



**Solar Power Viability in Pennsylvania and Other States** © 2007  
**An Introduction for Commercial Real Estate Owners**  
**November, 2007**

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## 1) Abstract

This white paper discusses the current viability of solar power for middle market commercial applications in Pennsylvania. This paper was prepared in response to the many general inquiries Eos receives from Pennsylvania businesses, regarding solar power. Therefore, this paper is targeted primarily at commercial real estate owners, operators, and investors who are adept with financial nomenclature, but are new to the concepts and technical aspects of solar power. The Eos staff is available for further consultation with prospective clients for specific projects.

The short answer to the question of solar power viability is: *We are currently at the tipping point.*

In states where rebate or subsidy programs already exist (such as California, Florida, New Jersey and New York), solar power is not just economically viable, but is an excellent capital investment with strong financial and social ROI. Solar power is technically viable anywhere in the Commonwealth of Pennsylvania but as of November 2007, it is cost-effective in only a very limited number of applications. We are at the tipping point because Bills now under consideration in the Pennsylvania Legislature would provide the subsidies necessary to propel solar power in PA from being *at the tipping point* to an excellent investment with strong financial and social ROI.

The short term future of the solar power in Pennsylvania is, therefore, contingent upon the success of the state legislature to pass and fund the elements of the Governor's Energy Plan that make solar cost viable in today's market – just as states such as California, Florida, New Jersey and New York have already done.

## 2) Solar Power Explained in 60 Seconds

Solar power is any one of many technologies that convert the energy in sunlight to a transportable energy medium such as electricity or hot water. For the purposes of this white paper, solar technologies or methods can be broadly grouped as being either “thermal” or “photovoltaic”. Thermal systems are generally used to produce hot water, most typically in residentially applications for domestic hot water demand. The fundamental principals, however, can also be applied to huge utility-scale systems where the steam generated from concentrated thermal solar collectors drives electricity generation turbines.

The other broad type of solar, photovoltaics (or “PV”) is the technology that converts light directly into electricity. The iconic roof-mounted solar panel that most people associate with solar power is PV. Photovoltaics are the subject of this white paper and commercial grid-tied PV is the focus of Eos Energy Solutions.

PV technology is based on the unique properties of some semiconductors to convert solar radiation to electricity. The conversion occurs between sets of solar cells, typically comprised of high-grade crystalline silicon. These cells individually produce a relatively small direct current – in general illustrative terms, less than a household 9 volt battery. The cell sets are grouped in large assemblies to create modules (or panels). A typical PV module may have about 40 cells and it is a little larger than a standard 2x4 acoustic ceiling tile. A number of panels are then combined to create an array. A residential array may be as small as 200 square feet, while some of Eos' larger commercial arrays are over 10,000 square feet. The composite power generation capacity of the thousands of cells in a large array can be enough to power a commercial facility – and with no moving parts, noise, or emissions.

Most PV systems (and nearly Eos designs) are “grid tied”, meaning they are directly connected to the utility power grid. These systems use a special “net meter” that measures total facility load, PV power production, and power consumed from the grid. In other words, most PV systems offset the power consumption from the grid – they do not provide 100% of a facility’s power demand, nor do they limit how much power a facility can purchase from the grid during times of peak demand. 42 states, plus the District of Columbia now have a net metering standard. Pennsylvania has an excellent net metering standard that requires utilities to provide the special meter to all customers, in most instances.

How much of a facility’s power is provided by its PV system depends on the size and efficiency of the system, as well as the power load required by the facility. A highly energy efficient office building with a large PV array, for example, may produce 75% of its power needs, while a manufacturing facility with the same size array but a much larger demand profile may be producing only 10% of its total power needs. PV systems can be sized and configured to almost any application. Initial capital investment amount and available roof areas are typically the prime limiting factors for sizing. PV systems can be configured with inverters that allow grid connection for single or three phase systems, and at all common voltages.

### 3) Solar Power is Already Mainstream – just not in Pennsylvania

PV power is not new, nor unusual. In Germany, Japan, and Southern California, grid-tied PV systems are ubiquitous. World-wide production of PV power in all forms is now greater than 8 gigawatts<sup>1</sup>, which about equal to PECO Energy’s record peak demand of 8.9 gigawatts in the summer of 2006<sup>2</sup>. There is enough existing PV power in the world today to provide the entire City of Philadelphia, plus all of the surrounding suburbs and towns served by PECO Energy !

