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Solar Energy: A New York State Perspective

Richard Perez[?] & Thomas Thompson[?]

Defining Solar Energy

Solar energy is a broad term that labels the conversion of the radiant energy received from the sun into forms of energy that can be exploited for human consumption.

It is useful to distinguish between two fundamentally different types of solar energy technologies/applications.

- Those which are ***end-use specific*** such as domestic hot water production, passive solar heating or daylighting, and
- Those which are ***universal*** in nature because they generate electricity that can be used, transported, stored and converted to reach virtually any application. These technologies include photovoltaics and concentrating solar power.

After a brief review of both types of applications, we focus largely on the universal type of solar energy. This is because while end-use-specific technologies could be sizeable and profitable, their impact would remain largely confined to their domain of application -- i.e., a moderate overall impact on the NY energy picture.

The real story lies in the electricity generating technologies which could have a considerable impact on the state's energy landscape.

End-Use-Specific Solar Technologies

Hot water production: This technology uses the energy of the sun to directly or indirectly heat water. It is mainly targeted to residential domestic production, but can be used on a larger scale and at higher operating temperatures to meet institutional, commercial and industrial needs (100 MW of industrial-grade process heat solar

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collectors are operating today in the world). A lower cost form of this technology is also successfully used for swimming pool heating.

The number of solar thermal system installations in New York is small and not well documented. Based on national data, it is estimated at a several hundreds to a few thousand residential installations and a smaller number of commercial installations.. While solar thermal system investments are more economical if included during initial construction or substantial renovations, solar thermal retrofits are cost-effective in most parts of New York

Commercial and industrial building heating: Wall mounted air collectors can be well suited to provide low cost heat to industrial buildings. Under favorable conditions they show a fast return of 5 year against electric heat and 10 years for gas. Designed for retrofit as well as new applications, they can supply 30-40% of the air heating load for industrial buildings with a good southern wall exposure. The technology could conceivably be used for residential applications as well, especially if embedded in new construction. At present, the total number of such installations is quite low. However, one of the largest such systems in North America was recently installed by the U.S. Army at the Fort Drum military base in Watertown, NY.

Universal Solar Technologies

There are two leading technologies to produce electricity from the sun

- Photovoltaics (PV) and,
- Concentrating Solar Power (CSP).

Both technologies are mature and backed by solid fast growing industries.

Concentrating Solar Power: This technology if fundamentally different from flat plate PV energy collection, because it uses concentrated sunlight (via mirrors and or lenses) to generate high temperatures that can be used to produce steam and drive electricity generating turbines. The leading technology consists of parabolic troughs tracking the sun. Other technologies include central receiving towers (surrounded by fields of heliostat mirrors) focusing the sun’s light on a single point for yet higher temperatures, and higher efficiencies. Other promising CSP technologies currently in development are based on sterling heat engines instead of steam turbines.

The solar to electric conversion efficiencies achieved by CSP are currently at the level of the most efficient PV technologies (20%+). One key advantage of the CSP technology is that it is capable of delivering something very close to the sort of reliable and predictable power output favored by utility companies.

On the other hand, CSP systems are most effective when deployed in large open spaces with unit sizes in the 100s of MW. Also, unlike PV, CSP can only utilize direct sunlight that can be focused. Therefore these technologies need clear, dry sky conditions to function well. Given the need for open spaces and clear skies, deployment of CSP in New York is not as likely as in the Southwest.

Current installed capacity: none in New York, but over a gigawatt worldwide.

Photovoltaics: This is the direct conversion of sunlight into electricity using semi-conductors. There are many different PV technologies evolving today with exciting prospects. The bulk of the production today, roughly 90%, is derived from crystalline silicon which currently delivers the highest conversion efficiency (now exceeding 20% from sun to electricity) and which has a very long operating life (25-year manufacturer warranties are common place). Other so-called thin film technologies such as amorphous silicon, CIGS, etc. are experiencing very fast growth. These technologies are less expensive but not as efficient.

The worldwide production of PV in 2007 reached 3,700 MW, averaging a growth rate of more than 40% during the last 11 years. Projecting a similar "business as usual", growth in the future, the worldwide production of PV could exceed 300,000 MW by 2020, (i.e., delivering annually the peaking capacity of 300 nuclear power plants). Many analysts estimate that with such a growth rate, over half of the new electrical generation capacity installed annually in the US in 2025 will be PV.

PV generation is well suited to deliver high value energy near point of use, because it can easily be retrofitted on commercial/residential building roofs, as well as many other suburban and urban spaces. PV technology can also be integrated into the skin of existing and new buildings. An additional benefit of solar is that new systems can be deployed and made operational rapidly.

