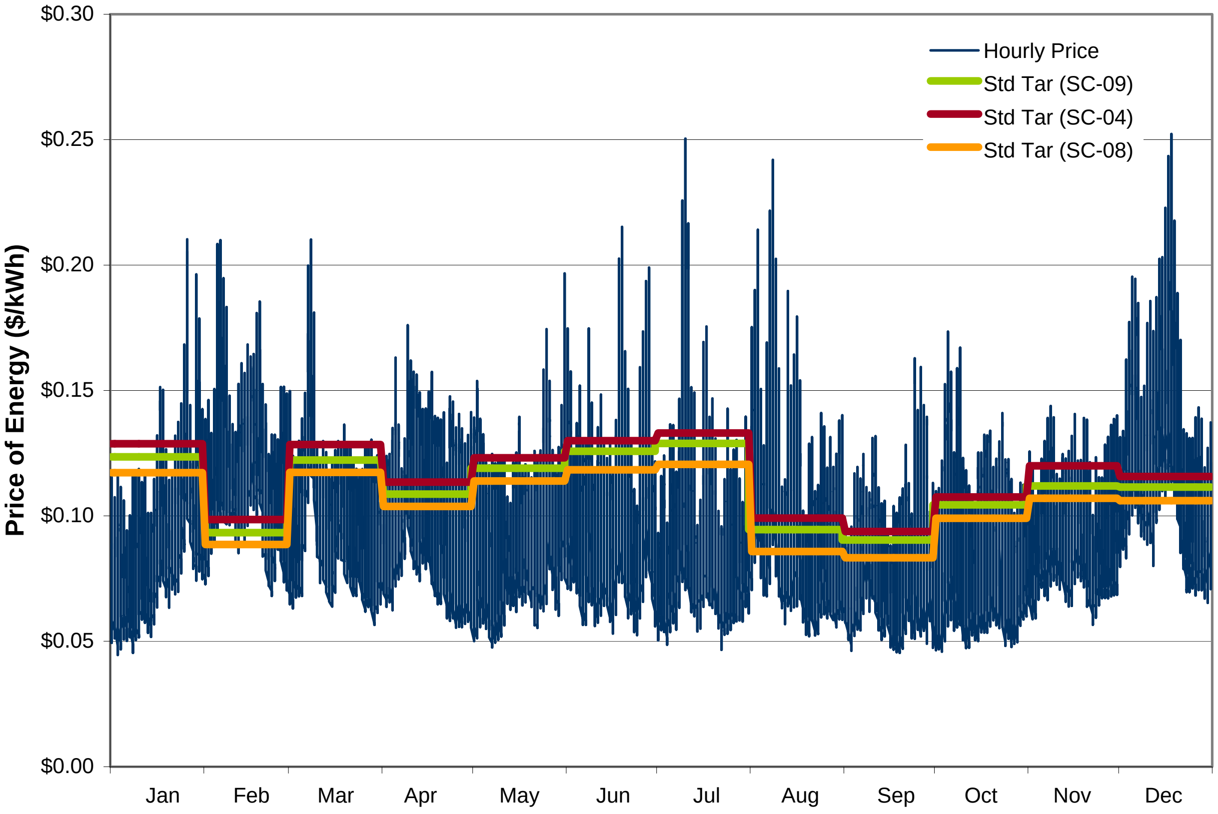

Figure 25 . Hourly Price vs. Standard Tariff ($/kWh), 2007.

The average price of energy is generally lower under hourly pricing, but it is also more volatile. Additionally, while the energy component of hourly pricing was $0.009/kWh cheaper than the Standard Tariff (SC-09) on average for 2007, a typical customer would use more energy during higher priced periods (by definition they are higher priced due to higher demand).[32] As such, this un-weighted price cannot be directly compared to the average energy component price paid by each building.

For the purposes of this study, a more interesting analysis arises by evaluating electric energy component prices during the hours in which PV systems are generating electricity. The price of electricity under the Hourly and Standard Tariffs can also be averaged according to relative levels of solar performance. The following figure demonstrates this calculation for solar system S4 under SC-09 for both Hourly and Standard Pricing.[33] In the chart below, a horizontal axis value of 0 represents no solar output, a value of 0.1 represents a solar performance factor (kWh/kW) greater than 0, but less than 0.1, and so on.

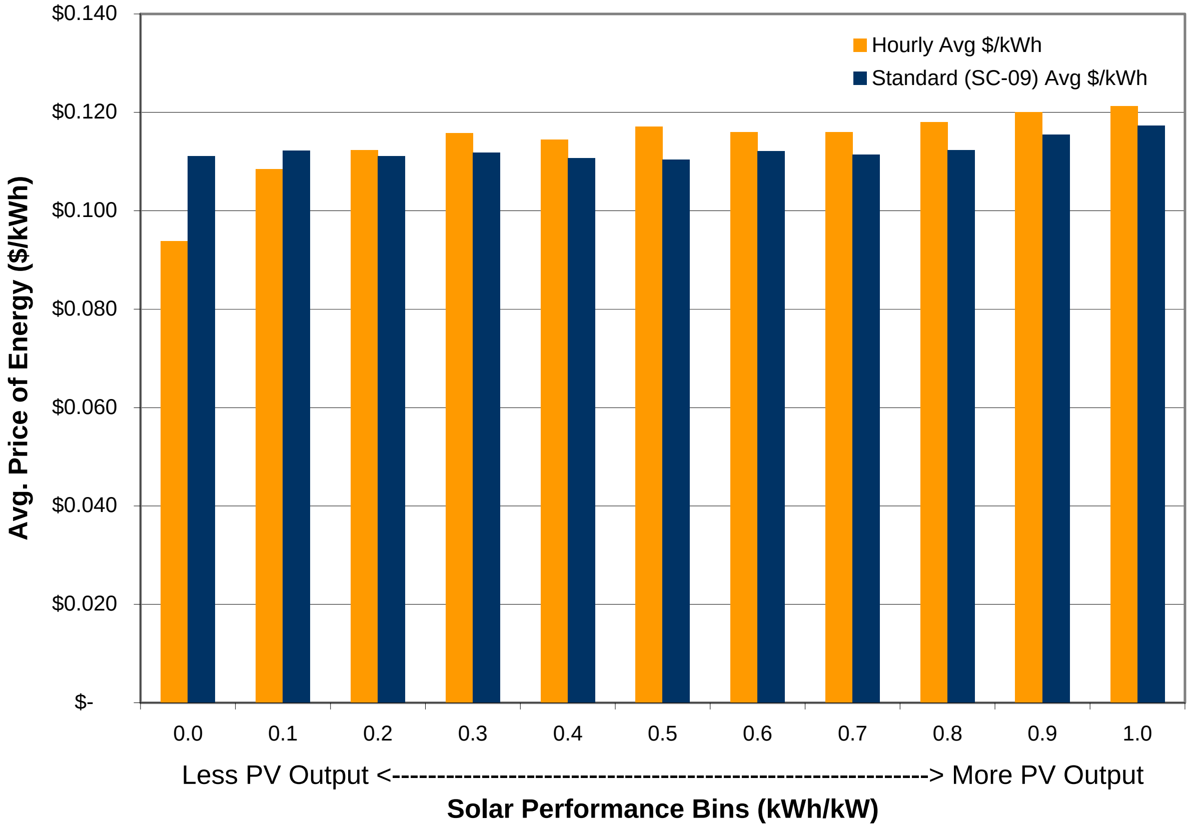

Figure 26. Average Cost of Energy vs. Solar Performance under Hourly and Standard Pricing, 2007.

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[32] The average Standard Tariff (SC-04) price was $0.116. Similarly, for Standard Tariff (SC-08) energy component ($/kWh) price was $0.1052.

[33] Solar Performance for system S4 is allocated into PV Performance Factor bins, with a higher bin number equaling better conversion of sunlight into electricity. Data points falling into the 0.1 bin represent those data points between zero and 0.1, data points falling into the 0.2 bin represent data points between 0.1 and 0.2, and so on.

At all bins of solar performance except the lowest, Hourly pricing has a higher value of energy ($/kWh) than the Standard Tariff.[34] It is worth noting that 57% of all hourly prices are in the 0.0 bin (corresponding to no PV output), the remaining 43% of the hourly prices in the year are spread across the hours of the year when the solar system has a measurable output. However, the above charts only show the *energy* component of the electric bill, the *demand* side of the story is another key element.

The Electric Demand Component

The demand component of both tariffs is dependent on peak usage, but under Real-Time Pricing it is also dependent on time of use. Under Hourly Pricing, the peak demand is billed in three distinct time-of-day periods – 8AM to 6PM, 8AM to 10PM, and at all hours – for each monthly billing cycle.

To discern the effect of demand cost, the all-in cost of electricity is a useful metric. The following figure shows the all-in cost of electricity under both tariffs for industrial, multifamily, and office buildings.

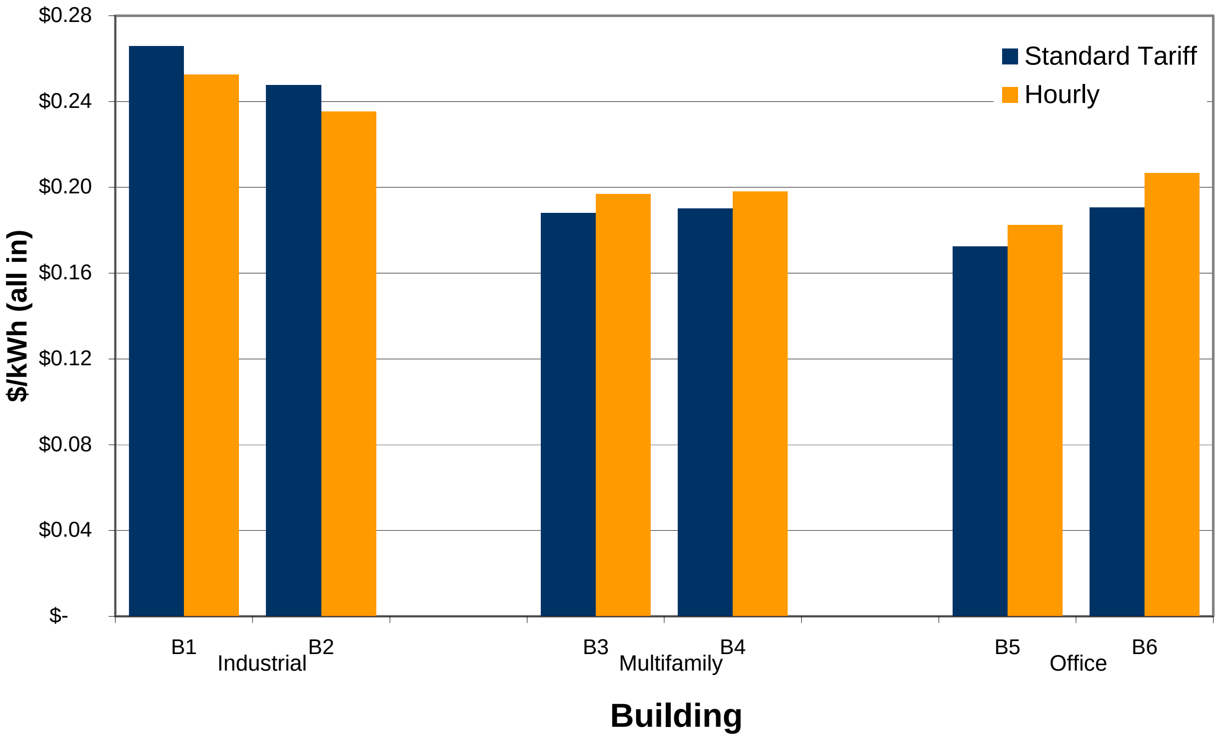

Figure 27. Electricity Price (annual average all-in $/kWh) – Standard Tariff and Hourly RTP Tariff (without Solar PV).

Figure 27 demonstrates two interesting points. For industrial buildings, the all-in cost of electricity is greater for Standard Tariff pricing than for Hourly Pricing. The cost of electricity is greater for industrial buildings than the other types of buildings under both tariffs. An analysis of the cost components (energy, demand, and taxes) reveals that the demand component (blue)

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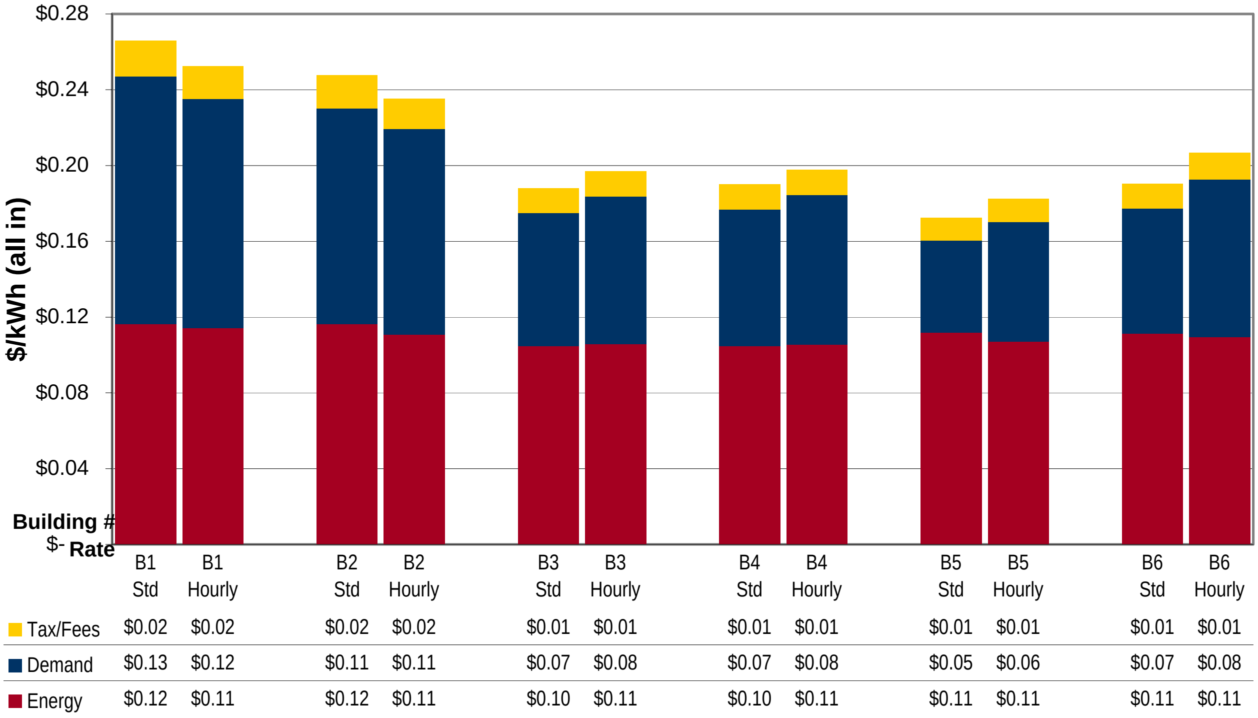
[34] SC-04 and SC-08 results show the same trend.

drives the all-in cost for buildings, while the energy component (red) remains relatively consistent. The following figure breaks down the cost components for all buildings in this study for both tariffs.