Almost every Pennsylvania resident encounters PV power every day in the form of PV powered highway signs, or consumer electronics. Every GPS connection and most of our everyday communications are facilitated by solar powered satellites. Even in states where building-application solar power remains rare (such as Pennsylvania), solar power in its various forms is commonplace.

PV power is nothing new. The basic technology of solar power dates to the 19<sup>th</sup> century, and by the 1950s, Bell Laboratories was producing commercially viable solar cells. The technology has been continually refined since then, with a tripling of solar cell efficiency<sup>3</sup>, and an incredible cost reduction to a fraction of the 1950s’s pricing – see discussion in Section 4 for more detail on pricing.

The solar industry in 2006 was an \$11 billion industry, growing at an average annual rate of approximately 40%. The US market is about 9% of the global market, or just under \$1B in 2006. The global market grew at 47% in 06 over 05 and at 41% in 05 over 04. It is about ten times the size it was in 2000, based on global production of 270 mW in 2000 against 2500 mW in 2006<sup>4</sup>.

Where is the \$1 billion solar market in the US? Many places, but not in Pennsylvania. California comprises about 70% of the US end-user market, and New Jersey an additional 18%. Nevada, New

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<sup>1</sup> Eos extrapolation from Prometheus Institute’s 2007 Presentation of *World PV Market by Application*, Bradford & Maycock

<sup>2</sup> *Transmission & Distribution World Magazine*. May 29, 2007

<sup>3</sup> Dunlop, Jim, and NJATC, *Photovoltaic Systems*, American Technical Publishers: Homewood IL. 2007

<sup>4</sup> Prometheus Institute’s 2007 Presentation of *Global Producers*, Bradford & Maycock

York and Arizona each comprise about another 3% of the US market. These states have taken the lead by offering state subsidies to negate the current cost disparity to consumers between clean PV produced electricity and fossil fuel and nuclear produced power. It is simply a matter of economics.

#### 4) Fundamental Economics of PV as a Power Source

Currently, PV for commercial buildings is economically viable against the cost of power from the grid only when state subsidies and federal investment tax credits are applied. As a general point of reference, power produced from PV costs about 28 cents per kWh, with the following financial and technical assumptions:

- (a) turn-key installation costs of \$8/w DCp,
- (b) capital costs are not leveraged,
- (c) 74% efficiency factor, eroding at 0.35% annually,
- (d) Insolation rate is 4.2 sunlight hours per day average (typical for Phila. as per NREL),
- (e) the system power production life is 25 years with inverter replaced in Year 14.

The 28 cents per kWh cost of PV compares unfavorably to the average US commercial end user cost of 9.4 cents per kWh<sup>5</sup>. Power costs in the US are highly variable, however. Costs as low as 7 cents in the Midwest states are common, and average commercial costs in CA, NY, and NJ are 11.7, 15.7 and 10.3 cents/kWh, respectively. Even within Pennsylvania, effective commercial rates are highly variable.

In Pennsylvania, commercial user power costs vary depending upon supplier, and rate structure. In PECO Energy territory, the effective cost of power for a typical commercial user with a GS plus demand charge rate structure would be about 11 to 13 cents/kWh. In PPL or PennElec territory, a more typical commercial customer rate may be 8 to 10 cents/kWh. In general, industrial customers pay less per kWh than commercial customers and commercial customers pay less than residential customers.

On the other side of the equation, the cost of PV has dropped precipitously over the past 30 years. In 1976, PV cost about \$4/kWh and by 1990 the cost had dropped to about \$0.52/kWh<sup>6</sup>, versus today's \$0.28/kWh. Continued production cost improvement through economies of scale are projected, as are continued efficiency improvements in each PV panel's ability to convert sunlight to DC power.

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<sup>5</sup> Energy Information Administration, Department of Energy, Form EIA-826, "Monthly Electric Sales and Revenue Report with State Distributions Report." October 2006

<sup>6</sup> Eos extrapolation of total costs under the assumptions delineated above, with US DoE provided historical cost data of modules at \$50/w DCp in 1976 and \$7.50/w DCp in 1990.