Although PV systems have and continue to be used to provide power to locations that are not served by the existing electricity grid, the great majority of PV systems are now designed to be function in conjunction with the existing electrical system by producing high quality electricity and injecting it back onto the grid. PV generation could also be coupled with built-in storage and backup for efficient load management functionality and for maintaining critical loads during emergencies.

Conversion efficiencies are increasing steadily, with over 20% conversion modules available commercially today – i.e. a 1000 $ft.^2$ residential roof located in upstate New York could pack in 18 kW of power generation, producing over 2,000 kWh per month, that is, well over the typical household consumption.

The continued improvement in both conversion efficiency and manufacturing processes have yielded dramatic cost reductions. Lately however, the combined effects of very high worldwide demand, and silicon production bottlenecks[1] have kept price declines in check. This trend is not endemic however, and many experts envision a halving in system price by 2015.

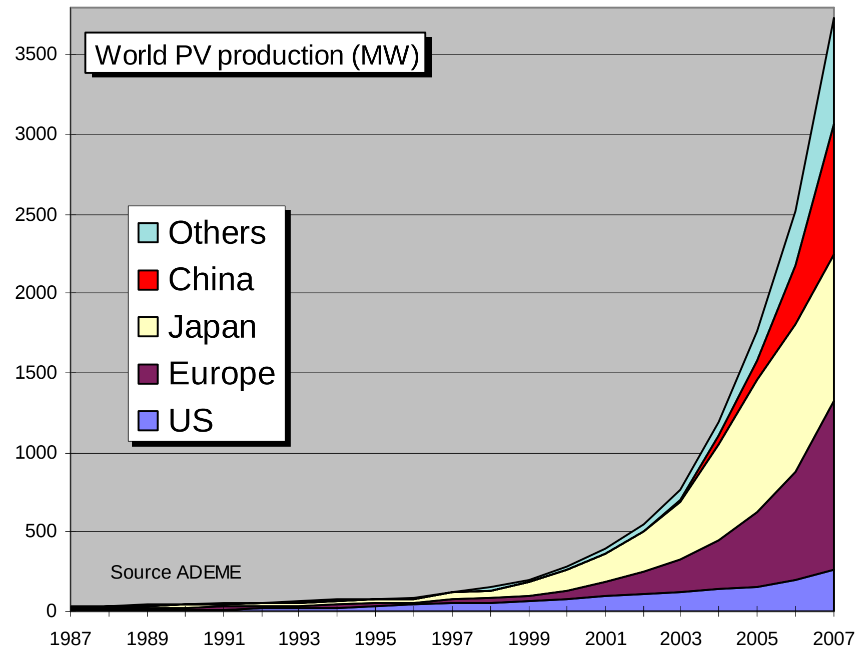

Figure 6: Evolution of worldwide PV production since 1987 (R. Perez et al.)

Current Deployment in New York:

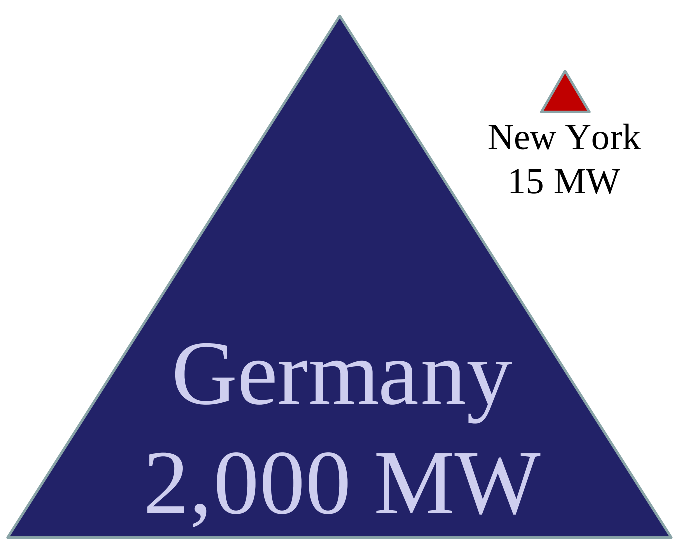

Figure 7: Contrasting PV deployment in Germany and New York (Tom Thompson, 2008)

The current deployment of PV in NY was 15 MW as of early 2008. This represents only 1/10 of 1 % of the world. In 2007, NYS deployed ½ of 1% of Germany where there is much less sun and a less attractive physical match between demand for energy and solar supply (see below).

The issue of toxicity and environmental footprint of PV cells is often discussed and should not be ignored. The production of PV cells uses energy, and as such, has an environmental footprint if this energy is non-renewable, as it will be initially. In the

[1] The current silicon shortage is largely a result of the dot.com boom and bust and has little to do with PV. The silicon industry had not anticipated the rapid growth of PV and was caught off guard after having suffered setbacks in overstating the chip industry growth during the dot.com boom

long run PVs and other technologies produce many times their embedded energy over their lifetime, renewable energy could be used entirely in the production chain.