	B1 Std	B1 Hourly	B2 Std	B2 Hourly	B3 Std	B3 Hourly	B4 Std	B4 Hourly	B5 Std	B5 Hourly	B6 Std	B6 Hourly
🟨 Tax/Fees	$0.02	$0.02	$0.02	$0.02	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01
🟦 Demand	$0.13	$0.12	$0.11	$0.11	$0.07	$0.08	$0.07	$0.08	$0.05	$0.06	$0.07	$0.08
🟥 Energy	$0.12	$0.11	$0.12	$0.11	$0.10	$0.11	$0.10	$0.11	$0.11	$0.11	$0.11	$0.11

Figure 28 . Electricity Price
(annual average all-in $/kWh) by Component of Bill for Standard Tariff and Hourly RTP Tariff, (without Solar PV).

The average cost of the energy component of the electric bill ($/kWh) for all buildings under both tariffs is $0.11 per kWh with a standard deviation of $0.004 per kWh. This result is a surprising conclusion: despite all the hourly fluctuations in energy prices in one tariff and no hourly fluctuations in the other, the cost of energy is nearly the same under both tariffs for all six buildings.

Across all buildings and both tariffs, the role of demand is the dominant factor for the average all-in electricity costs. What is driving the demand component? To address this question, the load factor load profile for all buildings must be considered. The load factor for all buildings in this study ranged from 0.28 to 0.38, with the exception of Building B5, which had a load factor of 0.58. Notice in that B5 shows the lowest value demand component of any building analyzed. Buildings with low load factors (meaning that peak demand is much higher than average demand) can have the demand component significantly affect the all-in cost of electricity. While the load factor plays a role in determining the importance of demand charges in relation to the electric bill as a whole, the load profile – or specific way the load varies over the course of each day and the entire year – determines which tariff will result in a higher price.[35] For example, the

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[35] The difference in the way demand is billed under the RTP Tariff and Standard Tariff together with the specific load profile of a given building the determines whether the price of demand will be higher under one tariff or another. With relatively low load factors, it is not surprising that demand played a significant role . Therefore, the occurrence of low load factors only plays a significant role affecting demand costs when the load profile of the building indicates peak loads during summer day light hours, as is the case of industrial buildings (Figure 7 and 8). It should be noted that the demand cost per kW for the other two Service Classifications under both tariffs had little effect on the contribution of demand costs to the all-in demand cost for every building in this study.

industrial buildings (B1 and B2) see a decrease in the cost of peak demand under Hourly Pricing because their demand is less seasonally dependent and thus they are able to compensate for higher summer demand costs with lower winter demand costs.

Table 16 and Table 17 demonstrate this seasonal dependency by displaying the average all-in electricity cost under both tariffs for Building 1 (Industrial, SC-04) and Building 4 (Multifamily, SC-08) on a monthly basis.

Table 16. Electric Price (monthly average all-in $/kWh) for Building B1, Industrial, by month

Hourly vs. Standard Tariff (SC-09)[36]

	RTP	Standard	Difference
Jan	0.19	0.24	-25%
Feb	0.22	0.21	3%
Mar	0.21	0.26	-20%
Apr	0.23	0.24	-7%
May	0.25	0.29	-17%
Jun	0.28	0.28	1%
Jul	0.31	0.31	1%
Aug	0.30	0.25	16%
Sep	0.29	0.26	10%
Oct	0.24	0.26	-10%
Nov	0.24	0.32	-33%
Dec	0.30	0.33	-12%
Average	**0.25**	**0.27**	**-5%**

Table 17. Electric Price (monthly average all-in $/kWh) for Building B4, Multifamily, by month

Hourly vs. Standard Tariff (SC-08)

	RTP	Standard	Difference
Jan	0.15	0.17	-18%
Feb	0.19	0.15	18%
Mar	0.17	0.17	0%
Apr	0.18	0.17	1%
May	0.21	0.21	-4%
Jun	0.25	0.22	11%
Jul	0.23	0.22	0%
Aug	0.24	0.20	19%
Sep	0.23	0.18	21%
Oct	0.19	0.19	2%
Nov	0.15	0.17	-8%
Dec	0.19	0.17	10%
Average	**0.20**	**0.19**	**7%**

These tables reflect that under an Hourly Pricing scenario, the all-in cost of electricity decreases for industrial buildings that have high demand costs due to low load factors and peak loads during day light hours. For both building types, Hourly Pricing generally results in higher summer electric costs and lower winter electric costs – the industrial building is able to realize net savings because winter savings compensate for summer cost increases.

PV Value under Real-Time Pricing vs. Standard Tariff

The value of PV is highly dependant on its ability to reduce the building's peak demand during summer when the demand component is most expensive under both Real-Time Pricing and the Standard Tariff. Solar generated electricity is best suited for buildings where peak demand is consistent and coincident with peak solar output of the chosen system both in terms of the hourly profile and seasonal profile. As shown previously in Figure 12, the load profile of office and industrial buildings are better correlated with solar production profiles and as such we would expect PV to better reduce demand in those buildings than in multifamily buildings. The more likely solar is to reduce monthly peak demand, the more valuable solar will be for the building. The following figure shows the all-in value of solar PV electricity, by component for each building and tariff.

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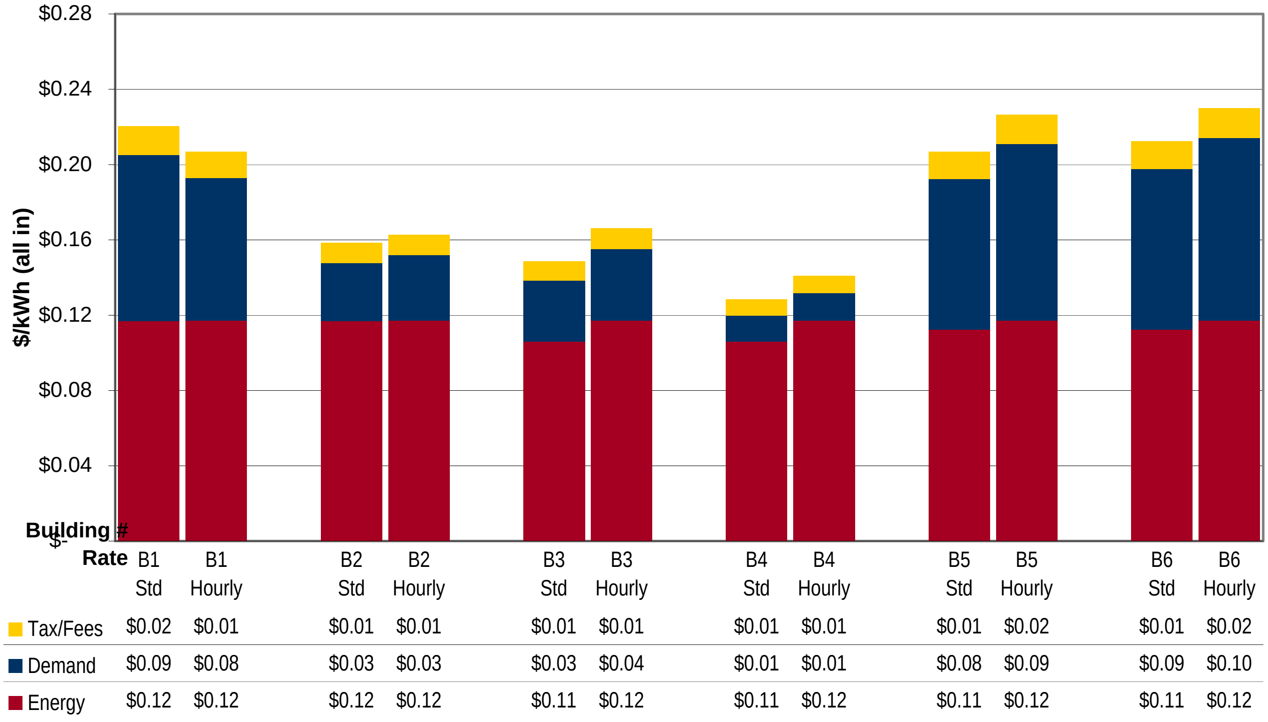
[36] The percent difference is calculated by (RTP – Standard)/Standard ×100%.



Rate	B1 Std	B1 Hourly	B2 Std	B2 Hourly	B3 Std	B3 Hourly	B4 Std	B4 Hourly	B5 Std	B5 Hourly	B6 Std	B6 Hourly
🟨 Tax/Fees	$0.02	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.01	$0.02	$0.01	$0.02
🟦 Demand	$0.09	$0.08	$0.03	$0.03	$0.03	$0.04	$0.01	$0.01	$0.08	$0.09	$0.09	$0.10
🟥 Energy	$0.12	$0.12	$0.12	$0.12	$0.11	$0.12	$0.11	$0.12	$0.11	$0.12	$0.11	$0.12

Figure 29. Value of Solar PV
(annual average all-in $/kWh) by Component of Bill under Standard Tariff and Real-Time Tariff (PV System S1)

Figure 29 powerfully demonstrates the following:

- The overall value of PV is generally higher under Hourly than Standard Pricing, but the is more dependent on the building load profile, which in turn determines the ability of PV to reduce the building peak *demand*
- The value of PV on an electric *demand* ($/kW) component basis is:
    - Highly variable
    - Dependent on the interaction of the building load with solar production (See Figure 12)
    - Increased under Hourly Pricing for 5 of 6 buildings[37]
- The value of PV on an electric *energy* ($/kWh) component basis is:
    - Consistent
    - Independent of building load
        - all Hourly energy components are $0.12/kWh
    - Dependent on tariff structure
        - Hourly Pricing energy component ($/kWh) is generally more valuable than the Standard energy components

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[37] Con Edison's Rider M has time-of-day demand rates: demand charges are relatively increased during the summer between 8AM and 10 PM and particularly between 8AM and 6PM. As such, the value of solar under hourly pricing is dependent on the coincidence of PV generation with building peak loads during these time periods. This tends to be favorable for PV and is likely the cause of the increase.

This finding is consistent with the Lawrence Berkeley National Lab study[38], which found that demand savings from solar PV were highly variable and dependent on the interaction of the building load profile with the tariff structure. It is also clear from this graph that a tariff structure completely or mostly based on energy cost savings would be more favorable to PV. This could be achieved through a specific PV Feed-In-Tariff or by increasing energy charges balanced against decreased demand charges.

The percent difference in the value of Solar PV and building electricity cost under the Standard Tariff and Hourly Pricing is shown in the table below;

Table 18. Value of PV and Building Electricity Cost under Standard and Hourly Tariff (PV System S1)

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%

The data presented here shows that Hourly Pricing was more valuable for solar for all buildings included in this assessment, with the exception of Building B1. It also shows (as in Figure 28) that Real-Time Pricing is more expensive than the Standard Tariff for office and multifamily buildings and less expensive for industrial buildings. It is important to note that the amount of money at stake for the building electricity cost is far greater than for the value of PV. The owner of office building B5 would likely not be interested in less than $2,000 in added value for the PV system if it might increase the cost of electricity by over $300,000. Industrial Building B2 is the only building which has both a lower overall electric bill and a higher value for PV overall under Hourly Pricing. While PV is generally more valuable under RTP, the rate structure tends to result in higher overall electricity costs. To encourage adoption of RTP to benefit PV economics it is of utmost importance to allow building owners the option to isolate RTP on the PV system, while keeping the base-building usage protected under a standard pricing option.

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[38] Wiser, Ryan et.al. "The Impact of Retail Rate Structures on the Economics of Commercial PV systems in California." Lawrence Berkeley National Lab. July 2007.

4-2. Estimated Costs of PV Systems

Incentive Considerations

For purposes of this study, the cost for PV systems is estimated to be $10 per Watt of installed capacity.[39] A 50 kW system would then have an installed cost of $500,000.[40] Since the installed costs of PV systems are intrinsically tied to government incentives, the value of those incentives is included in this analysis.

For 2009, the available incentives for PV systems include:

Federal incentives

- Energy Investment Tax Credit[41], 30% of the cost of the installed solar system
- MACRS Accelerated Depreciation[42]

State & Local incentives

- NYSERDA Cash Incentive (systems up to 80 kW, amount varies with customer type and system size)
- Sales Tax Exemption
- State Tax Credit (only for residential customers)
- NYC Property Tax Abatement (35% of system cost, divided over 4 years)

Systems greater than 80 kW are not typically economically viable in New York because the NYSERDA cash incentive is only available up to that size. Of the six buildings analyzed, only B1 has roof area greater than what would be required for an 80 kW solar system.[43] Table 6 shows the estimated solar system size for each building. The cost of these systems will be used to evaluate their cost-effectiveness under different pricing scenarios.

Non-profit organizations usually cannot directly utilize the available tax incentives. Without these incentives non-profit building B3 would see a payback greater than 25 years (Shown as B3** in the tables below). For consistency of analysis, Building B3 is also analyzed as being able to take advantage of all tax incentives. There are other types of buildings which likewise cannot make use of available tax incentives – the inability to use even one of the tax incentives can be enough to discourage the installation of a PV system.

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[39] 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 which would further affect the price.

[40] This estimate is intended only to give a very rough estimate of installed costs. Actual costs may vary on site-specific conditions, market-based factors, etc.

[41] Note, the Federal Investment Tax Credit may also be taken as a Grant, which has tax consequences on the remaining incentives

[42] Modified Accelerated Cost Recovery System

[43] An economic analysis of the 304 kW system estimated to be able to fit on the roof of B1 is included in the Appendix.

Payback and NPV of PV Systems

To evaluate the economic effects of real-time pricing, the annual economic value under hourly and standard pricing schemes are compared. The benefits are evaluated in terms of:

- Annual dollar value of PV generated electricity
- Simple payback
- Net Present Value (NPV)[44]

At the time of this report, the incentives for solar PV in New York City are higher than ever before for the "right" customer – but it is important to remember that this is a "stars aligned" moment in time and that many customers are not able to make use of the incentives. The incentives take up to five years to accrue and much of the incentive is contingent on the tax appetite of the building and building owner. This means the owner of the system may need to allocate significant cash toward the purchase or take out debt in year one.

The NPV of the PV systems generally increases under the Hourly Tariff as compared to the Standard Tariff. The increase in NPV is similar to the increase in value of PV previously shown in Table 18. Simple payback is only reduced by 1-2%, with the exception of building B3**. This is because incentives are playing a relatively larger role in determining the economics of a solar PV system than the effect of hourly pricing. The variability in solar production profile has relatively little effect on overall NPV or simple payback for a given building, as such PV system S1 is used in all tables and charts below.

Table 19. Net Present Value (NPV) of Solar PV system under Standard and Hourly tariff.

		Net Present Value of PV		
Building Type	**ID #**	**Std**	**RTP**	**% Diff**
Industrial	B1	$ 260,923	$ 242,125	**-7%**
	B2	$ 130,276	$ 134,750	**3%**
Multifamily	B3	$ 19,560	$ 22,343	**14%**
	B3**	$ (47,314)	$ (44,531)	**6%**
	B4	$ 23,713	$ 26,585	**12%**
Office	B5	$ 227,743	$ 253,270	**11%**
	B6	$ 29,555	$ 32,277	**9%**

Table 20. Simple Payback of Solar PV system under Standard and Hourly tariff.