## 5) Governmental Incentives for PV Investments

The incentives that make PV viable today exist in three “buckets”: (a) federal investment tax credit, or the “ITC”, (b) state rebates or grants, and (c) the tradable value of the “green power” produced via Renewable Energy Credits (“RECs” or “Solar REC” or “SRECs”).

### 5.a Federal Investment Tax Credit

The federal ITC is now 30% on solar, with special MACRS depreciation rules that radically improve initial cash flow. An excellent technical manual explaining application of the ITC and its special MACRS provisions is available at <http://www.seia.org/SEIAManualversion1point2.pdf>. The current Solar ITC is scheduled to expire at the end of 2008, but Congress is currently working through an extension with a provision to allow solar tax credits against the AMT. After a 30% ITC, the \$0.28/kWh cost of PV power drops to about \$0.20/kWh.

### 5.b State Rebate Programs

The state programs are diverse and exist in many states. Few states, however, have state-wide, long term rebate programs. In general, the state programs rebate an average of \$2/w to \$4/w of the ballpark \$8/w turn-key cost. Combining the ITC with a \$3 state rebate drops the \$0.28/kWh cost of PV power drops to about \$0.09/kWh, which compares favorably to most current rates – especially after a cost escalator is applied to current power costs from the grid versus the fixed cost of the PV power over term. An excellent consolidated website of state programs is available at <http://www.dsireusa.org/>

***Based on the assumptions delineated above, plus capital investment leverage of 75% at 8% over 12 years, the combined effect of the federal ITC and a \$3/watt state rebate for an investment in a commercial photovoltaic system in Pennsylvania's PECO Energy territory can yield a 32.7% IRR over 12 years.***

### 5.c Renewable Energy Credits

Of the three “buckets”, the REC market is by far the most speculative, most complicated, and the largest potential upside for PV Investments.

REC markets are either “voluntary” or “compliance” based. Compliance markets exist only where a Renewal Portfolio Standards (RPS) with non-compliance penalties has been passed. 18 states have passed Renewal Portfolio Standards. Each state's RPS is a little different, but they all set a standard for that state's utilities to meet with regard to renewable energy. Pennsylvania's RPS is “18 by 20”, meaning 18% of all power produced by 2020 must be from renewable sources, phased in over time. The current House version of the federal energy bill proposes a 15% national standard by 2020.

Not all of the RPSs have non-compliance penalties and not all have set-asides for solar, meaning the RPS could be fully satisfied by more cost efficient wind turbines, hydro, or landfill gasses. But several states have a mandatory solar set aside that is enforced by creating a financial penalty to the utility company for non-compliance. Such penalties are roughly in the ballpark of 40 to 50

cents/kWh. This is a severe penalty when compared to the average cost to end user (or GR to utility) of less than 10 cents/kWh.

The REC trading market is just now beginning to develop, but in Massachusetts, SRECs have traded as high as 40 cents/kWh and in New Jersey the pricing is hovering at about 22 cents/kWh. In states such as California and Florida where the market is still effectively “voluntary”, RECs have failed to gain value beyond about a penny per kWh.

*If the real REC value is only \$0.10/kWh in Pennsylvania, the 32.7% IRR rises to an extraordinary 83.8%.*

## 6) ROI for PV Investments

The financial return on investment for solar projects can be outstanding – but as discussed herein, there are many variables. In a state with a rebate-based incentive program, Eos can typically design and deliver a system with IRRs in excess of 20% - sometimes far in excess of 20%

Eos has developed a proprietary project-specific financial modeling tool to assist client in assessing ROI based on NPV and IRR, over both short term (5 to 7 year) and long term (25 year) scenarios. The following is a sample of prospective projects:

Location	Philadelphia, PA	Los Angeles, CA	Tampa, FL
Real Estate Asset Type	Office	Retail	Hotel
System Size (DC rated)	62 kW	48 kW	25 kW
Turn Key System Cost	\$520,800	\$403,200	\$215,000
Less Federal ITC	\$156,240	\$120,960	\$64,500
Less State Rebate or Grant (1)	\$204,161	\$134,400	\$100,000
Effective Cost to Owner	\$160,399	\$147,840	\$50,500
Existing Power Cost Ave., kWh	\$0.101	\$0.142	\$0.135
Ave. REC value kWh/yr	\$0.13	\$0.015	\$0.015
Average Daily Insolation	4.2	5.3	5.2
Aggregate System Efficiency (2)	74%	74%	76%
kWh Annual Yield	69,686	75,196	37,239
<b>First Year Cash Flows</b>	<b>\$25,101</b>	<b>\$20,851</b>	<b>\$13,863</b>
<b>6 Year IRR (3)</b>	<b>43.7%</b>	<b>31.6%</b>	<b>39.6%</b>
<p>Notes: (1) PA rebate based on current proposals for program in development. CA rebate level is performance based (for commercial projects) and decreases over time. FL rebate program is fully allocated through 2007 at \$4/w DC.</p> <p>(2) Illustrated FL project efficiency is higher due to cap on commercial PV rebates at \$100,000, such that highest efficiency modules are cost effective</p> <p>(3) IRR includes asset divestiture with value of resultant increased NOI at a 8.25% capitalization rate. First year Cash Flow and 6 year IRR assume 70% capital investment leverage at 8.00%</p>			

## 7) Site Specific Viability Variables

### 7a. Current Rates & Rate Structures

The economic viability of a commercial photovoltaic system is, of course, dependent upon the alternative cost of power from the local electrical utility. As discussed above, effective costs to end users for electricity from the grid can range as low as 7 cents/kWh in some Midwest states, to almost twice that figure in some coastal states

In general, current commercial electrical rates in Pennsylvania are less than the 2006 national average of 9.4 cents/kWh, except in PECO Energy territory where they are higher than the national averages. Effective costs for a "typical" PECO Energy customer are in the ballpark of 11 to 13 cents/kWh, while in the other five utility service areas, a more typical commercial customer rate may be 8 to 10 cents/kWh.

All six of Pennsylvania's PUC regulated electrical utility companies (PECO Energy, PPL, Penn Electric, Duquesne, West Penn Power, and Metropolitan Edison) have variable commercial rate structures wherein the actual cost per kWh of power is determined by several variables. Such variables typically include service voltage, peak demand, and power factor. Pennsylvania commercial customers who purchase their power at voltages above 480 (an "HT" rate) typically pay a discounted rate that may preclude a cost effective PV system. **All Eos Energy Solutions statements regarding generic ROIs assume a non-HT commercial rate payer.**

In most areas, a typical commercial consumer electric bill is comprised of two major parts -- charges based on the number of kWh consumed (units of power), and a separate charge based on the peak demand at any one time during the building period (kW). The charge for peak demand is typically referred to as the "demand charge". Where existing, the demand charge structure complicates analysis of the value of the power produced by photovoltaic system because PV systems are generally thought to be ineffective in materially reducing demand charges. However, there is a growing body of field evidence (mostly based on California projects) to indicate that commercial photovoltaic systems actually can be effective in reducing demand charges<sup>7</sup>.

**The current conservative conventional wisdom is to model PV pro formas with an assumption of zero decrease in demand charges -- and this is the assumption which Eos Energy Solutions utilizes in all project pro formas.**

To further complicate the analysis for Pennsylvania commercial PV projects, all six of the Pennsylvania PUC regulated electrical utilities have a tariff which allows for a "CTC charge." The CTC (Competitive Transition Charge) is a residual element of the 1990s industry deregulation agreement that all allows these utilities to charge all customers for stranded electrical generation costs. CTC charges are applied as a surcharge on each kWh of consumption, with a typical rate of one to four cents per kWh. The relevant Pennsylvania tariffs allow the suppliers to continue to charge the CTC even when the kWh procured by the customer from alternative sources (such as PV). The authority for Pennsylvania utilities to charge a CTC will end concurrent with their rate cap expirations in 2008 through 2011. Eos Energy Solutions is not aware of any precedent of a Pennsylvania utility actually charging the CTC on customer produced PV power, but **all Eos project**

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<sup>7</sup> Wiser, Mills, et al. "The Impact of Retail Rate Structures on the Economics of Commercial Photovoltaic Systems in California", Berkeley National Laboratory, Environmental Energy Technologies Division, July 2007.  
<http://eetd.lbl.gov/EA/EMP/reports/63019.pdf>

pro forma's assume the CTC liability will be incurred by the customer until rate cap expiration.