The issue of chemical toxicity of PV materials is also a fair question. However, PV production is not much different from glass production, and that after long operating lifetimes, all materials can be recycled almost entirely.

Finally, the issue of land occupancy is largely a irrelevant to New York since a good part of the solar production could take place on spaces which have already been disturbed and the total area involved, even at very large penetration levels, is minimal.

Solar Potential in New York State: Two Deployment Scenarios

Solar is often perceived of as a marginal source of energy, largely because it is mostly viewed as a niche application to "produce hot water on a sunny day". It is clear however that the solar resource is by far the largest source of energy on earth. Figure 8 shows that New York State alone receives substantially more solar energy than is currently consumed by all the countries on earth.

Of course the solar resource is more abundant in the tropical belts than it is in the temperate regions, but the difference is considerably smaller than most people think. The State of New York receives "only" 35% less solar energy per unit area than the southwestern US deserts. The upstate-downstate solar resource difference is only a few percent.

Each square foot in the State of New York receives roughly 130 kWh worth of solar energy per year. Using current technology, each square foot in New York could generate 20 kWh per year worth of electricity, meaning that just 0.45% of the State's surface area would be sufficient to generate all the electrical energy used by New York State today. A substantial fraction of this space could be used to harvest solar energy without modifying its primary use (such as parking lot PV canopies or solar roofs) .

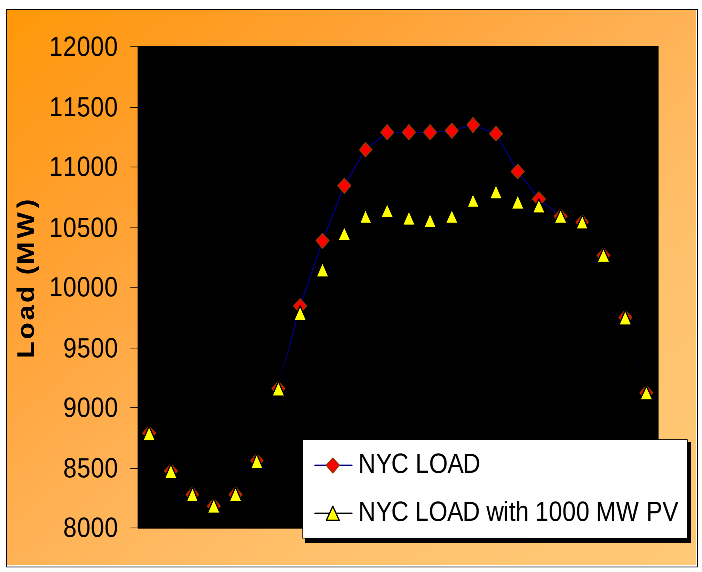

Figure 9: Peak Day New York City electric Load without PV and with a hypothetical 1,000 MW distributed over its grid.

Option 1: Solar as a Peak Shaving technology:

6000 MW of high value "peak shaving" PV: As shown above, the solar resource in New York is enormous. Its actual deployment will depend on the value it brings to the table and the ability of the power grid to absorb it effectively. One of the most promising avenues for large scale deployment of solar power is as a "peak shaving" technology. Like other renewables, such as wind, solar energy is an intermittent energy resource that cannot be controlled at will or dispatched by utility operators. However, unlike these other renewables, solar is reliably available at times of peak power demand. This is because peak electrical demand occurs during the summer and is largely driven by air conditioning use, which is directly related to solar heat. During times of peak demand New York's power grid is strained, threatening supply. In order to meet the demand, utilities purchase power at higher prices and from less efficient and dirtier generating sources. Managing peak demand is an important goal of the State's long term energy policy. The solar resource that creates this high power demand can also be used to serve that demand via PV generation. This attribute is often referred to as **"PV peak shaving.**"

Figure 9 illustrates this capability by comparing energy usages in New York City during the 2006 Queens blackout to what it would have been had 1000 MW of PV been deployed in the city.. Local deployment of PV generation would have reduced that peak demand, relieved local stress and likely prevented the blackouts that caused tremendous economic damage to countless Queens stores..

Distributed PV generation has the ability to not only displace the highest priced and dirtiest "peaking plants", but also to reduce the need for infrastructure upgrades and enhance the overall security and reliability of the power grid.

It has been shown that **6,000 MW of PV** could be deployed in New York State (~20% of the State's generating capacity) to meet peak shaving needs. New York, because of its electrical demand profile, is probably one of the best places in the country and the world to take advantage of this capability. How soon this deployment will happen will largely depend on the will of New York stakeholders (rate payers, tax payers and utilities) to see it happen – see economic discussion below.