		Simple Payback Period	
Building Type	**ID #**	**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
	B4	3.3 Yrs	3.3 Yrs
Office	B5	3.2 Yrs	3.1 Yrs
	B6	3.0 Yrs	2.9 Yrs

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[44] NPV is calculated over a 25 year period and with an annual 3% rate of energy price inflation under both pricing schemes

4-3. Effect of Net-Metering and Curtailment Incentives

Since solar power does not currently qualify for curtailment incentives, curtailment is analyzed on a hypothetical basis in this report.

Even if 100% of its kWh output could be applied toward the Emergency Demand Response Program, the value of this for an 80kW PV system based on actual events in 2007 would have amounted to $24.87, approximately one-tenth of one percent of the annual income of the PV system.

Net metering likewise has a negligible effect on the value of solar output for the office and multifamily buildings analyzed in this assessment since the buildings loads always exceed PV system output. For the industrial buildings analyzed, net metering has a 1-3% impact on the annual value of solar as shown in following table, meaning that in the course of the year, 1-3% of the production of the PV system could not have been exported to the grid. It is not surprising that the industrial buildings are reliant on net metering, given their relatively large roof area and variable loads.

Table 21. Total hourly solar production in excess of hourly building load and the annual value under Hourly and Standard Tariff.

		Excess PV Output		Value of Excess PV Output	
Building Type	**ID #**	**kWh**	% Total	**Hourly**	**Std.**
Industrial	B1	1,847	2%	$190	$219
	B2	2,780	4%	$280	$321
Multifamily	B3	-	-	-	-
	B4	-	-	-	-
Office	B5	-	-	-	-
	B6	-	-	-	-

While the PV systems analyzed in this study show relatively little benefit from it, net metering does have an important effect on the installed cost of a PV system. A costly reverse power relay would likely be required by the utility in the absence of net-metering in order to ensure that no power is back-fed to the grid. This typically results a significant increase in the installed cost of a PV system, roughly $10,000 depending on system size.

5. Recommendations

Below are recommendations on rate designs suited for Solar PV applications and potential topics for further research.

5-1. Recommendations for Rate Designs Suited for Solar PV Applications

1. Reduce Demand Weight of RTP Tariff

   Since solar PV systems are more consistent at saving energy than at reducing 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. Under Con Edison's hourly pricing tariff Rider M, the demand charges are high compared to energy charges. Parties interested in changing tariff structure might consider working with the Public Service Commission and Con Edison to structure an RTP tariff with a lower demand component.

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. Presently, the peak demand is charged from 8AM to 6PM, 8AM to 10PM, and at all hours under Mandatory Hourly Pricing. A more narrow window of 8AM to 4PM or even 10AM to 2PM would be more likely to benefit solar PV.

3. Feed-in Tariff

   A Feed-in Tariff is a way of making the installation of renewable energy more appealing. The electricity that is generated is bought by the utility at above market prices. For example, if the retail price of electricity is 15¢/kWh then the rate for Solar PV power might be 50¢/kWh. The difference is spread over all of the customers of the utility. For example, if $100,000 worth of green power is bought in a year by a utility that has 1,000,000 customers, then each of those customers will have 10¢ added on to their bill annually.

   One of the key findings of this study is that PV produces power when it is most valuable, but that added value often does not translate to savings on a consumer's electric bill. As shown in this and other studies, tariffs with little to no demand charges can increase the consistency of the value of PV. A Feed-in Tariff would provide a retail rate for PV on the basis of *energy* ($/kWh), avoiding compensating PV on a demand ($/kW) basis. The retail rate for Solar PV under a Feed-in Tariff could be structured to reflect the increased value of solar energy in terms of its higher hourly price and the other societal benefits it provides[45].

   Feed-In Tariffs have been associated with a large growth in solar power in Spain and Germany: these countries now boast the supply of 9% and 5% of their electricity respectively. These systems involve fixed payments that are guaranteed for the long term; 20 years in the cases of those countries.

   Policymakers might consider an RTP Feed-in Tariff, whereby the rate for the PV system might be a multiplier of or adder to the RTP rate. This would be a form of hourly performance based incentive and could simultaneously increase enrollment in RTP.

4. Mandate building load and PV system monitoring

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[45] This might include improved air quality, energy security, grid reliability, and a number of other factors.

The city could also mandate and/or strongly incentivize the installation of building load monitoring and PV monitoring systems to conduct more detailed research and allow for a transition to RTP or other rate structures for PV in the future.

5. Other means to isolate benefit of PV

Block and Index Option

The capacity of most PV systems typically represents only a small portion of a facility's load. But under Con Edison's Rider M real time pricing regime, all power to a single account would be charged at the RTP. While hourly pricing may benefit the PV portion of an account's supply, it could seriously raise the cost for the remaining load when hourly RTP is high.

An alternative pricing structure could allow the PV capacity to be valued at the RTP price, while protecting the remaining load under a fixed price. That structure is called 'block and index' and is common for large facilities purchasing power from a third-party power marketer (also called an ESCO).

Assume, for example, that the PV system's capacity is equal to 10% of a facility's peak hourly demand. Under a block and index, any hourly power consumption greater than 90% of that peak hourly load would be purchased at the RTP price plus a fixed adder called an index. The remaining 90% would be purchased at a fixed price. Blocks are described by the number of days a week in which they are utilized, and the number of hours in a day when they are in effect. A '5 by 16' block, for example, would run for the 5 weekdays of a week, for 16 hours each day (to cover all hours during which most of a facility's consumption occurs). Block and Index pricing is shown in the following figure.

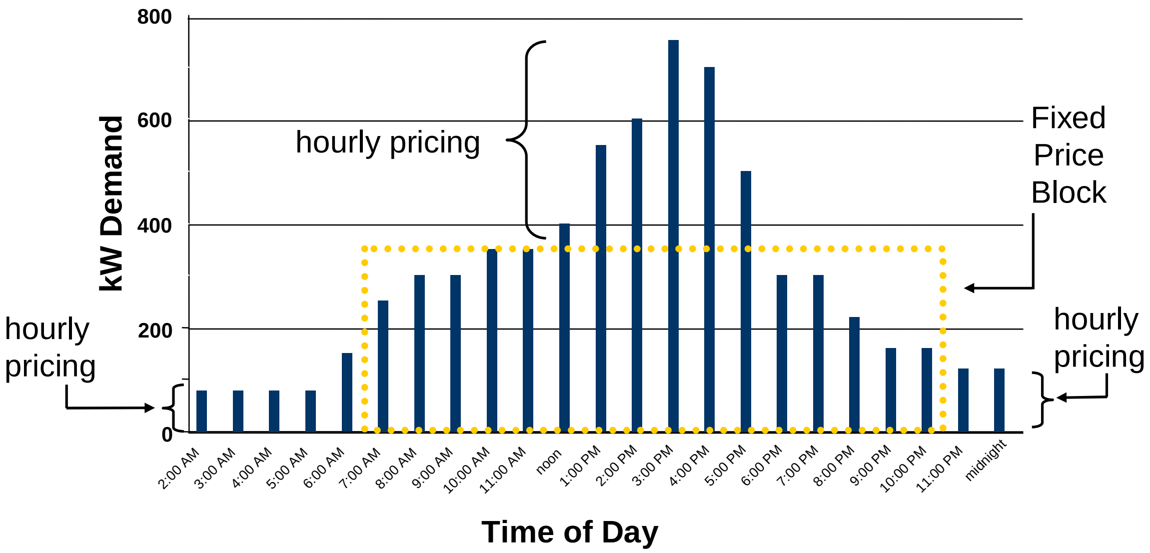

Figure 30 Block and Index Pricing.[46]

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[46] If purchased for several consecutive months, a block may be bought under a forward contract (the standard method) or as a wholesale strip (for a very large customer), or in the form of a futures contract, if its shape matches the parameters of an existing futures contract.

This option has a second benefit. Under Rider M, Con Edison adds to the RTP its Market Supply Charge (MSC) demand charge. Failure of a PV system to consistently supply power during a building's peak would expose the entire building load to that demand charge. Demand charges are based on the highest quarter-hourly consumption in two consecutive quarter-hourly intervals (between 8 AM and 10 PM on weekdays) in a given month. Even a brief (e.g., 30 minute) drop in PV output could therefore result in levying of a large MSC demand charge.

When power is bought through an ESCO, however, there is no MSC demand charge (demand charges for delivery continue to be levied). Instead, the ESCO collects only on a \$/kWh basis and builds into its index and block pricing the same capacity costs that Con Edison seeks through its \$/kW demand charge.

Instead of charging for a single high demand each month, the ESCO amortizes such costs over the entire kWh volume of the term of the contract (e.g., 1 year). This means that the impact of a PV supply failure affects only the cost during the duration of the problem, rather than affecting an entire month's electric bill, regardless of later PV success in supplying power.

Two Part RTP

A Two-Part RTP tariff would achieve similar ends as a block and index, while keeping customers under a regulated rate, instead of an ESCO contract. Two-part RTP tariffs have existed for a decade or more through utilities such as Georgia Power, but as of the writing of this report are not available through Con Edison.

The first portion of a two-part RTP tariff is a fixed component which is determined by applying the customer's historical hourly load characteristics, known as the customer baseline load , to a standard (non-RTP) rate characterized by a forward contract. The second rate is an hourly price that closely reflects forecasted marginal costs, which in the case of New York City would be the NYISO Zone J hourly price. This variable price is applied to hourly differences from the customer baseline load to determine hourly charges or credits[47]. This concept is demonstrated in the conceptual figure below[48].

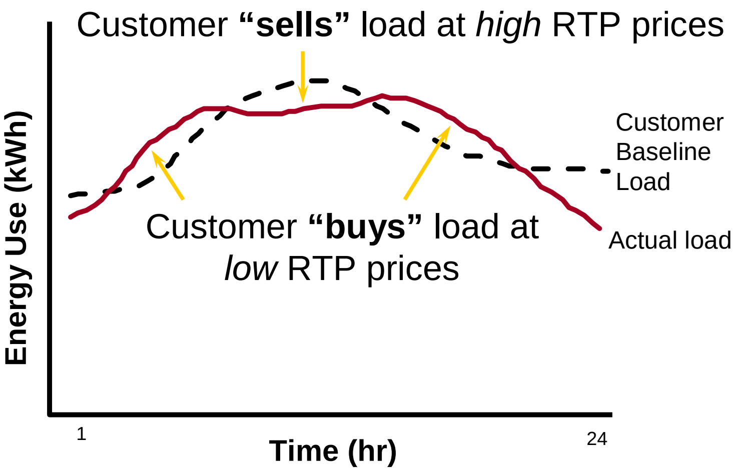

Figure 31. Conceptual Graph of Two-part RTP Rate Design

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[47] Ahmed Faruqui and Kelly Eakin. "Pricing in Competitive Electricity Markets." p315. Kluwer Academic Publishers, 2000.

[48] Jeff Burleson (Georgia Power) and Michael O'Sheasy (Christensen Associates). "What's new about Georgia Power Company's RTP Program?" p8. April 2005. Powerpoint presentation: http://www.peaklma.com/files/public/burleson-o%27sheasygapwr.ppt

This rate would allow PV to capture the high value RTP energy at mid-day but would also enable the vast majority of a customer’s usage to be protected under a standard rate. This would substantially isolate the benefit of RTP for PV.

A two-part RTP rate may be worth developing as it could offer a substantial cost-benefit to PV and encourage further adoption of RTP.

A note on solar incentives:

Generally speaking, solar installers in the marketplace prefer uniformity in solar incentives. Current solar incentives already vary widely by state and municipality; the the economics of solar in each state and sometimes municipality can require detailed study. Adding a preferred rate option for PV has the potential to further complicate the installation of PV. Rate design should be undertaken with care to ensure that it is clear and well understood by potential customers. Also, because PV is a long term investment, 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 nationally and globally to incentivize PV. The most successful have consistent long-term structures and incentive levels that make PV an attractive investment.

5-2. Recommendations for Further Research

The six buildings and four solar systems analyzed as part of this assessment provide insight into the way hourly pricing affects the economics of Solar PV in a few very specific instances. However, there are a number of ways in which this research could be expanded upon. Those ideas are collected here and are as follows:

- Build a tool to enable easy comparison of hourly pricing and Standard Tariff options for buildings with and without solar. Given that RTP can be either a benefit or cost, depending on building load profile, a tool that allows for comparisons of the costs and benefits of different rate structures would be valuable to educate customers on the cost effects of under both tariffs.
- Model different tariffs or service classifications for both the standard and real-time tariff. This could include pricing models from third-party power providers, known as Energy Service Companies or ESCOs.
- Evaluate additional building types and load profile types. This could uncover new customer types that may be uniquely well-suited for real-time pricing and/or solar PV. Industrial buildings with night shifts, computer server centers, hospitals, and public transit power usage are a few examples.
- Conduct a statistically significant study by increasing the number of buildings in the study. Since it is clear that building load profile and tariff structure are more important than the solar production profile, this research could be targeted towards collecting additional building load information. Since the machinery for analysis is largely already in place, this additional research would be easier to conduct
- Enhance demand analysis by collecting 15-minute load data. Currently all data in the study is hourly, but Con Edison charges for demand based on the highest two consecutive 15 minute intervals in a month. The accuracy of the demand savings would be greatly increased by conducting the analysis in this manner.
- Analyze available "Class Demand Studies", in which Con Edison (and potentially other utilities) display the time of day at which peak occurs under each service classification. This could enable targeted PV system marketing and deployment to customers in the service classifications with the greatest coincidence of peak loads and peak solar output.
- Analyze other time periods, which may be more or less volatile in price than 2007
- There are many other ways of broadening the scope or increasing the depth and accuracy of this report, the authors of the study are open to ideas and further communication about how to improve the study.

References

Con Ed: Rates and Tariffs. Con Edison. accessed 2009 June 30 <http://www.coned.com/rates>.

Burleson, Jeff (Georgia Power) and O'Sheasy, Michael (Christensen Associates). "What's new about Georgia Power Company's RTP Program?" p8. 2005 April. Powerpoint presentation: <http://www.peaklma.com/files/public/burleson-o%27sheasygapwr.ppt>.

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PV Watts. Renewable Resource Data Center, National Renewable Energy Laboratory. <http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1>.

Wiser, Ryan et.al. "The Impact of Retail Rate Structures on the Economics of Commercial PV systems in California." Lawrence Berkeley National Lab. 2007 July.