**Eos Energy Solutions offers a no-cost, no-commitment analysis of prospective client electric bills to assist in the assessment of PV viability for a specific commercial project.**

#### *7b. Future Rates & Rate Structures*

The cost of electricity from the grid is increasing rapidly. In 2007, national average electrical rates for all users increased by 9%<sup>8</sup>. Electrical rates throughout the nation are likely to continue to increase rapidly, as the fossil fuel costs which power most of the nation's generation plants continue to rise. In 2006, 71% of US electricity was generated by coal, oil, or natural gas<sup>9</sup>. In many states, deregulation and the related rate caps established in the 1990s will expire in the next five years. In the most extreme case of rate cap expiration price shocks, the largest electrical utility in Maryland sought and obtained a 72% rate increase (phased)<sup>10</sup> when its rate caps expired in July 2006.

Pennsylvania is subject to both of the aforementioned rate increase drivers. Pennsylvania's electric rates will increase dramatically as the rate caps which were part of the 1990s Pennsylvania deregulation scheme expire. The Duquesne rate caps expires at the end of 2008. The PPL rate caps expires at the end of 2010. The rate cap expiration for the four remaining PUC regulated utilities occurs at the end of 2011. The amount that Pennsylvania electrical rates will increase has not yet been determined, but conventional wisdom is that the rate increases will be substantial. PECO Energy has publicly stated they are anticipating a rate increase of 12 to 15%. PPL has publicly stated they are expecting a rate increase in excess 30%<sup>11</sup>. **Eos Energy Solutions project-specific pro formas incorporate a conservative assumption of a 30% increase for PPL in its rate expiration year, and 12% for the remaining utilities in Pennsylvania**

It is also likely that the new tariffs and rate structures will be structured concurrent with the future Pennsylvania rate cap expirations. In particular, Pennsylvania may adopt the national trend in the direction of "smart meters" and time-of-use (TOU) rate structures.

The fundamental concept of these alternative rate structures is to allow commercial (and residential) users to better understand their demand profiles and to alter demand accordingly to reduce peak demand. The TOU element of this concept creates a graduated charge per kWh consumed, based on time of day. Electrical consumption during the peak demand from the grid is charged at a higher rate, with discounted rates applying at other times. This concept employs standard market mechanisms to reduce peak demand across the grid, and it also improves the economic viability of photovoltaic systems. TOU rate structures work well for photovoltaic systems because PV systems generally output their highest rate of power in the afternoon, when TOU rate structures are typically at the highest rate. Therefore, the PV system can off set power consumption during the period of

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<sup>8</sup> Hoover, Kent, "Price of Power Jumped in '07" (citing EIA DoE data) Washington Business Journal, October 26, 2007.

<sup>9</sup> Energy Information Administration, Department of Energy. Form EIA-920 "Combined Heat and Power Plant Report, Net Generation by Energy Source by Type of Producer, 1995 through 2006", October 22, 2007

<sup>10</sup> Adams, Paul, "PSC delays rate-fix advice", Baltimore Sun, Jan 3, 2007.

<sup>11</sup> Public Press Release, May 2007. <http://www.depweb.state.pa.us/news/cwp/view.asp?a=3&q=522630>

time when power costs the most. The impact on the economic viability of a PV system can be dramatically increased with TOU rate structures.

**Eos Energy Solutions financial pro formas for photovoltaic systems conservatively assume that no TOU rate structures will be implemented in Pennsylvania. If TOU rate structures are adopted, the value of installed PV power will increase significantly**

### *7c. Solar Insolation & System Efficiency*

The economic viability of a commercial PV system is also dependent upon how much sunlight falls upon the target PV array and the efficiency with which the array can convert sunlight to usable AC power.

The amount of sunlight any specific geographic area receives is a function of its latitude and climate. Lower latitude areas with dry climates (Phoenix AZ, for example) are better locations for PV systems than higher altitude wet climates (Green Bay WI, for example). The amount of sunlight received is referred to as "solar insolation" and it is (for PV design purposes) measured in an annual average of number of hours per day of sunlight that a specific area will receive. The data set upon which the industry relies is published by the National Renewable Energy Laboratory <sup>12</sup> (NREL), part of the US Department of Energy. The NREL data is based on actual measurements at locations throughout the nation over a 30 year time frame.