Among the immediate benefits of this sort of solar deployment strategy would be:

- Displacing High Priced Transmission Investments: The inherent value of PV electricity in NYS and many other places is that it generates electric power at the point where electricity is consumed and at the time of the utility peak, thereby displacing the need to invest in expensive and difficult to site transmission lines that would only be needed for a few hours each year to serve peak loads. By combining its peak shaving and localized production attributes, PV deployment would yield power grid decongestion. In this important way, solar PV power is unlike most other energy resources that would have to be piped into load pockets

- Security and Resiliency: Having dispersed localized resources near the points of use that can relieve highest stress is an important security asset The analysis of the massive 2003 power blackout[2] in New York and Toronto showed that even a modest solar resource (less than 500 MW) dispersed around the large cities of the northeast would have averted the heat wave-driven outage at a small fraction of its cost by reducing the northeast electric power grid's demand, which at the time of the outage had to import over 7,000 MW through overburdened power lines.

Option 2: Long term, high PV penetration beyond 6,000MW:

Larger deployments of solar power will require storage and infrastructure upgrades. Thus, solar development will have to go hand-in-hand with the development of smart grids and energy demand management practices as well as with the development of storage technologies. No breakthroughs are necessary to carry out such a plan to fruition, just a determined effort to enhance already highly evolved approaches: The storage panoplies which will have to be developed will range for very short term (capacitors, fly wheels, batteries, load demand response) to mid term (e.g., interactive electric/hybrid cars load/backup management), to long term (e.g., flow batteries, hydrogen, compressed air). Note again that Germany, far ahead of us in terms of deployment, is facing this reality today because it cannot exploit PV peak shaving as New York could. Therefore, Germany is fast becoming an expert at developing the appropriate solutions to large scale PV penetration and it is probable that they will subsequently market these solutions to people like us.

Given the size of the solar resource compared to all alternatives, logic alone would say that for the long term, even in cloudy New York, solar energy penetration may well be in excess of 50%. It may be early to fully envision such penetration level, but two broad avenues may be envisaged:

- Decentralized – dispersed generation, consisting largely of PV deployed within or near load centers, with local energy management/storage.

- Centralized generation in the planet's sunny regions – both CSP and PV -- with large power plants feeding load centers via long distance super-grids. For instance, resources deployed in the Southwest could feed customers in the Northeast. Another long-term option would be to float PV on parts of the nation's man made hydropower lakes where transmission already exists, and whose combined areas would be much more than enough to generate the nation's entire electrical needs.

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[2] Perez R., B. Collins, R. Margolis, T. Hoff, C. Herig J. Williams and S. Letendre, (2005) Solution to the Summer Blackouts – How dispersed solar power generating systems can help prevent the next major outage. Solar Today 19,4, July/August 2005 Issue, pp. 32-35.

Getting There: The COST of PV:

The cost of the PV technology has fallen from $100/watt (effectively $5/kWh) in the early 1970's to well under $4/watt today. If PV cost reductions are to continue, the role of government policy in spurring market activity is critical to private sector investment decisions. Without continued government support, however, the cost reductions that come from scaled production in both the manufacturing and service/installation sectors of this market will be stalled.

Short term economic realities: The economic reality of PV deployment today is summarized in Table 1. The turnkey cost of a PV installation in 2008 in New York is of the order of $8/Watt. Without incentives, the life-cycle breakeven energy value produced by a PV system would have to be more than 50 cents per kWh, i.e., considerably higher than the current retail price of electricity and almost an order of magnitude higher than wholesale prices achieved with the current New York generation mix of hydro, nuclear, gas and coal. Using the measure of simple payback as a yardstick, it would take almost 100 year for an un-incentivized grid-connected PV power plant competing with conventional, polluting generation to pay for itself.

The economic assessment of PV often stops at this point, with an out-of-hand dismissal. Looking deeper into table 1 reveals a different picture. First, with incentives available today in New York, small installations (40 kW and less) would break even at 15-20 cents per kWh which is very close to the current electricity retail range, particularly downstate. Because the PV technology can effectively be deployed on the retail side, PV can already be an economically attractive option today for such installations. This breakeven cost is still substantially higher than wholesale generation. However, a recent study commissioned by the New York Solar Energy Industry Association and the Solar Alliance[3] shows that, because PV generates power at times of greatest need, it can capture a wholesale value substantially higher than the average wholesale generation price.