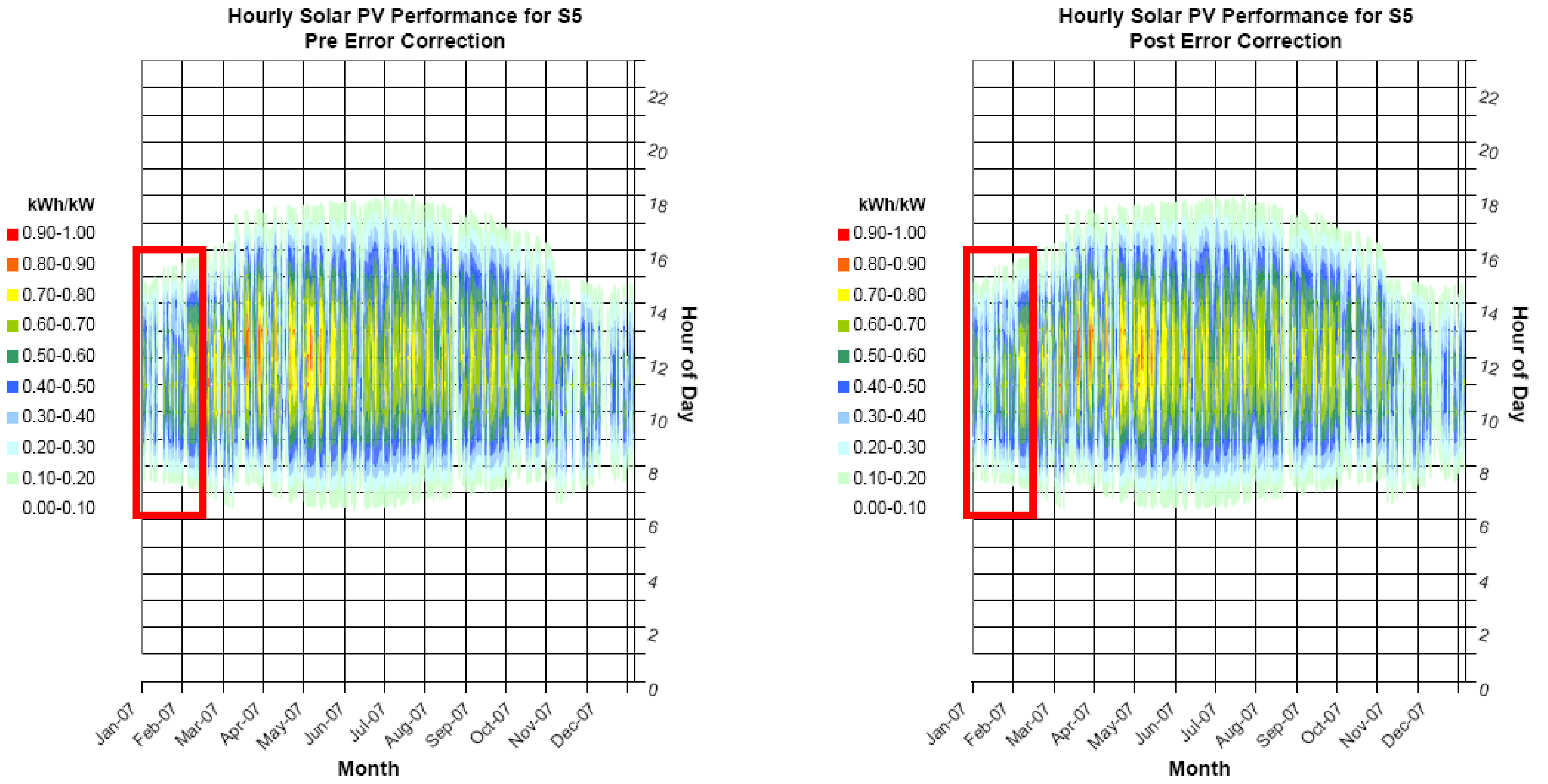
Appendix A. High Resolution 3D Plots

Due to large file size, high resolution images are available in a separate document.

Appendix B. Example Error Correction Analysis

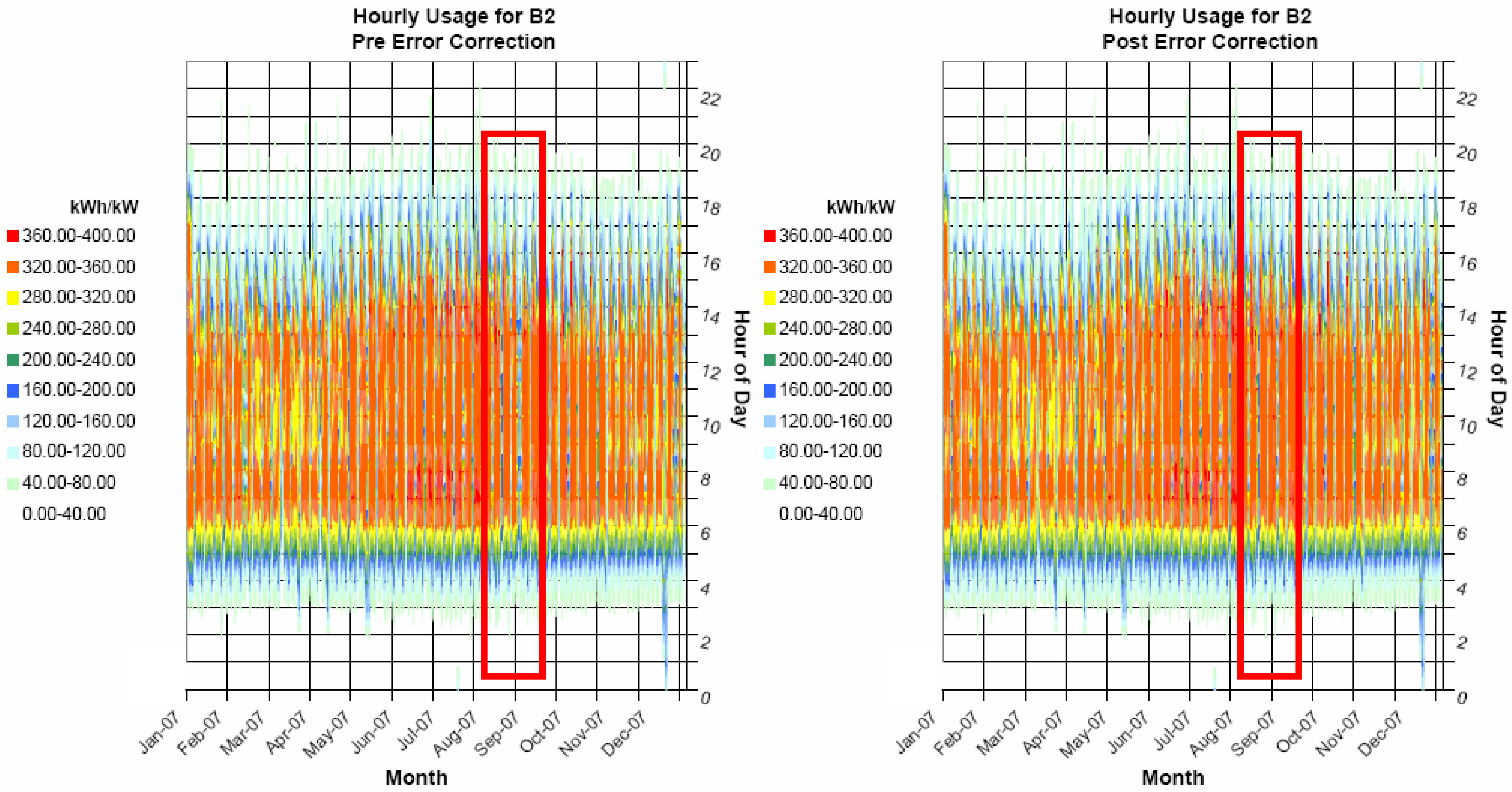
Error correction for solar data was completed by filling in data gaps longer than 24 hours with the average solar output for the same hour on the surrounding 14 days (1 week before and 1 week after). The red box below highlights one of the corrected areas. Notice how the blank area in January on the left is filled on the right. November and December also have a number of error corrected hours. The error correction partially fills in the gaps in the data with average data from surrounding days. The gaps which appear unfilled, are either due to short periods without data (< 24 hrs) or periods of low solar PV output (in the 0.00-0.10 kWh/kW range).

Example of Actual vs. Error Corrected Solar Data



Error correction for building data was completed by filling in any data gap with the equivalent data from the same hours and same day of the prior week. The red box below highlights one of the corrected areas. Notice how the blank area in September on the left is filled on the right. Both the Building and Solar data represented in these charts is the same data as in the main body of the report. This "overhead" vantage point on the chart allows for easier viewing of error correction.

Example of Actual vs. Error Corrected Building Data



Appendix C. Block & Index Pricing Example

Block and Index Pricing is noted in the main body of the study as a price structure which can allow solar PV to capture the favorable benefits of real-time pricing without requiring the entire building load to be at risk of price spikes. Below is the "nuts and bolts" of how one such agreement is structured, courtesy of Hess, Inc.

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x,xxx kW, 7x24 Energy Only, MMMYY-MMMYY, $x.xxxx per kWh

- Total Bill = Energy + Capacity + Ancillaries + Adder + Block Purchase
- Adder is applied to all metered kWh and is $x.xxxx per kWh
- Energy Settlement Formula is as follows:

$$\sum_{n=1}^{n}(Q_n(1+EF)-B_n)*LBMP_n$$

n=hours in the month
Q=Actual energy used in hour n
EF=Expansion factor (Line Loss Factor)
B=Volume of block purchased each hour
LBMP= Day Ahead Hourly Zonal LBMP

- Capacity Settlement Formula is as follows:

  UCAP * (Capacity Price + Demand Curve Excess Reqt * Spot Capacity Price)

  Capacity Price is based on the NYISO capacity auction clearing price. Customer may choose to settle at the 6 month strip capacity or single month auction clearing price. The demand curve requirement is based on the NYISO spot capacity auction. Select one: ☐ 6 month strip auction ☐ monthly auction

- Ancillary Settlement Formula is as follows:

$$\sum_{n=1}^{n}(Q_n(1+EF))*Hourly\_Ancillary\_Rate$$

- Block Purchase = Block Size (MW) * Block Price ($/MWH) * Hours in month

- On Peak Hours are defined as 7 AM – 11 PM Monday through Friday excluding NERC holidays. Off Peak Hours are defined as all hours not On Peak.
- Hess shall provide Customer the opportunity to hedge/fix the price of all of Customer's load when Customer decides to do so during on-peak, or 24-hour periods.

Appendix D. Economic Analysis of Larger (304 kW) PV system

The size of PV systems analyzed in this assessment is limited to 80kW. There are several reasons for this:

- The NYSERDA incentive is capped at 80kW. While other incentives continue on the payback on a Solar PV system larger than 80kW is severely hampered by the capping of this incentive. In addition, the owner of the PV system must have significant tax liability to take the remaining incentives.
- The New York City Property Tax Abatement is currently capped at $250,000. At an installed cost of $10/Watt, and under the assumptions specific to this study, a PV system capacity of 91.5kW would receive the full value of the incentive and systems of greater capacity would receive no marginal benefit.
- An 80kW system requires at least 5,000 ft^2 of clear roof space with south facing exposure. A typical New York building only has 30-50% of roof space available for solar meaning that a building would need to have a roof size of 10,000 – 16,000 ft2. This limits the number buildings in New York City capable of hosting an 80kW system.
- As shown in the study by Lawrence Berkeley Laboratory[49] the all-in value of solar on a $/kWh basis decreases with system size because solar is less effective at reducing peak load than at saving energy. This is visible in the table below.

In order to evaluate the effect of a larger system, the one building in this study capable of hosting a solar system larger than 80kW, Building 1, was evaluated against its maximum S1 system size of 304kW. The results are shown in the table below.

	80 kW		304 kW	
	Std Tariff	RTP Tariff	Std Tariff	RTP Tariff
Value of Solar	$20,948	$19,661	$67,252	$64,790
Value of Solar ($/kWh)	$0.220	$0.207	$0.186	$0.179

The value of solar in $/kWh terms drops significantly, under both the real-time and standard pricing. This, combined with the loss of incentives, drops the NPV and significantly hurts payback under both the Hourly and Standard Tariffs.

	80 kW		304 kW	
	Std Tariff	RTP Tariff	Std Tariff	RTP Tariff
NPV	$331,141	$312,343	$90,491	$54,525
Simple Payback	2.36	2.39	11.9	12.3

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[49] Wiser, Ryan et.al. "The Impact of Retail Rate Structures on the Economics of Commercial PV systems in California." Lawrence Berkeley National Lab. July 2007.

Appendix E. Building Rooftop Images

Appendix E. Building Rooftop Images

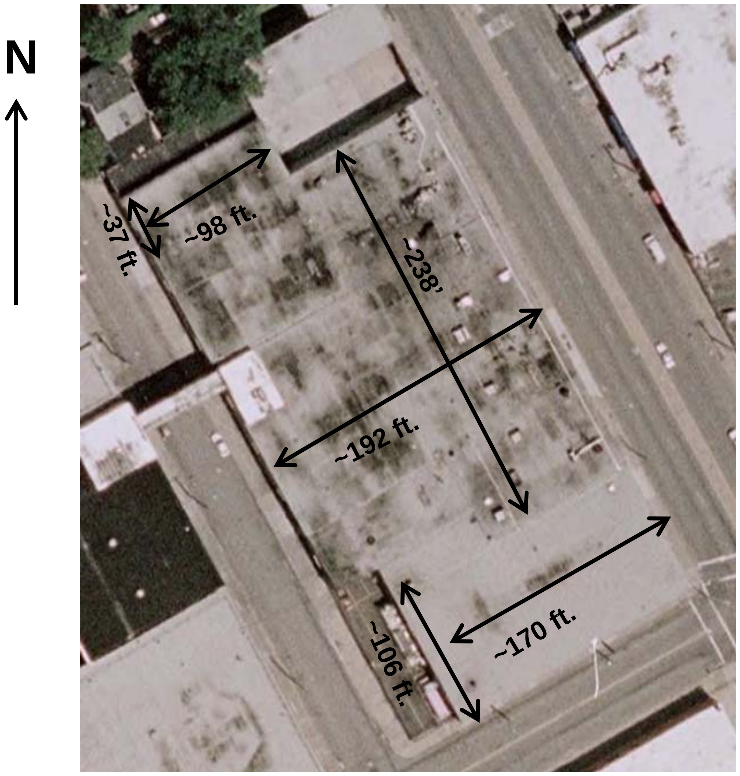

Image: Google Earth

Industrial B1: Food processing facility, Brooklyn

Roof area = approximately 67,342 ft^2;
Approximately 60% usable

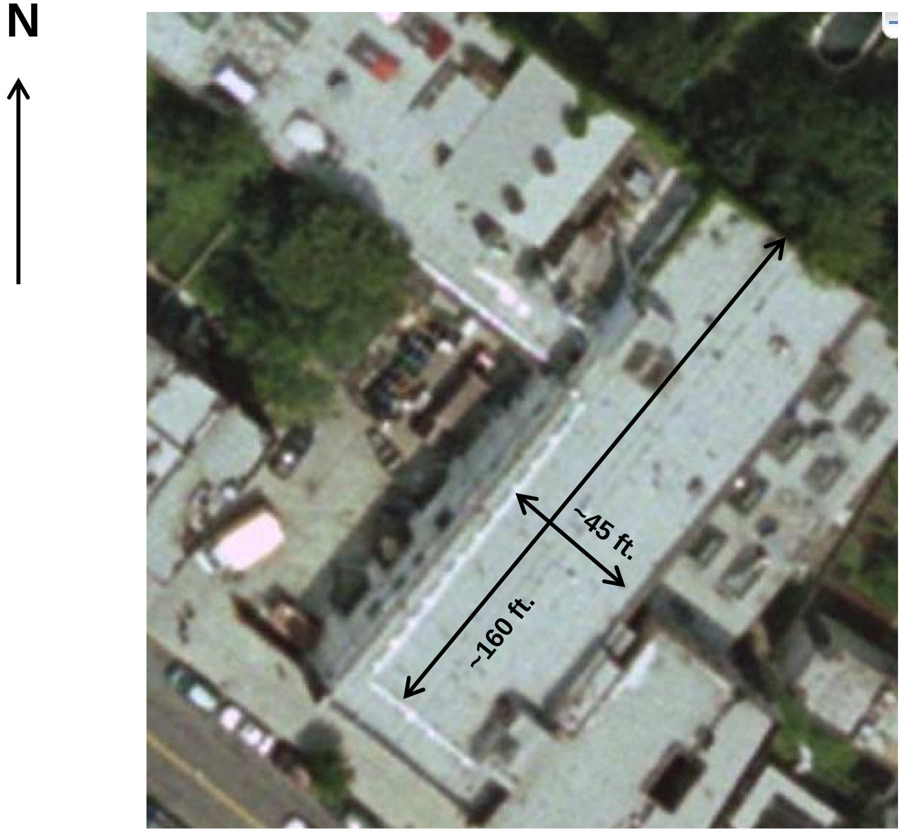

Image: Google Earth

Industrial B2: Industrial laundry, Brooklyn

Roof area = approximately 7,200 ft^2
Approximately 80% usable

Image: Google Earth

Multifamily B3: Residential building, Manhattan

Upper roof area = approximately 650 ft^2
Lower roof area = approximately 850 ft^2
Both approximately 60% usable