Pennsylvania it is surprisingly rich in its solar resources - particularly in the southeast corner of the state. The solar insolation rate in the southeastern part of Pennsylvania (in most of PECO Energy territory) is about as good as Houston or New Orleans. In most of the rest of the state, the solar insolation is typical for the MidAtlantic and New England states. In all parts of Pennsylvania, the solar insolation is sufficient for an economically viable PV system. Most parts of Pennsylvania have better insolation values than most parts of Germany which is, by far, the largest PV market in the world.

How efficiently the PV system captures and converts the sunlight also impacts economic viability. Contemporary efficient PV cells will capture and convert about 15% of the available sunlight. The efficiency of the design, and the ancillary equipment such as the inverters which invert the DC power from the modules to AC then also impact total energy production. Most systems that Eos has designed exceed the industry standard of 74% efficiency by selection of premium quality components (albeit at a cost premium). **For all base-line Eos Energy Solutions pro forma's a conservative 74% efficiency factor is used.**

### *7d. Array Area Availability & Appropriateness*

A photovoltaic system can be sized to almost any application and it can be either ground mounted or roof mounted. Most PV applications, however, are roof mounted. The roof structure must be capable of supporting the dead load and increased wind-induced loads, but most commercial buildings already have roof structures capable of supporting these loads. This is particularly true for the significant number of commercial buildings in older cities which were designed to support a fully ballasted roof system and which now have a lighter clean-surfaced EPDM or similar SPR roof

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<sup>12</sup> National Renewable Energy Laboratory (NREL), "30 Year Average of Monthly Solar Radiation, 1961-1990" [http://rredc.nrel.gov/solar/old\\_data/nsrdb/redbook/sum2/state.html](http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/sum2/state.html)

system. The roof architecture may be low sloped (flat) or steep sloped. If it is steep sloped, only the faces with southeasterly to southwesterly orientations are optimal.

The amount of area necessary for a PV system is relatively small. Most commercial buildings have sufficient space for a system to offset a significant percent of the total electrical load, but few have the area necessary to offset more than about a quarter to half of the entire load.

As gross "rule of thumb", a PV system requires approximately one square of roof area (100 SF) for each kW of system capacity. In Pennsylvania, each kW of system capacity may produce an average of about 1,100 kWh per year (highly variable depending upon exact location, tilt, shading, and efficiency – but 1,100 kWh per kW of capacity is in the "right ballpark" for Pennsylvania).

By way of example, if we assume a contemporary efficient office building consumes about 22 kWh per year per SF (equates to about \$2.50/SF in electrical expense per year per SF at average PA commercial rates), a typical 50,000 SF office building may then have a 1,100,000 kWh load per year (equates to about \$125,000 total electrical expense per year). To offset 20% of the electrical expense with a PV system, the building would need a PV system with a rated capacity of about 200 kW  $((1,100,000 \times 20\%)/1100)$ . A 200 kW system would require about 20,000 SF of free roof area. This would typically be available at a 50,000 SF building, provided the building was no more than two stories (and gross roof area was therefore at least 25,000 SF). This example would equate to about a \$1.5 million capital investment *prior to* federal tax credits, state rebates, and cost reduction via SRECs.

The target roof area must also be free of shading factors, or have only minor early morning or late afternoon shading. Even partially shaded PV modules produce far less power. Shading of only a section of a PV module can adversely impact output from the entire array. Therefore, low-rise buildings surrounded by taller buildings, or single story buildings surrounded by large trees are often not good candidates. Most commercial buildings, however, have site development features that inherently limit external shading factors (such as ringed parking attributes).

**For prospective clients, Eos Energy Solutions provides no-cost, no-commitment site surveys with shading analysis to assess structural load and available roof area variables.**

## 8) Next Steps

Contact Eos Energy solutions Today for a no-cost, no commitment initial consultation and site survey.

Eos will conduct a detailed analysis of your historic electric bills and load profile. We will then develop a preliminary photovoltaic system design for your specific facility and project goals. The initial design includes preliminary CAD drawings and presentation of the prospective financial returns in Eos's proprietary financial modeling program.

Eos Energy Solutions 215-431-0565