Most experts believe that by 2015, PV turnkey costs will be well within the $3-$5 per Watt range. In fact this price range has already been reached in the large Japanese market, and for large, multi-megawatt PV installations recently bid in California. No technological breakthrough will be needed to reach this price range, just a combination of the following factors: an easing of the silicon shortage resulting from the massive current silicon manufacturing build-up worldwide, some supply-demand relief in the hottest markets on the demand side resulting from a leveling of subsidies in maturing markets and from the sustained PV manufacturing growth currently nearing 50% per year. Longer terms prospects (2020-25) call for turnkey system costs at in the range of $2-3/Watt.

By 2015 the breakeven cost of PV generation will be respectively 25 cents per kWh without incentives and 8-12 cents with current incentives, and respectively 15 cents and

[3] Perez, R. and T. Hoff, (2008) Energy and Capacity Valuation of PV Power Generation in New York, NYSEIA/Solar-Alliance Publication

6-9 cents by 2025, bringing PV substantially below retail rates, even without incentives and close to the present wholesale range.

Two key questions arise:
(1) What will the retail rates be in 2015 and 2025?
(2) What will the incentives be and how will they be justified?

The two are closely linked because incentives have been implemented to level the playing field, i.e., to account for the fact that the rates at which electricity is bought and sold today do not yet reflect all the costs involved and all the value PV would bring to the table both from a utility and a ratepayer/taxpayer standpoint.

For the utilities, the unaccounted PV value and generation costs are:

- Transmission & Distribution capacity deferral value (because PV provides stress reduction on the power grid at peak time, reducing wear and tear and postponing needed upgrades)
- Loss savings (because of reduced energy transmission losses by producing power near point of use)
- Environmental compliance value (which utilities only pay today for Sox and Nox compliance, but not for green-house gas emissions -- a potentially staggering amount, once the full extent of possible damage will have been internalized)
- Fuel price hedge protection (i.e., the insurance against future commodity price increases, because the solar fuel is free and quasi-limitless – this a potentially large amount as well, given recent price trends all traceable to supply limits in face of increasing demand -- Crude oil prices has been in the news of late, but all energy generation commodities (coal, gas and nuclear fuel) have experienced considerable increase for the very same reason: high demand and finite supply. To get an idea of the rate impact, think that hedging a 5-fold energy-generating commodity price increase between now and 2030 is, alone, worth 30 cents per kWh.

For the ratepayers/tax payers the unaccounted PV value and generation costs are:

- Long-term, system-wide rate protection (from energy commodity price hedging)
- Environmental health benefits (from reduced emissions)
- Business development opportunities (job and business creation resulting from solar business development)
- Use of in-state resource and reduction of state imports
- Power grid security enhancement
- Disaster recovery
- Reduction of the need to protect conventional energy resource pathways.

These values and costs will directly or indirectly provide value to PV via sustained incentives, conventional rate increases, or other tradable such as Renewable Energy Credits or RECs where the environmental value of renewable electricity is traded independently from its strict energy value on a per kWh basis. From a PV producing standpoint, RECs are equivalent to PV preferential tariff, or feed-in tariffs, available in much of Europe today. Hence the paybacks periods reported for the foreseeable future in Table 1 are likely to be upper limits and could well be considerably shorter.

TABLE 1

	2008	2015
Turnkey Cost	$7-8/Watt	$3-5/Watt
Breakeven kWh cost no incentives	50 cents/kWh	25 cents per kWh
Breakeven kWh cost with incentives*	15-20 cents per kWh	8-12 cents per kWh
Retail electricity cost per kWh	10-25 cents per kWh	**
Wholesale electricity cost per kWh	5-10 cents per kWh +	**
Solar coincident wholsesale cost per kWh	7-13 cents per kWh +	**
Simple pay back years no incentives (retail)	30-65 years	less than 15 years **
Simple pay back yeas with incentives (retail)	9-25 years	less than 5 years **
Simple pay back years no incentives (wholesale)	60-125 years	Less than 30 years **
Simple pay back yeas with incentives (wholesale)	20-48 years	Less tan 10 years **

* Only achievable today in New York for systems smaller than 40 kW

\+ Perez, R. and T. Hoff, (2008) Energy and Capacity Valuation of PV Power Generation in New York, NYSEIA/The Solar Alliance Publication

** we are refraining to make future rate projections, noting that current rates do not yet factor in the costs listed below . Threfore the payback period listed above are likely to be shorter

Cost of global warming mitigation
Allowance for future commodity cost increase from resource depletion
Cost of protecting energy supply routes
Cost of insuring power grid reliability/security for the long term

Getting There: POLICY Issues:

The PV industry got its start in the U.S. in 1953 when Bell Labs, a U.S. company, initiated a PV commercialization effort focused on communications technology. For the next 3 decades, US companies and scientists were the world's leaders in the industry, pioneering the use of PV in space applications and remote power installations as well as in military and private communications systems. However, beginning in the 1980's and accelerating in the 1990's, US companies began dissolving their PV divisions or selling them to European or Asian companies for pennies on the dollar. This move was precipitated by the retreat of US policy support for solar technologies while other countries, notably Germany and Japan, began to implement policies to foster the growth of their solar industry.