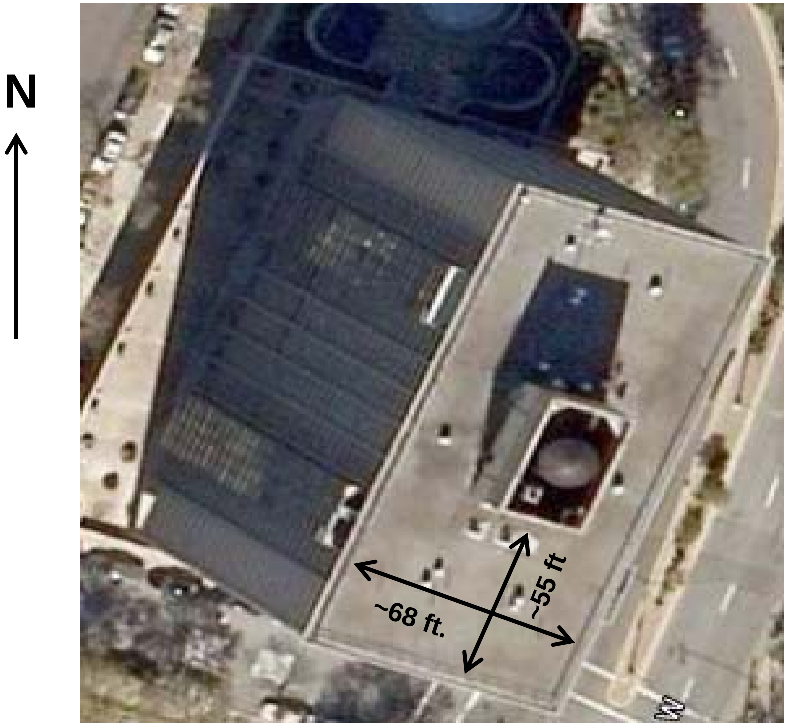

Image: Google Earth

Multifamily B4: Residential building, Brooklyn

Roof area (south of water tower enclosure) = approximately 3,740 ft^2
Approximately 35% usable

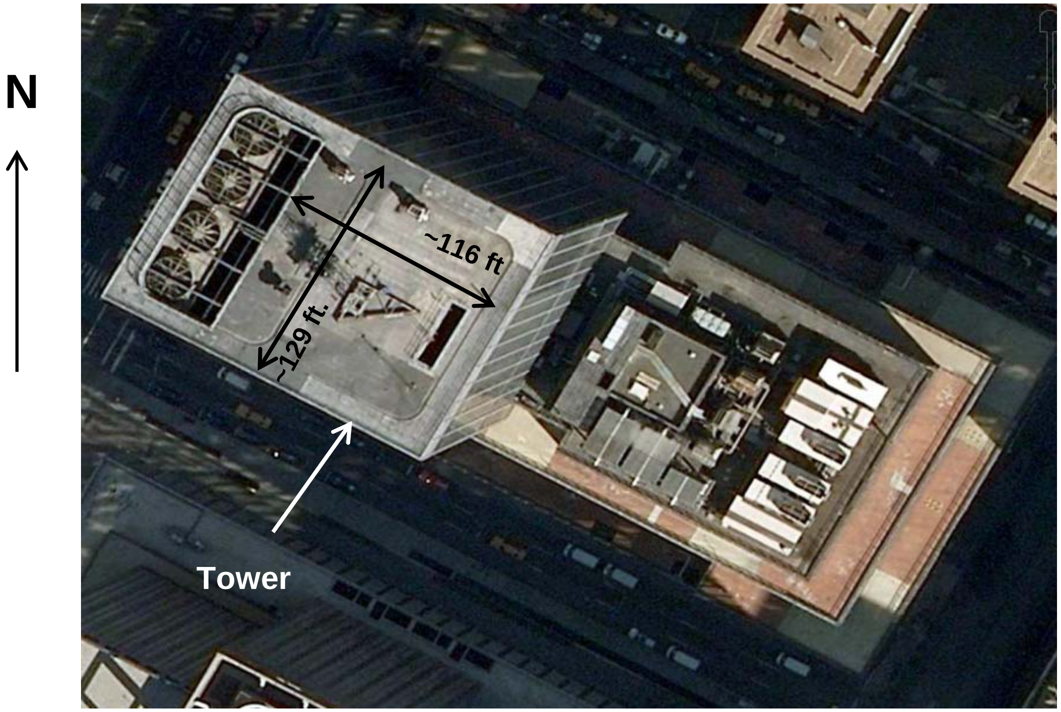

Image: Google Earth

Office B5: Office Building, Manhattan

Roof area (tower only) = approximately 14,964 ft^2
Approximately 50% usable

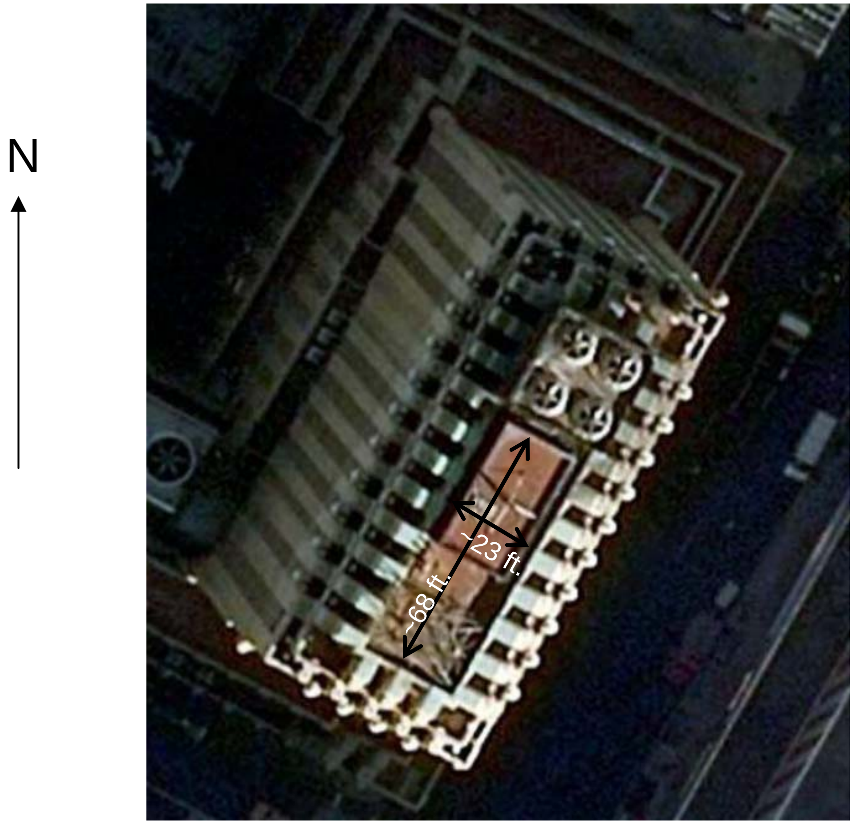

Image: Google Earth

Office B6: Office Building, Manhattan

Roof area = approximately 1,564 ft^2
Approximately 60% usable

Appendix F. Periods of Curtailment Events and Available Incentive Amounts

The NYISO Demand Response Program gives incentives for reduction of load during system-wide peaks in energy usage. Under current curtailment regulations, PV alone does not qualify as a load shedding technology[50]. As such, this section addresses the potential benefit of curtailment on a hypothetical basis.

In 2007 the NYISO called two curtailment events for Zone J (New York City) one in sub-zone J3 and one in sub-zone J8. The first event on 7/19/2007 in subzone J3 lasted 15 hours and the second on 8/3/2007 in subzone J8 lasted 4.5 hours.

Table 22. Curtailment Events for Zone J in 2007

Type	Date	Start	End	Total time	Where
TDRP	7/19/2007	8:00	23:00	15:00	J8
TDRP	8/3/2007	19:30	23:59	4:29	J3

The two curtailment events called in 2007 were classified as TDRP (Targeted Demand Response Program). This program, established in July, 2007, allows Demand Response for system reliability to be deployed for specific subzones of Zone J (vs. the entirety of Zone J).

Solar could potentially qualify for the Emergency Demand Response Program (EDRP) as a local generator, but likely not as a load reducing technology.[51] In order to qualify, a baseline must be established based on prior like days and corresponding hours. The value of load reduction is calculated as the hourly kWh generated above and beyond this baseline multiplied by the NYISO Zone J Hour Ahead Real-Time price for each hour of the event.

Solar system S1 produced 1,188 kWh for each kW in 2007, or 95,060 kWh for an 80 kW system. On July 19th from 8:00 to 23:00 this system would have produced 287kWh. Under the current EDRP rules, this building would have to subtract a baseline of 321kWh resulting in no value to the building under the existing EDRP program.

Assuming that solar could be incentivized in such a way that 100% of its kWh output, in this case 287 kWh (meaning that baseline was zero), could be applied toward the EDRP the value of EDRP for this 80 kW system for this day would have amounted to $24.87. Given the barriers to entry for solar in the curtailment market and the relatively low value, curtailment has not been included in the economic analysis for this study.

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[50] Solar does not qualify as ICAP (Rider P) or the demand response program.

[51] Qualification for the EDRP program currently requires a minimum of 100 kW of eligible load reduction capability – a number that none of the analyzed systems meet. Aggregation of systems may be a possibility, although it was not investigated for purposes of this study.

Appendix G. Analysis of All PV Systems on All Buildings

The below charts show building electric costs and the value of solar under standard and hourly pricing. Each chart shows a "mix and match" of the four different solar systems on each of the six different buildings. For example, in the Value of Solar chart, the upper left cell would show the value of a solar system with the output profile of Solar System S1 on the load profile of Building B1. In this chart, PV System S4 shows the most value because it has unusually high production. The last row of charts, the Value of Solar (all-in), shows that the orientation and tilt have a relatively small effect on the value of PV. There is much more variability in the value of PV across various the six building types than the four solar systems, this indicates that the building load profile is a more important factor in the value of PV than solar production profile.

STANDARD PRICING

Electric Bill without Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 312,409	$ 312,409	$ 312,409	$ 312,409
	B2	$ 311,785	$ 311,785	$ 311,785	$ 311,785
Multifamily	B3	$ 184,411	$ 184,411	$ 184,411	$ 184,411
	B4	$ 290,121	$ 290,121	$ 290,121	$ 290,121
Office	B5	$ 5,245,244	$ 5,245,244	$ 5,245,244	$ 5,245,244
	B6	$ 2,047,776	$ 2,047,776	$ 2,047,776	$ 2,047,776

Electric Bill with Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 291,461	$ 291,517	$ 287,778	$ 291,185
	B2	$ 300,870	$ 300,902	$ 299,221	$ 301,075
Multifamily	B3	$ 182,823	$ 182,769	$ 182,598	$ 182,872
	B4	$ 288,139	$ 288,117	$ 287,709	$ 288,209
Office	B5	$ 5,226,816	$ 5,226,416	$ 5,223,309	$ 5,226,008
	B6	$ 2,045,505	$ 2,045,325	$ 2,045,108	$ 2,045,348

Value of Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 20,948	$ 20,892	$ 24,631	$ 21,224
	B2	$ 10,915	$ 10,883	$ 12,564	$ 10,710
Multifamily	B3	$ 1,588	$ 1,642	$ 1,813	$ 1,539
	B4	$ 1,982	$ 2,005	$ 2,412	$ 1,913
Office	B5	$ 18,429	$ 18,829	$ 21,935	$ 19,236
	B6	$ 2,272	$ 2,452	$ 2,668	$ 2,428

Value of Solar as a percentage of building electric bill

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	6.7%	6.7%	7.9%	6.8%
	B2	3.5%	3.5%	4.0%	3.4%
Multifamily	B3	0.9%	0.9%	1.0%	0.8%
	B4	0.7%	0.7%	0.8%	0.7%
Office	B5	0.4%	0.4%	0.4%	0.4%
	B6	0.1%	0.1%	0.1%	0.1%

Value of Solar ($/kwh) all in

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 0.2204	$ 0.2155	$ 0.2143	$ 0.2166
	B2	$ 0.1584	$ 0.1548	$ 0.1508	$ 0.1508
Multifamily	B3	$ 0.1485	$ 0.1505	$ 0.1402	$ 0.1396
	B4	$ 0.1283	$ 0.1273	$ 0.1291	$ 0.1201
Office	B5	$ 0.2068	$ 0.2072	$ 0.2036	$ 0.2094
	B6	$ 0.2124	$ 0.2248	$ 0.2063	$ 0.2203

HOURLY PRICING

Electric Bill without Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 296,742	$ 296,742	$ 296,742	$ 296,742
	B2	$ 296,266	$ 296,266	$ 296,266	$ 296,266
Multifamily	B3	$ 193,204	$ 193,204	$ 193,204	$ 193,204
	B4	$ 302,009	$ 302,009	$ 302,009	$ 302,009
Office	B5	$ 5,550,333	$ 5,550,333	$ 5,550,333	$ 5,550,333
	B6	$ 2,222,266	$ 2,222,266	$ 2,222,266	$ 2,222,266

Electric Bill with Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 277,081	$ 277,199	$ 273,705	$ 276,939
	B2	$ 285,045	$ 285,037	$ 283,375	$ 285,238
Multifamily	B3	$ 191,425	$ 191,383	$ 191,181	$ 191,473
	B4	$ 299,830	$ 299,803	$ 299,381	$ 299,861
Office	B5	$ 5,530,157	$ 5,529,740	$ 5,526,271	$ 5,529,397
	B6	$ 2,219,808	$ 2,219,610	$ 2,219,373	$ 2,219,664

Value of Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 19,661	$ 19,542	$ 23,037	$ 19,803
	B2	$ 11,221	$ 11,229	$ 12,891	$ 11,028
Multifamily	B3	$ 1,778	$ 1,821	$ 2,023	$ 1,731
	B4	$ 2,179	$ 2,206	$ 2,628	$ 2,148
Office	B5	$ 20,176	$ 20,593	$ 24,062	$ 20,936
	B6	$ 2,458	$ 2,655	$ 2,892	$ 2,602

Value of Solar as a percentage of building electric bill

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	6.6%	6.6%	7.8%	6.7%
	B2	3.8%	3.8%	4.4%	3.7%
Multifamily	B3	0.9%	0.9%	1.0%	0.9%
	B4	0.7%	0.7%	0.9%	0.7%
Office	B5	0.4%	0.4%	0.4%	0.4%
	B6	0.1%	0.1%	0.1%	0.1%

Value of Solar ($/kwh) all in

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	$ 0.2068	$ 0.2016	$ 0.2004	$ 0.2021
	B2	$ 0.1628	$ 0.1598	$ 0.1547	$ 0.1552
Multifamily	B3	$ 0.1663	$ 0.1670	$ 0.1564	$ 0.1570
	B4	$ 0.1411	$ 0.1400	$ 0.1407	$ 0.1349
Office	B5	$ 0.2264	$ 0.2266	$ 0.2233	$ 0.2279
	B6	$ 0.2298	$ 0.2434	$ 0.2237	$ 0.2361

COMPARISON

% Difference between Standard and Hourly Tariff in Value of Solar

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	-6%	-7%	-7%	-7%
	B2	3%	3%	3%	3%
Multifamily	B3	11%	10%	11%	12%
	B4	9%	10%	9%	12%
Office	B5	9%	9%	9%	8%
	B6	8%	8%	8%	7%

% Difference between Standard and Hourly Tariff in Building Electric Bill

Building Type	ID #	S1	S3	S4	S5
Industrial	B1	-5%	-5%	-5%	-5%
	B2	-5%	-5%	-5%	-5%
Multifamily	B3	5%	5%	5%	5%
	B4	4%	4%	4%	4%
Office	B5	6%	6%	6%	6%
	B6	8%	8%	8%	8%

Appendix H. Solar Economic Proformas

Proformas displaying the economic performance of solar PV systems on each building are presented on the following pages. The assumptions behind each proforma are consistent with those in the main body of the study and are also listed at the top of each proforma.

Building B1 - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$800,000
Upfront Costs (less NYSERDA Incentive)	$600,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.220365 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

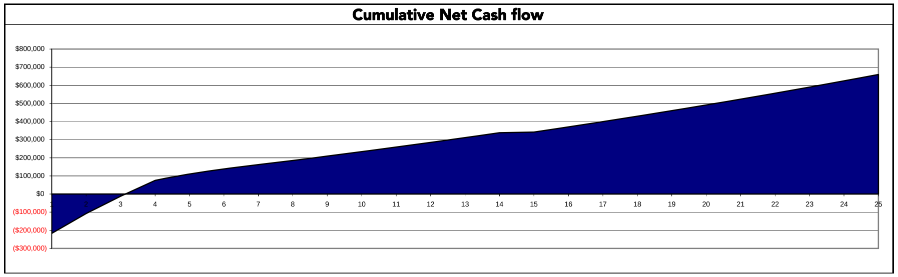
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$20,948	$21,468	$22,002	$22,549	$23,109	$23,683	$24,272	$24,875	$25,493	$26,126	$26,776	$27,441	$28,123
Less O&M Expenses	($1,200)	($1,236)	($1,273)	($1,311)	($1,351)	($1,391)	($1,433)	($1,476)	($1,520)	($1,566)	($1,613)	($1,661)	($1,711)
Purchase Price or Down Payment / Buyout	($800,000)												
NYSERDA Incentive	$200,000												
Less Tax on NYSERDA	($68,000)												
Federal Tax Credit	$240,000												
NYC Property Tax Abatement	$52,500	$52,500	$52,500	$52,500									
Total MACRS Benefit	$138,720	$36,992	$22,195	$13,317	$13,317	$6,659							
Annual Cash Flow	**($217,032)**	**$109,724**	**$95,424**	**$87,054**	**$35,075**	**$28,951**	**$22,839**	**$23,399**	**$23,973**	**$24,561**	**$25,163**	**$25,780**	**$26,412**
Cumulative Cash Flow	**($217,032)**	**($107,308)**	**($11,884)**	**$75,170**	**$110,246**	**$139,196**	**$162,035**	**$185,434**	**$209,407**	**$233,968**	**$259,131**	**$284,910**	**$311,323**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$28,822	$29,538	$30,272	$31,024	$31,795	$32,585	$33,395	$34,225	$35,075	$35,947	$36,840	$37,756	
Less O&M Expenses	**($1,762)**	($25,815)	($1,870)	($1,926)	($1,983)	($2,043)	($2,104)	($2,167)	($2,232)	($2,299)	($2,368)	($2,439)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$27,060**	**$3,723**	**$28,403**	**$29,099**	**$29,812**	**$30,542**	**$31,291**	**$32,058**	**$32,843**	**$33,648**	**$34,472**	**$35,317**	
Cumulative Cash Flow	**$338,382**	**$342,105**	**$370,508**	**$399,606**	**$429,418**	**$459,961**	**$491,252**	**$523,309**	**$556,152**	**$589,800**	**$624,272**	**$659,589**	

NPV (25 years)	**$260,923**
Simple Payback Period	**3.14 Years**


Cumulative Net Cash flow

Note: The tax code is complex. All numbers in this document should be considered illustrative examples only. This information is neither legal nor tax advice. Please consult a taxation specialist. Bright Power Inc shall not be responsible for damages

Building B1 - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$800,000
Upfront Costs (less NYSERDA Incentive)	$600,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.206830 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

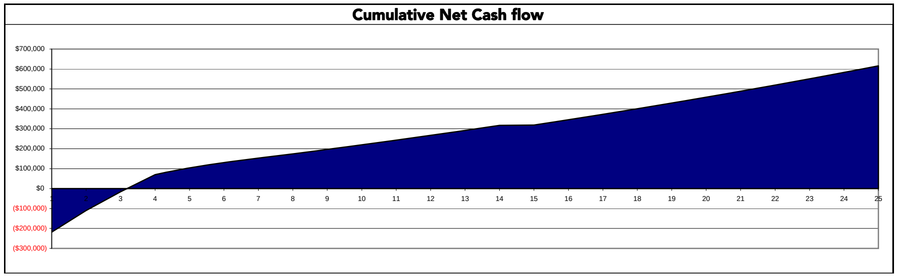
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$19,661	$20,150	$20,650	$21,164	$21,690	$22,228	$22,781	$23,347	$23,927	$24,522	$25,131	$25,756	$26,396
Less O&M Expenses	($1,200)	($1,236)	($1,273)	($1,311)	($1,351)	($1,391)	($1,433)	($1,476)	($1,520)	($1,566)	($1,613)	($1,661)	($1,711)
Purchase Price or Down Payment / Buyout	($800,000)												
NYSERDA Incentive	$200,000												
Less Tax on NYSERDA	($68,000)												
Federal Tax Credit	$240,000												
NYC Property Tax Abatement	$52,500	$52,500	$52,500	$52,500									
Total MACRS Benefit	$138,720	$36,992	$22,195	$13,317	$13,317	$6,659							
Annual Cash Flow	**($218,319)**	**$108,406**	**$94,073**	**$85,669**	**$33,656**	**$27,496**	**$21,348**	**$21,871**	**$22,407**	**$22,956**	**$23,518**	**$24,095**	**$24,685**
Cumulative Cash Flow	**($218,319)**	**($109,913)**	**($15,841)**	**$69,829**	**$103,485**	**$130,981**	**$152,329**	**$174,200**	**$196,607**	**$219,563**	**$243,081**	**$267,176**	**$291,861**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$27,052	$27,724	$28,413	$29,119	$29,842	$30,584	$31,344	$32,123	$32,921	$33,739	$34,578	$35,437	
Less O&M Expenses	**($1,762)**	($25,815)	($1,870)	($1,926)	($1,983)	($2,043)	($2,104)	($2,167)	($2,232)	($2,299)	($2,368)	($2,439)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$25,289**	**$1,909**	**$26,543**	**$27,193**	**$27,859**	**$28,541**	**$29,240**	**$29,956**	**$30,689**	**$31,440**	**$32,209**	**$32,998**	
Cumulative Cash Flow	**$317,150**	**$319,059**	**$345,602**	**$372,795**	**$400,654**	**$429,195**	**$458,435**	**$488,390**	**$519,079**	**$550,519**	**$582,728**	**$615,726**	

NPV (25 years)	**$242,125**
Simple Payback Period	**3.19 Years**


Cumulative Net Cash flow

Note: The tax code is complex. All numbers in this document should be considered illustrative examples only. This information is neither legal nor tax advice. Please consult a taxation specialist. Bright Power Inc shall not be responsible for damages

Building B2 - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$580,000
Upfront Costs (less NYSERDA Incentive)	$424,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.158376 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

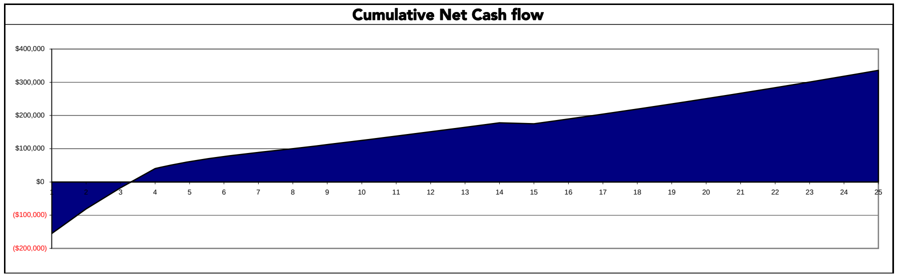
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$10,915	$11,186	$11,464	$11,749	$12,041	$12,340	$12,647	$12,961	$13,283	$13,613	$13,952	$14,298	$14,654
Less O&M Expenses	($870)	($896)	($923)	($951)	($979)	($1,009)	($1,039)	($1,070)	($1,102)	($1,135)	($1,169)	($1,204)	($1,240)
Purchase Price or Down Payment / Buyout	($580,000)												
NYSERDA Incentive	$156,000												
Less Tax on NYSERDA	($53,040)												
Federal Tax Credit	$174,000												
NYC Property Tax Abatement	$37,100	$37,100	$37,100	$37,100									
Total MACRS Benefit	$100,572	$26,819	$16,092	$9,655	$9,655	$4,827							
Annual Cash Flow	**($155,323)**	**$74,209**	**$63,733**	**$57,553**	**$20,717**	**$16,159**	**$11,608**	**$11,891**	**$12,181**	**$12,478**	**$12,782**	**$13,094**	**$13,413**
Cumulative Cash Flow	**($155,323)**	**($81,114)**	**($17,381)**	**$40,172**	**$60,889**	**$77,048**	**$88,656**	**$100,547**	**$112,729**	**$125,207**	**$137,989**	**$151,083**	**$164,496**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$15,018	$15,391	$15,773	$16,165	$16,567	$16,979	$17,401	$17,833	$18,276	$18,730	$19,196	$19,673	
Less O&M Expenses	($1,278)	($18,716)	($1,355)	($1,396)	($1,438)	($1,481)	($1,526)	($1,571)	($1,618)	($1,667)	($1,717)	($1,769)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$13,740**	**($3,325)**	**$14,418**	**$14,769**	**$15,129**	**$15,498**	**$15,875**	**$16,262**	**$16,658**	**$17,063**	**$17,479**	**$17,904**	
Cumulative Cash Flow	**$178,237**	**$174,912**	**$189,330**	**$204,099**	**$219,228**	**$234,726**	**$250,601**	**$266,863**	**$283,521**	**$300,584**	**$318,063**	**$335,968**	

NPV (25 years)	**$130,276**
Simple Payback Period	**3.30 Years**


Cumulative Net Cash flow

Note: The tax code is complex. All numbers in this document should be considered illustrative examples only. This information is neither legal nor tax advice. Please consult a taxation specialist. Bright Power Inc shall not be responsible for damages

Building B2 - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$580,000
Upfront Costs (less NYSERDA Incentive)	$424,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.162819 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

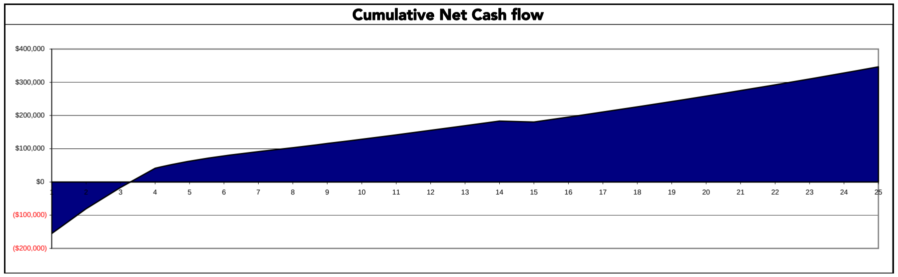
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$11,221	$11,500	$11,786	$12,079	$12,379	$12,686	$13,002	$13,325	$13,656	$13,995	$14,343	$14,699	$15,065
Less O&M Expenses	($870)	($896)	($923)	($951)	($979)	($1,009)	($1,039)	($1,070)	($1,102)	($1,135)	($1,169)	($1,204)	($1,240)
Purchase Price or Down Payment / Buyout	($580,000)												
NYSERDA Incentive	$156,000												
Less Tax on NYSERDA	($53,040)												
Federal Tax Credit	$174,000												
NYC Property Tax Abatement	$37,100	$37,100	$37,100	$37,100									
Total MACRS Benefit	$100,572	$26,819	$16,092	$9,655	$9,655	$4,827							
Annual Cash Flow	**($155,017)**	**$74,523**	**$64,054**	**$57,883**	**$21,055**	**$16,505**	**$11,963**	**$12,255**	**$12,554**	**$12,860**	**$13,174**	**$13,495**	**$13,824**
Cumulative Cash Flow	**($155,017)**	**($80,494)**	**($16,439)**	**$41,443**	**$62,498**	**$79,003**	**$90,966**	**$103,221**	**$115,775**	**$128,635**	**$141,809**	**$155,304**	**$169,128**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$15,439	$15,823	$16,216	$16,619	$17,032	$17,455	$17,889	$18,333	$18,789	$19,256	$19,734	$20,225	
Less O&M Expenses	**($1,278)**	($18,716)	($1,355)	($1,396)	($1,438)	($1,481)	($1,526)	($1,571)	($1,618)	($1,667)	($1,717)	($1,769)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$14,161**	**($2,893)**	**$14,861**	**$15,223**	**$15,594**	**$15,974**	**$16,363**	**$16,762**	**$17,171**	**$17,589**	**$18,017**	**$18,456**	
Cumulative Cash Flow	**$183,290**	**$180,397**	**$195,257**	**$210,480**	**$226,074**	**$242,048**	**$258,411**	**$275,173**	**$292,344**	**$309,933**	**$327,950**	**$346,407**	

NPV (25 years)	**$134,750**
Simple Payback Period	**3.28 Years**



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Building B3 - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$90,000
Upfront Costs (less NYSERDA Incentive)	$63,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.148455 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