Today, the U.S. has lost its leadership position. The good news for the U.S. is that it is not too late to adopt policies to create both markets and manufacturing jobs to support the emerging U.S. marketplace. The lessons learned from these other countries are that thoughtful government policies will spur not only the deployment of the technology, but also an industry that is capable of employing tens of thousands of workers.

In the U.S., the role of government in this arena has always been to foster the creation and advancement of new technologies. Today, the goal of government energy programs is to use public funds to support clean energy technologies in a manner that fosters the creation of sustainable markets. Over time, as the technologies mature and the costs decline, public investment is eliminated and the technology stands on its own, without the need for government support. The point at which the costs of owning and operating a PV system are equal to or less than simply buying polluting power from the utility is known as Grid Parity. What will it take to achieve grid parity and what are the characteristics of public private partnerships that seem to be most successful?

The essential elements of an effective PV program:

It is useful to think of the policy mechanisms needed to create a viable solar market as the pillars that support a building. Essentially, there are four *pillars* that must be included if a sustainable PV market is to flourish in NYS. They are:

1. *Interconnection Rules* – This is the part of utility policy that deals with safety. While all electric systems should be treated with great caution, PV systems are inherently the safest electric power systems available.
2. *Net Metering Laws* – Net metering is a policy that allows excess energy production from PV systems on building to flow on to the grid and serve local loads in the area. This policy has nothing to do with safety and is strictly a mechanism for accounting for energy used and energy generated and delivered to the utility system. Essentially, under net metering, if a building owner puts PV on their roof top and the PV system produces power in excess of what the building requires, the PV power goes through the building owner's electric meter and is delivered to the grid. In the process, the building owner's meter spins backward, providing a credit that is equal to the retail price of the energy purchased through the meter.
3. *Financing*– As experience in Japan and Germany has shown, a stable, predictable but declining incentive structure that incorporates the value PV delivers to society (economic development, less public health damage from pollution, etc.) and to the utility grid (avoided blackouts, lower cost of peak power purchases, etc.) can and will yield impressive growth numbers.
4. *Solar Power Mandates on New Building and Major Renovations* – In addition to providing open access to the grid and financial incentives to encourage development, progressive government policy will mandate the incorporation of solar PV in new construction and in major renovations. While incentives mentioned above will be provided for these actions, the fact is that the cost of incorporating solar thermal and PV is lowest at the time of new construction and government policies that mandate it will ensure that all new buildings have a guaranteed supply of clean energy at a fixed, long term price.

New York State's PV incentives and programs:

To understand what government program strategies are most effective in advancing PV market growth, there is now more than a decade of PV incentive program history to review. Table 2 provides a bird's eye view of where NY stands today. This table compares the design attributes of NYS's residential PV program with those of other northeastern states (New Jersey and Massachusetts) as well as those parts of the US and the world where policies have resulted in successful programs, including California, Ontario, Canada and Germany. We also show the size of the PV market in these areas in 2007.

TABLE 2

Solar Attribute	NEW YORK	NEW JERSEY	MASS.	CALIF.	ONTARIO	GERMANY
Net Metering	2 MW	2 MW	2 MW	1 MW	500 kW	N/A
Federal Tax Credit & Cap	Yes - 30%	Yes - 30%	Yes – 30%	Yes - 30%	N/A	N/A
Accelerated Depreciation	Yes	Yes	Yes	Yes	N/A	N/A
State Tax Credit & Cap	25% – $5,000	No	15% – $1,000	No	N/A	N/A
Property Tax Exemption/Abatement	Yes/Yes* *NY City only	Yes/No	No/No	No/No	No/No	No/No
Loan Financing	Yes	Yes	No	No	No	Yes
Rebate ($/W), System Cap & Annual Budget	$4/W – 40 kW $5 mil.	$4.10/W – 10 kW $100 mil.	$2 – 5/W – 5 kW <$5 mil.	<$2/W – 50 kW $300 mil.	N/A No Cap	N/A No Cap
REC Value & Term	Unk	>$.50/kWh – 8 Years	$.03/kWh – 3 Years	Paid as Rebate	N/A	N/A
FIT Value & Annual Budget	N/A N/A	N/A N/A	N/A N/A	N/A N/A	$.42/kWh Unk.	>$.70/kWh ≤ $1 Bil
07 Market Size	4.3 MW	16.4 MW	1.4 MW	89 MW	>100 MW	>1,000 MW

Interconnection: Until recently, it was very difficult or even illegal to install a PV system on your home and connect it to the NYS electric grid. Today, the NYS PSC has adopted a Standard Interconnection Rule (SIR) that allows relatively easy access to the NYS grid for smaller systems of less than 15 kW. Systems of greater size or that are interconnecting at higher voltage levels require greater due diligence (that can still sometimes be expensive and needlessly time-consuming) but are generally able to interconnect in most places in NYS.