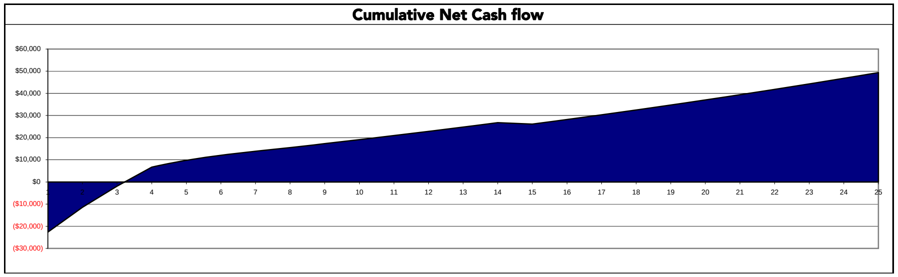
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$1,588	$1,627	$1,667	$1,709	$1,751	$1,795	$1,840	$1,885	$1,932	$1,980	$2,029	$2,080	$2,131
Less O&M Expenses	($135)	($139)	($143)	($148)	($152)	($157)	($161)	($166)	($171)	($176)	($181)	($187)	($192)
Purchase Price or Down Payment / Buyout	($90,000)												
NYSERDA Incentive	$27,000												
Less Tax on NYSERDA	($9,180)												
Federal Tax Credit	$27,000												
NYC Property Tax Abatement	$5,513	$5,513	$5,513	$5,513									
Total MACRS Benefit	$15,606	$4,162	$2,497	$1,498	$1,498	$749							
Annual Cash Flow	**($22,609)**	**$11,162**	**$9,534**	**$8,572**	**$3,098**	**$2,388**	**$1,678**	**$1,719**	**$1,761**	**$1,804**	**$1,848**	**$1,893**	**$1,939**
Cumulative Cash Flow	**($22,609)**	**($11,447)**	**($1,913)**	**$6,659**	**$9,757**	**$12,144**	**$13,822**	**$15,542**	**$17,303**	**$19,107**	**$20,955**	**$22,847**	**$24,786**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$2,184	$2,239	$2,294	$2,351	$2,410	$2,470	$2,531	$2,594	$2,658	$2,724	$2,792	$2,861	
Less O&M Expenses	**($198)**	($2,904)	($210)	($217)	($223)	($230)	($237)	($244)	($251)	($259)	($266)	($274)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$1,986**	**($666)**	**$2,084**	**$2,135**	**$2,187**	**$2,240**	**$2,294**	**$2,350**	**$2,407**	**$2,466**	**$2,526**	**$2,587**	
Cumulative Cash Flow	**$26,772**	**$26,107**	**$28,191**	**$30,326**	**$32,512**	**$34,752**	**$37,046**	**$39,396**	**$41,803**	**$44,269**	**$46,795**	**$49,382**	

NPV (25 years)	**$19,560**
Simple Payback Period	**3.22 Years**


Cumulative Net Cash flow

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Building B3 - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$90,000
Upfront Costs (less NYSERDA Incentive)	$63,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.166267 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

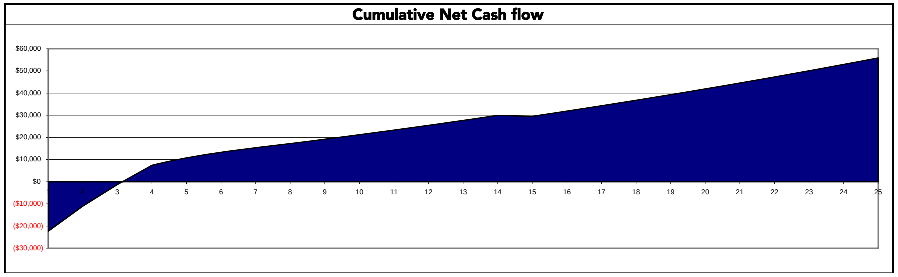
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$1,778	$1,822	$1,868	$1,914	$1,962	$2,010	$2,060	$2,111	$2,164	$2,218	$2,273	$2,329	$2,387
Less O&M Expenses	($135)	($139)	($143)	($148)	($152)	($157)	($161)	($166)	($171)	($176)	($181)	($187)	($192)
Purchase Price or Down Payment / Buyout	($90,000)												
NYSERDA Incentive	$27,000												
Less Tax on NYSERDA	($9,180)												
Federal Tax Credit	$27,000												
NYC Property Tax Abatement	$5,513	$5,513	$5,513	$5,513									
Total MACRS Benefit	$15,606	$4,162	$2,497	$1,498	$1,498	$749							
Annual Cash Flow	**($22,418)**	**$11,357**	**$9,734**	**$8,777**	**$3,308**	**$2,603**	**$1,899**	**$1,945**	**$1,993**	**$2,042**	**$2,091**	**$2,142**	**$2,195**
Cumulative Cash Flow	**($22,418)**	**($11,061)**	**($1,327)**	**$7,450**	**$10,758**	**$13,360**	**$15,259**	**$17,205**	**$19,198**	**$21,239**	**$23,331**	**$25,473**	**$27,668**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$2,446	$2,507	$2,570	$2,633	$2,699	$2,766	$2,835	$2,905	$2,977	$3,051	$3,127	$3,205	
Less O&M Expenses	**($198)**	($2,904)	($210)	($217)	($223)	($230)	($237)	($244)	($251)	($259)	($266)	($274)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$2,248**	**($397)**	**$2,359**	**$2,417**	**$2,476**	**$2,536**	**$2,598**	**$2,661**	**$2,726**	**$2,793**	**$2,861**	**$2,930**	
Cumulative Cash Flow	**$29,916**	**$29,519**	**$31,878**	**$34,295**	**$36,771**	**$39,307**	**$41,905**	**$44,566**	**$47,292**	**$50,085**	**$52,945**	**$55,876**	

NPV (25 years)	**$22,343**
Simple Payback Period	**3.15 Years**



Cumulative Net Cash flow

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Building B3** - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$90,000
Upfront Costs (less NYSERDA Incentive)	$63,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.148455 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

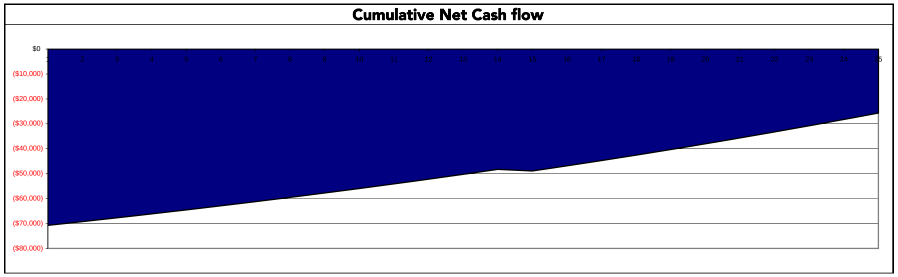
PV Incentives	**Option**
MACRS	No
Federal Incentive:	No
NYSERDA (net of tax)	Yes
Property Tax Abatement	No

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$1,588	$1,627	$1,667	$1,709	$1,751	$1,795	$1,840	$1,885	$1,932	$1,980	$2,029	$2,080	$2,131
Less O&M Expenses	($135)	($139)	($143)	($148)	($152)	($157)	($161)	($166)	($171)	($176)	($181)	($187)	($192)
Purchase Price or Down Payment / Buyout	($90,000)												
NYSERDA Incentive	$27,000												
Less Tax on NYSERDA	($9,180)												
Federal Tax Credit													
NYC Property Tax Abatement													
Total MACRS Benefit													
Annual Cash Flow	**($70,727)**	**$1,488**	**$1,524**	**$1,561**	**$1,599**	**$1,638**	**$1,678**	**$1,719**	**$1,761**	**$1,804**	**$1,848**	**$1,893**	**$1,939**
Cumulative Cash Flow	**($70,727)**	**($69,239)**	**($67,715)**	**($66,154)**	**($64,554)**	**($62,916)**	**($61,238)**	**($59,518)**	**($57,757)**	**($55,953)**	**($54,105)**	**($52,213)**	**($50,274)**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$2,184	$2,239	$2,294	$2,351	$2,410	$2,470	$2,531	$2,594	$2,658	$2,724	$2,792	$2,861	
Less O&M Expenses	**($198)**	($2,904)	($210)	($217)	($223)	($230)	($237)	($244)	($251)	($259)	($266)	($274)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$1,986**	**($666)**	**$2,084**	**$2,135**	**$2,187**	**$2,240**	**$2,294**	**$2,350**	**$2,407**	**$2,466**	**$2,526**	**$2,587**	
Cumulative Cash Flow	**($48,288)**	**($48,953)**	**($46,869)**	**($44,734)**	**($42,548)**	**($40,308)**	**($38,014)**	**($35,664)**	**($33,257)**	**($30,791)**	**($28,265)**	**($25,678)**	

NPV (25 years)	**($47,314)**
Simple Payback Period	**33.81 Years**



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Building B3** - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$90,000
Upfront Costs (less NYSERDA Incentive)	$63,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.166267 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

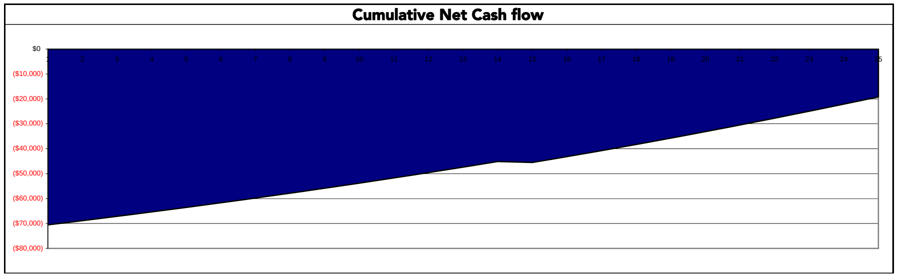
PV Incentives	**Option**
MACRS	No
Federal Incentive:	No
NYSERDA (net of tax)	Yes
Property Tax Abatement	No

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$1,778	$1,822	$1,868	$1,914	$1,962	$2,010	$2,060	$2,111	$2,164	$2,218	$2,273	$2,329	$2,387
Less O&M Expenses	($135)	($139)	($143)	($148)	($152)	($157)	($161)	($166)	($171)	($176)	($181)	($187)	($192)
Purchase Price or Down Payment / Buyout	($90,000)												
NYSERDA Incentive	$27,000												
Less Tax on NYSERDA	($9,180)												
Federal Tax Credit													
NYC Property Tax Abatement													
Total MACRS Benefit													
Annual Cash Flow	**($70,537)**	**$1,683**	**$1,724**	**$1,766**	**$1,810**	**$1,854**	**$1,899**	**$1,945**	**$1,993**	**$2,042**	**$2,091**	**$2,142**	**$2,195**
Cumulative Cash Flow	**($70,537)**	**($68,854)**	**($67,129)**	**($65,363)**	**($63,553)**	**($61,700)**	**($59,801)**	**($57,855)**	**($55,862)**	**($53,821)**	**($51,729)**	**($49,587)**	**($47,392)**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$2,446	$2,507	$2,570	$2,633	$2,699	$2,766	$2,835	$2,905	$2,977	$3,051	$3,127	$3,205	
Less O&M Expenses	**($198)**	($2,904)	($210)	($217)	($223)	($230)	($237)	($244)	($251)	($259)	($266)	($274)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$2,248**	**($397)**	**$2,359**	**$2,417**	**$2,476**	**$2,536**	**$2,598**	**$2,661**	**$2,726**	**$2,793**	**$2,861**	**$2,930**	
Cumulative Cash Flow	**($45,144)**	**($45,541)**	**($43,182)**	**($40,765)**	**($38,289)**	**($35,753)**	**($33,155)**	**($30,494)**	**($27,768)**	**($24,975)**	**($22,115)**	**($19,184)**	

NPV (25 years)	**($44,531)**
Simple Payback Period	**31.01 Years**



Note: The tax code is complex. All numbers in this document should be considered illustrative examples only. This information is neither legal nor tax advice. Please consult a taxation specialist. Bright Power Inc shall not be responsible for damages

Building B4 - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$130,000
Upfront Costs (less NYSERDA Incentive)	$91,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.128338 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

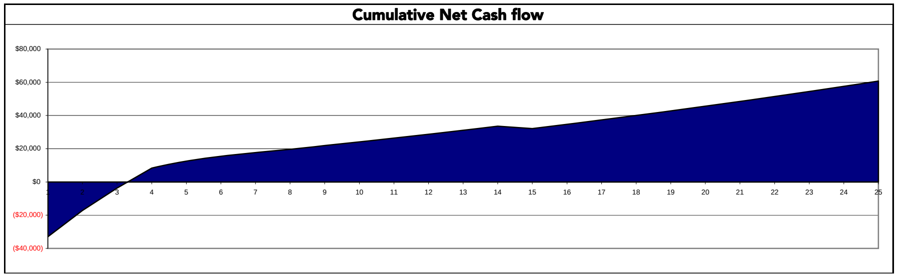
PV Incentives	**Option**
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$1,982	$2,032	$2,082	$2,134	$2,187	$2,241	$2,297	$2,354	$2,413	$2,473	$2,534	$2,597	$2,662
Less O&M Expenses	($195)	($201)	($207)	($213)	($219)	($226)	($233)	($240)	($247)	($254)	($262)	($270)	($278)
Purchase Price or Down Payment / Buyout	($130,000)												
NYSERDA Incentive	$39,000												
Less Tax on NYSERDA	($13,260)												
Federal Tax Credit	$39,000												
NYC Property Tax Abatement	$7,963	$7,963	$7,963	$7,963									
Total MACRS Benefit	$22,542	$6,011	$3,607	$2,164	$2,164	$1,082							
Annual Cash Flow	**($32,968)**	**$15,805**	**$13,445**	**$12,047**	**$4,132**	**$3,097**	**$2,064**	**$2,114**	**$2,166**	**$2,218**	**$2,272**	**$2,327**	**$2,383**
Cumulative Cash Flow	**($32,968)**	**($17,163)**	**($3,719)**	**$8,328**	**$12,460**	**$15,557**	**$17,621**	**$19,736**	**$21,901**	**$24,119**	**$26,391**	**$28,718**	**$31,102**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$2,728	$2,795	$2,865	$2,936	$3,009	$3,084	$3,160	$3,239	$3,319	$3,402	$3,487	$3,573	
Less O&M Expenses	**($286)**	($4,195)	($304)	($313)	($322)	($332)	($342)	($352)	($363)	($374)	($385)	($396)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$2,441**	**($1,400)**	**$2,561**	**$2,623**	**$2,687**	**$2,752**	**$2,819**	**$2,887**	**$2,957**	**$3,028**	**$3,102**	**$3,177**	
Cumulative Cash Flow	**$33,543**	**$32,144**	**$34,705**	**$37,328**	**$40,015**	**$42,767**	**$45,585**	**$48,472**	**$51,429**	**$54,457**	**$57,559**	**$60,735**	

NPV (25 years)	**$23,713**
Simple Payback Period	**3.31 Years**



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Building B4 - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$130,000
Upfront Costs (less NYSERDA Incentive)	$91,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.141063 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

PV Incentives	**Option**
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

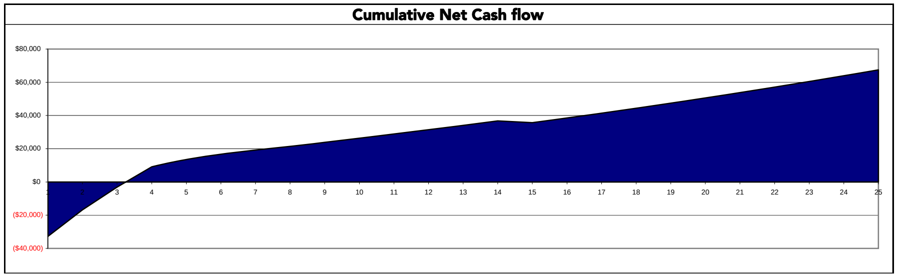
Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$2,179	$2,233	$2,289	$2,346	$2,404	$2,464	$2,525	$2,588	$2,652	$2,718	$2,785	$2,854	$2,925
Less O&M Expenses	($195)	($201)	($207)	($213)	($219)	($226)	($233)	($240)	($247)	($254)	($262)	($270)	($278)
Purchase Price or Down Payment / Buyout	($130,000)												
NYSERDA Incentive	$39,000												
Less Tax on NYSERDA	($13,260)												
Federal Tax Credit	$39,000												
NYC Property Tax Abatement	$7,963	$7,963	$7,963	$7,963									
Total MACRS Benefit	$22,542	$6,011	$3,607	$2,164	$2,164	$1,082							
Annual Cash Flow	**($32,771)**	**$16,006**	**$13,651**	**$12,259**	**$4,348**	**$3,320**	**$2,292**	**$2,348**	**$2,405**	**$2,463**	**$2,523**	**$2,585**	**$2,647**
Cumulative Cash Flow	**($32,771)**	**($16,765)**	**($3,114)**	**$9,145**	**$13,493**	**$16,812**	**$19,104**	**$21,452**	**$23,857**	**$26,320**	**$28,843**	**$31,428**	**$34,075**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$2,998	$3,073	$3,149	$3,227	$3,307	$3,390	$3,474	$3,560	$3,649	$3,739	$3,832	$3,927	
Less O&M Expenses	**($286)**	($4,195)	($304)	($313)	($322)	($332)	($342)	($352)	($363)	($374)	($385)	($396)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$2,712**	**($1,122)**	**$2,845**	**$2,914**	**$2,985**	**$3,058**	**$3,132**	**$3,208**	**$3,286**	**$3,366**	**$3,447**	**$3,531**	
Cumulative Cash Flow	**$36,787**	**$35,665**	**$38,510**	**$41,424**	**$44,409**	**$47,467**	**$50,599**	**$53,807**	**$57,092**	**$60,458**	**$63,905**	**$67,436**	

NPV (25 years)	**$26,585**
Simple Payback Period	**3.25 Years**

Cumulative Net Cash flow



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Building B5 - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$750,000
Upfront Costs (less NYSERDA Incentive)	$560,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.206792 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

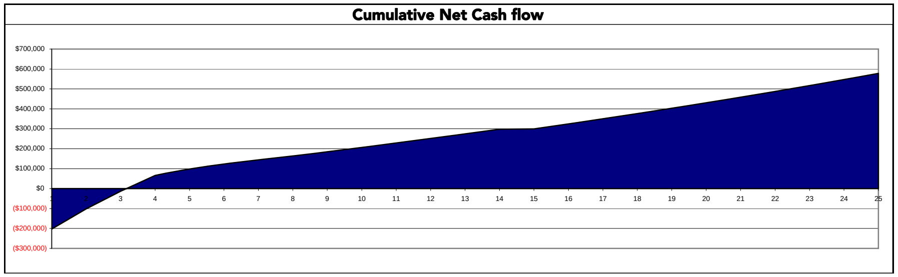
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$18,429	$18,887	$19,356	$19,837	$20,330	$20,835	$21,353	$21,884	$22,428	$22,985	$23,556	$24,141	$24,741
Less O&M Expenses	($1,125)	($1,159)	($1,194)	($1,229)	($1,266)	($1,304)	($1,343)	($1,384)	($1,425)	($1,468)	($1,512)	($1,557)	($1,604)
Purchase Price or Down Payment / Buyout	($750,000)												
NYSERDA Incentive	$190,000												
Less Tax on NYSERDA	($64,600)												
Federal Tax Credit	$225,000												
NYC Property Tax Abatement	$49,000	$49,000	$49,000	$49,000									
Total MACRS Benefit	$130,050	$34,680	$20,808	$12,485	$12,485	$6,242							
Annual Cash Flow	**($203,246)**	**$101,408**	**$87,971**	**$80,093**	**$31,549**	**$25,774**	**$20,010**	**$20,500**	**$21,002**	**$21,517**	**$22,044**	**$22,584**	**$23,137**
Cumulative Cash Flow	**($203,246)**	**($101,838)**	**($13,867)**	**$66,225**	**$97,774**	**$123,548**	**$143,558**	**$164,058**	**$185,060**	**$206,577**	**$228,621**	**$251,206**	**$274,343**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$25,356	$25,986	$26,632	$27,294	$27,972	$28,667	$29,380	$30,110	$30,858	$31,625	$32,411	$33,216	
Less O&M Expenses	**($1,652)**	($24,202)	($1,753)	($1,805)	($1,859)	($1,915)	($1,973)	($2,032)	($2,093)	($2,156)	($2,220)	($2,287)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$23,704**	**$1,785**	**$24,879**	**$25,489**	**$26,113**	**$26,752**	**$27,407**	**$28,078**	**$28,765**	**$29,469**	**$30,190**	**$30,929**	
Cumulative Cash Flow	**$298,047**	**$299,832**	**$324,711**	**$350,200**	**$376,312**	**$403,064**	**$430,471**	**$458,549**	**$487,314**	**$516,783**	**$546,973**	**$577,902**	

NPV (25 years)	**$227,743**
Simple Payback Period	**3.18 Years**


Cumulative Net Cash flow

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Building B5 - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$750,000
Upfront Costs (less NYSERDA Incentive)	$560,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.226397 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

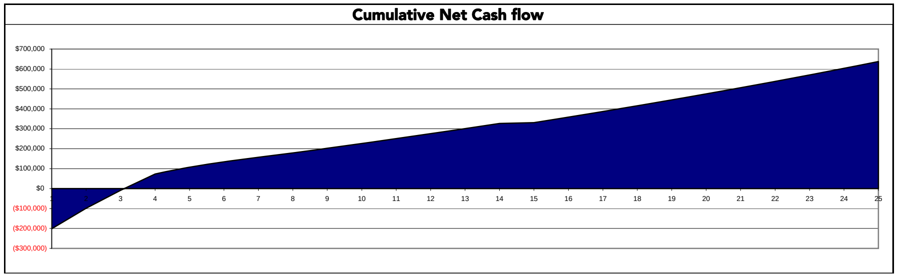
PV Incentives	**Option**
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$20,176	$20,677	$21,191	$21,718	$22,258	$22,811	$23,378	$23,958	$24,554	$25,164	$25,789	$26,430	$27,087
Less O&M Expenses	($1,125)	($1,159)	($1,194)	($1,229)	($1,266)	($1,304)	($1,343)	($1,384)	($1,425)	($1,468)	($1,512)	($1,557)	($1,604)
Purchase Price or Down Payment / Buyout	($750,000)												
NYSERDA Incentive	$190,000												
Less Tax on NYSERDA	($64,600)												
Federal Tax Credit	$225,000												
NYC Property Tax Abatement	$49,000	$49,000	$49,000	$49,000									
Total MACRS Benefit	$130,050	$34,680	$20,808	$12,485	$12,485	$6,242							
Annual Cash Flow	**($201,499)**	**$103,199**	**$89,806**	**$81,973**	**$33,476**	**$27,749**	**$22,034**	**$22,575**	**$23,129**	**$23,696**	**$24,277**	**$24,873**	**$25,483**
Cumulative Cash Flow	**($201,499)**	**($98,300)**	**($8,494)**	**$73,479**	**$106,955**	**$134,704**	**$156,738**	**$179,313**	**$202,442**	**$226,138**	**$250,415**	**$275,288**	**$300,771**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$27,760	$28,450	$29,157	$29,881	$30,624	$31,385	$32,165	$32,964	$33,783	$34,623	$35,483	$36,365	
Less O&M Expenses	**($1,652)**	($24,202)	($1,753)	($1,805)	($1,859)	($1,915)	($1,973)	($2,032)	($2,093)	($2,156)	($2,220)	($2,287)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$26,108**	**$4,248**	**$27,404**	**$28,076**	**$28,765**	**$29,470**	**$30,192**	**$30,932**	**$31,691**	**$32,467**	**$33,263**	**$34,078**	
Cumulative Cash Flow	**$326,879**	**$331,127**	**$358,532**	**$386,608**	**$415,372**	**$444,842**	**$475,034**	**$505,967**	**$537,657**	**$570,125**	**$603,388**	**$637,466**	

NPV (25 years)	**$253,270**
Simple Payback Period	**3.10 Years**


Cumulative Net Cash flow

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Building B6 - Standard Tariff

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$90,000
Upfront Costs (less NYSERDA Incentive)	$63,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.212424 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

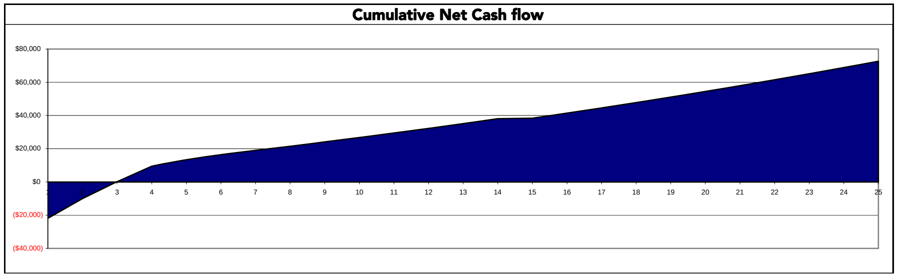
PV Incentives	Option
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$2,272	$2,328	$2,386	$2,445	$2,506	$2,568	$2,632	$2,698	$2,765	$2,833	$2,904	$2,976	$3,050
Less O&M Expenses	($135)	($139)	($143)	($148)	($152)	($157)	($161)	($166)	($171)	($176)	($181)	($187)	($192)
Purchase Price or Down Payment / Buyout	($90,000)												
NYSERDA Incentive	$27,000												
Less Tax on NYSERDA	($9,180)												
Federal Tax Credit	$27,000												
NYC Property Tax Abatement	$5,513	$5,513	$5,513	$5,513									
Total MACRS Benefit	$15,606	$4,162	$2,497	$1,498	$1,498	$749							
Annual Cash Flow	**($21,925)**	**$11,863**	**$10,252**	**$9,308**	**$3,852**	**$3,161**	**$2,471**	**$2,532**	**$2,594**	**$2,657**	**$2,722**	**$2,789**	**$2,857**
Cumulative Cash Flow	**($21,925)**	**($10,062)**	**$191**	**$9,499**	**$13,351**	**$16,512**	**$18,983**	**$21,515**	**$24,108**	**$26,766**	**$29,488**	**$32,277**	**$35,134**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$3,126	$3,203	$3,283	$3,364	$3,448	$3,534	$3,622	$3,712	$3,804	$3,898	$3,995	$4,094	
Less O&M Expenses	**($198)**	($2,904)	($210)	($217)	($223)	($230)	($237)	($244)	($251)	($259)	($266)	($274)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$2,927**	**$299**	**$3,073**	**$3,148**	**$3,225**	**$3,304**	**$3,385**	**$3,468**	**$3,553**	**$3,640**	**$3,729**	**$3,820**	
Cumulative Cash Flow	**$38,062**	**$38,361**	**$41,433**	**$44,581**	**$47,806**	**$51,110**	**$54,495**	**$57,962**	**$61,515**	**$65,155**	**$68,884**	**$72,704**	

NPV (25 years)	**$29,555**
Simple Payback Period	**2.98 Years**



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Building B6 - Hourly Pricing

Financial Summary of PV Investment

Key Assumptions and Incentives:

System Parameters	
Size of PV System (kW)	75 kw
Cost per KW of capacity	$10,000
Sale Price of System	$90,000
Upfront Costs (less NYSERDA Incentive)	$63,000
Project Installation Date	11/1/2009

Energy Parameters	
Energy Cost per KWh (Retail)	$0.229842 Per KWh
Annual kWh Produced by One kW	1,188 kWh
PV annual degradation factor	0.50%
Inverter Replacement Year	Year 15

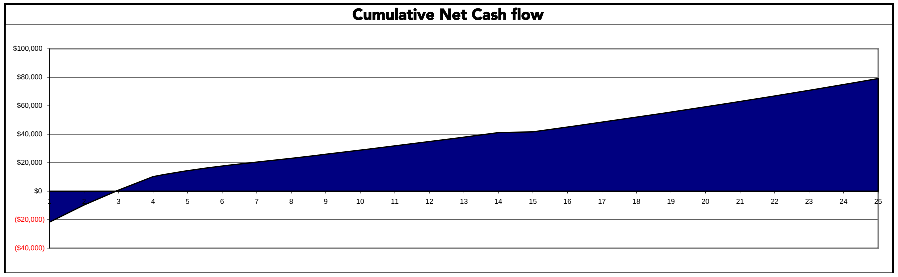
PV Incentives	**Option**
MACRS	Yes
Federal Incentive:	Tax Credit
NYSERDA (net of tax)	Yes
Property Tax Abatement	Yes

Financial Parameters	
Assumed Federal Income Tax Rate	34%
Assumed Discount Rate	7.0%

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Energy Cost Savings	$2,458	$2,519	$2,582	$2,646	$2,712	$2,779	$2,848	$2,919	$2,991	$3,066	$3,142	$3,220	$3,300
Less O&M Expenses	($135)	($139)	($143)	($148)	($152)	($157)	($161)	($166)	($171)	($176)	($181)	($187)	($192)
Purchase Price or Down Payment / Buyout	($90,000)												
NYSERDA Incentive	$27,000												
Less Tax on NYSERDA	($9,180)												
Federal Tax Credit	$27,000												
NYC Property Tax Abatement	$5,513	$5,513	$5,513	$5,513									
Total MACRS Benefit	$15,606	$4,162	$2,497	$1,498	$1,498	$749							
Annual Cash Flow	**($21,739)**	**$12,054**	**$10,448**	**$9,509**	**$4,058**	**$3,372**	**$2,687**	**$2,753**	**$2,820**	**$2,889**	**$2,960**	**$3,033**	**$3,107**
Cumulative Cash Flow	**($21,739)**	**($9,684)**	**$763**	**$10,272**	**$14,330**	**$17,702**	**$20,389**	**$23,141**	**$25,962**	**$28,851**	**$31,811**	**$34,844**	**$37,952**

	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25	
Energy Cost Savings	$3,382	$3,466	$3,552	$3,640	$3,731	$3,824	$3,919	$4,016	$4,116	$4,218	$4,323	$4,430	
Less O&M Expenses	**($198)**	($2,904)	($210)	($217)	($223)	($230)	($237)	($244)	($251)	($259)	($266)	($274)	
Purchase Price or Down Payment / Buyout													
Annual Cash Flow	**$3,184**	**$562**	**$3,342**	**$3,424**	**$3,508**	**$3,594**	**$3,682**	**$3,772**	**$3,865**	**$3,959**	**$4,056**	**$4,156**	
Cumulative Cash Flow	**$41,135**	**$41,697**	**$45,039**	**$48,463**	**$51,970**	**$55,564**	**$59,246**	**$63,018**	**$66,882**	**$70,842**	**$74,898**	**$79,054**	

NPV (25 years)	**$32,277**
Simple Payback Period	**2.93 Years**


Cumulative Net Cash flow

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