Net Metering: In 1997, NYS was one of the first states in the nation to adopt net metering. However, the law was limited to small residential systems and, over time as other states passed more progressive net metering laws, NY's rule came to be a barrier to the development of the PV market in NYS. For example, only about 20% of the systems installed in NYS are non-residential, where as the national average is 60%[4]. This year, the NYS legislature passed a more progressive law that puts NY in league with other leading PV states including California and New Jersey.

State Tax Incentives – Income Tax Credits & Property Tax Exemptions/Abatement: To supplement the federal incentives, some states have adopted an additional state income tax benefit for homeowners who install solar PV systems. Here, NYS has been a leader, offering a tax credit of up to $5,000 (capped at 25% of system costs). However, while this can be an important ingredient in making markets work at the state level, it has not been used by other states that have achieved meaningful PV penetration and, by itself, it has not proven to be a market maker in NYS. NYS also exempts the value of a solar

[4] IREC Report: 2007 US Solar Market Trends, Sherwood, pg. 8.

system in the calculation of property taxes. Nevertheless, the elimination of this tax is important to removing barriers to PV market growth, but not an important market development tool. Finally, new York City has adopted a property tax abatment strategy that will allow building owners to claim up to $62,000 in tax abatement towards the cost of their PV system (capped at 35%).

Federal Tax Incentives :

In the US, government policy support for PV has reflected the fact that utilities and the electricity market are primarily regulated by the states. As a result, in the US at the federal level, an Investment Tax Credit (ITC) has been the mainstay of the PV industry.

Investment Tax Credit & Accelerated Depreciation: These dual tax strategies are available nationwide and only recently provided any benefit to residential tax payers ($2,000/system). However, on its own, this federal incentive strategy has not spurred significant market development unless integrated and corresponding incentive and interconnection programs were implemented at the state level. Further, industry needs a stable, long term commitment to give it both the time and the confidence in the market to make investments that will drive down costs. To date, neither Congress nor the President has secured a long term commitment for this tax credit. As such, it is set to expire by the end of 2008 and the impacts on the US market place are expected to be significant.

Strategies for advancing PV in New York State:

A variety of strategies exist that could be implemented in New York State in order to make New York a national leader in the effort to deploy solar power.

Rebate Amounts, System Size Caps & Annual PV Incentive Budgets: One successful means of encouraging private sector investment in PV technology in the US is through the provision of cash incentives in the form of after-purchase rebates. Under these rebate schemes, utility ratepayers pay into a fund that provides a rebate for a portion of the installed cost of the system. Typically, installed costs average $8/watt. Rebate amounts range from under $2/watt in California, where ample sunshine and lower installation costs require a lower incentive, to as much as $5/watt in niche markets in Massachusetts.

NYS, at $4/watt, has a fairly lucrative rebate amount. However, as a result of its net metering limitations (changed in 2008) and a limited total budget for PV incentives ($5 million/year, though this is increasing), the rebate has been capped at 40 kW.

Solar Renewable Energy Credits (SREC's): A market for Renewable Energy Credits (REC's) has been created. These credits are traded similarly to the way stocks are traded. Generators must be certified to be credited with REC's, but simply speaking, for each megawatt-hour (MWh) of PV energy generation, the owner of the system is awarded 1 SREC. The SREC market is immature and at this point, the SREC's are not easily traded across state lines. Nevertheless, some states, notably New Jersey, have established SREC markets that are working to seed PV market activity.

Feed-In Tariff: A Feed-In Tariff (FIT) is a utility rate agreement whereby the owners of PV systems connect those systems directly to the utility grid and receive a payment, funded by all ratepayers, for the power their systems generate and deliver to the grid. All of the power generated is delivered to the grid and then repurchased by the host site for use in the building upon which the system is located. The rate paid for the PV power placed on the grid is generally quite high and this strategy has resulted in the largest and most successful PV markets in the world.

For example, in 2006, Ontario, Canada enacted a FIT that paid 42 cents (Canadian) for every kWh generated by a PV system and delivered to the grid. Over the past 2 years, Ontario's Renewable Energy Standard Offer Program (RESOP) has exceeded all expectations - achieving an excess of 1,000 megawatts of contracted projects - surpassing the 10-year target for renewable energy in the first year of the program! This represents a potential investment of almost $5 billion in new renewable energy supply projects. [5]
An even more successful result has been achieved in Germany, the pioneer of the FIT concept as a clean energy development strategy. With a solar resource equivalent to northern Maine, Germany is installing more than 1,000 MW of PV each year. This is greater than the capacity equivalent of one of the Indian Point nuclear plants and by this time in 2009, Germany will have installed more PV capacity than all of the Indian Point plants combined. And while this represents more than a 10 fold increase in the PV deployment success of California, the cost of Germany's success has been achieved at a fraction of the cost/kWh from the rebate approach used in California. Germany's FIT is codified in law. As a result, the assured availability of a feed in tariff allows the German banking industry to collateralize the FIT revenue stream, ensuring access to capital needed to buy and install the systems.

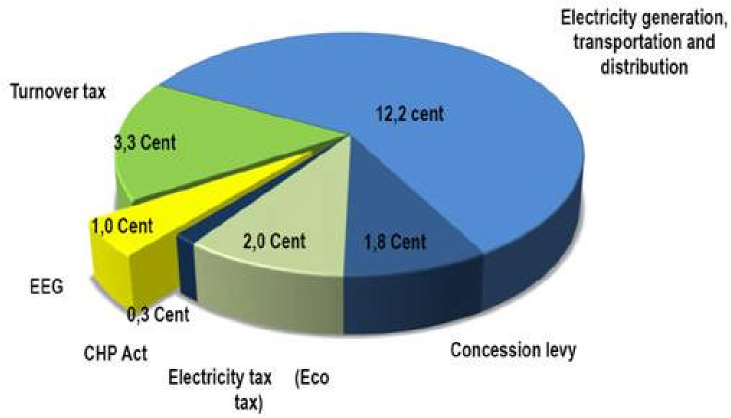

Fig. 10 Rate Impacts of FIT (EEG) on German Utility Bills[6]

[5] Ontario Power Authority Website:
http://www.powerauthority.on.ca/sop/Page.asp?PageID=122&ContentID=6555&SiteNodeID=412
[6] Courtesy of German Renewable Energy Association DENA, www.dena.de

Figure 1 provides a breakdown of cost components required to provide one kWh of electricity to a typical residential utility customer in Germany. The average rate per kWh paid by German utility customer was 20.7 Euro-cents in 2007. The portion of the German FIT (EEG) was 1 Euro-cent per kWh or just under 5% of the costs for a kWh of household electricity in 2007. In 2007, the cost of Germany's FIT to the average household with an electricity consumption of 3,500 kWh per annum was around 3 Euro per month.

However, what is not presented here is the fact that the PV power that was delivered to the German grid was displacing even more expensive power and ultimately resulted in a net savings to the typical German family. Here's how this works.

The market price of electricity is determined by the most expensive power station still needed to satisfy the demand for electricity (merit order). Because priority is given to FIT-generated PV energy, demand for conventional electricity is reduced. As a result, the most expensive power plants are no longer needed to meet demand, and the market price falls accordingly. This effect is also known as the merit order effect. As the market price is the most important price indicator for the electricity market as a whole, the FIT therefore not only leads to considerable price reductions on the market, but should also lead to savings for all customers. This effect has been quantified on the basis of a detailed electricity market model (PowerACE) used by the German government.[7] Further, the implementation of the FIT in Germany has allowed German industry to take a dominant role in the manufacture of PV technology, resulting job growth and cost savings. Spain offers a similar tariff and is now quickly establishing its leadership position in this global marketplace. The rest of the European Union is now following suit.

California also offers a feed-in tariff, though it differs from the similarly named European "feed-in tariffs. The European model includes an incentive payment for PV generation. Under the feed-in tariffs in California, customers are paid for the cost of generation based on the value of electrical generation to the grid at the time it is generated, but is not intended to embed a subsidy or rebate in the price offering.

The California feed-in tariff allows eligible customer-generators to enter into 10-, 15-, or 20-year standard contracts with their utilities to sell the electricity produced by small renewable energy systems -- up to 1.5 megawatt (MW) -- at time-differentiated market-based prices. The price paid will be based on the CPUC's market price referent (MPR). Time-of-use adjustments will be applied by each utility and will reflect the increased value of the electricity to the utility during peak periods and its lesser value during off-peak periods. A special, higher-level rate is provided for solar electricity generated between 8 a.m. and 6 p.m.

2007 Market Size: In spite of the policy and financial limitations identified here, New York's PV market has continued to grow. Still, that growth has been capped by the limited incentive budget. In 2007, NYS installed just over 4 MW of PV. New Jersey, who started it program later than NYS, deployed four times as much. California, which has a

[7] August 08 Email Interview, Christina Heldwein of the German Renewable Energy Association (DENA)

more mature program, installed 20 times what NYS did. However, Germany's FIT resulted in the installation of over 1,000 MW.