DEVELOPING PV CERTIFICATES FOR THE GREEN POWER MARKET

Presented at ASES Solar 2002 Conference, June 18, 2002, Reno, NV

Janis C. Pepper
Enertron Consultants
418 Benvenue Avenue
Los Altos, CA 94024
pepper@enertroncons.com

Sam Swanson
Pace Energy Project
P. O. Box 4245
Burlington, VT 05406
samswanson@aol.com

ABSTRACT

There is a growing demand by consumers in the marketplace for solar photovoltaic, or PV-generated, electricity. Consumers want to support PV even though they may not be able to afford to have their own PV system on their roof. PV "certificates" represent the positive technology and environmental attributes of a PV system and are measured in the same units as the energy output. This paper examines the unique attributes of PV systems with regard to certificates and how these can be configured to generate additional revenues for PV owners in wholesale and retail green markets. The paper discusses disclosure requirements, production verification needs, and metering issues unique to PV, including net metering. Estimates of additional revenues are made based on recent activities in the wholesale certificate market. Specific follow-up actions on the supply- and demand-side are recommended to implement a pilot program for PV certificates.

1. INTRODUCTION

PV "certificates" provide a means for aggregators or utilities to offer consumers a way to support the use of PV without having to make a large investment. Certificate-backed products can be offered in the retail market where consumers either have the ability to choose a green energy option offered by a non-utility load-serving entity (LSE) or through a green pricing program offered by a utility company.

It is difficult for PV to participate in the wholesale energy market for a variety of reasons. Most PV installations are below the size recognized by Independent System Operators (ISOs), which prevents them from participating in ISO forward or real-time energy markets. Scheduling is difficult because of PV's intermittent nature. Many PV systems are metered on the customer-side, which are not accommodated by existing metering protocols. The use of certificates provides a way for PV to overcome some of these obstacles and participate more fully at the wholesale level.

PV manufacturers and system integrators are continually looking for ways to generate additional revenue from PV installations or reduce the cost of installed systems. Even though PV systems have shown some reductions in cost, the economics continue to present challenges to the industry. Developing methods that enable PV to gain additional revenues through certificate sales will allow PV to be more price-competitive.

Renewable certificates are non-physical products, representing the air, water, land, and other benefits or avoided impacts associated with renewable energy production. A renewable generator delivers megawatt-hours into the electrical grid, where the electrons from renewable plants are mixed with the electrons delivered by every other power plant, and flow where physics dictate. The renewable certificates correspond to the meter reads of the generating plant, usually measured in megawatt-hours (MWh). The certificates are then traded at a price representing the wholesale premium for the renewable energy production.

In most cases where certificates are used, an LSE purchases power from the general commodity market, and couples it with renewable certificates, to present a renewable energy product for their customers. Retailers have also emerged that offer a certificates-only product to their customers, providing an easy way for consumers to support renewable energy development through their dollars in cases where they cannot or do not want to choose an alternative provider for their commodity electricity.

This paper presents the current status of the wholesale and retail markets for renewable certificates, and looks at the

specific issues affecting PV. First, the status of certificates in the wholesale market is described. Second, existing and emerging certificates-based products in the retail market are presented. Third, issues about verification of renewable certificate products are discussed. This leads into the fourth major discussion area, which is metering. Fifth, sizing and pricing of PV certificates are discussed. And last, aggregation of PV production is presented as a way to develop a supply of PV certificates. The conclusion presents a set of action items that define the next steps toward configuring and successfully marketing PV certificates[1].

2. STATUS OF CERTIFICATES IN THE MARKETPLACE

2.1 Wholesale Market

The first wholesale market for renewable certificates evolved in California in response to a growing green retail market that emerged in 1998 and 1999 under the state's electric industry restructuring. Other wholesale markets for renewable power have developed as a result of deregulation in Pennsylvania, New England, and Texas. Additionally, green power programs operated by utility companies in regulated markets have grown.

Table 1 below shows the kilowatts of PV installations that have been built recently for green markets. A complete listing of these installations is found at: www.eren.doe.gov/greenpower/summary.

TABLE 1. PV INSTALLED FOR GREEN MARKETS[2]

Deregulated Markets	**Size (kW)**
- Total Installed	337
- CA	206
- New England	58
- Pennsylvania	73
- Total Planned	295
Utility Green Pricing Programs	
- Total Installed	3,891
- Total Planned	1,570

Regulatory acceptance of renewable certificates has come slowly. In some states, specific rules address the use of renewable certificates, as shown in Table 2. In some cases, these rules are associated with mandated renewable portfolio standards (RPS) or disclosure requirements.

The use of renewable certificates provides a number of advantages in the wholesale market. These specific advantages include:

- Certificates can cross geographic or regional boundaries that the actual kWh cannot cross.
- Certificates provide a simple method of verification for claims of fuel source.
- Generators can maximize their revenue for both energy and certificates by selling into the highest market for each.
- Intermittent generators avoid the need to match their generation with the hourly load of the buyer.
- Clear price signals are sent to the market as to the value of the premium for renewable power.

TABLE 2. STATES WHERE SPECIFIC RULES SUPPORT RENEWABLE CERTIFICATES

State Rules Support Renewable Certificates	**Certificate Use**
California	Open Market
Nevada	RPS
Texas	RPS
Wisconsin	RPS
Massachusetts	RPS
ISO-New England	GIS[3]
New York	Open Market
Oregon	Green Pricing

2.2 Retail Market

Certificates can play a role in two types of green energy products: 1) certificate-only products where the consumer purchases the renewable certificate as a single transaction, and probably continues to purchase their power from their local utility, and 2) green products in which the consumer purchases bundled green power (commodity power + certificate) from the LSE.

There are a number of companies emerging that are offering, or plan to offer, certificate-only products to the retail market. Some of these include Sterling Planet, Sun Power Electric, Community Energy, and the Bonneville Environmental Foundation.

Bundled green products, consisting of commodity energy plus certificates, are more commonly offered into the market. Key retailer suppliers of bundled green products are Green Mountain Energy and Community Energy.

2.3 Demand for Certificates Products

While there certainly is an adequate supply of certificates products offered in the market, it begs the question as to whether there is sufficient demand to support the ever-growing supply. Demand comes from four main market

segments: deregulated markets, RPS markets, utility green pricing programs, and corporate purchases.

The demand for green power in states with deregulated markets has fallen short of expectations. In California, a market for renewable products grew during 1998 to 2000, but has virtually disappeared. In Pennsylvania, deregulation has been much more successful, where significant numbers of customers have switched to cleaner or renewable energy electricity products. However, the participation in Pennsylvania has slipped recently due to rising wholesale prices. As of January 1, 2002, all customers in Texas have the option of choosing an alternative provider. Two retailers are offering 100% green bundled products in those service areas that are now open to competition.

A number of states have adopted a renewable portfolio standard (RPS), which requires a certain percentage of renewable energy in the overall electricity mix.[4] This creates a demand for renewable power in those states.

Utility green pricing programs currently represent the biggest market for PV certificates. A number of utilities are instituting green pricing programs, which include a photovoltaics component. Certificates provide a convenient way for utilities to offer solar to their customers.

Another potentially large market for PV certificates is the corporate market. Some companies have announced their intention to purchase renewable power over the next few years. For example, the "Green Power Market Development Group" is a collection of 10 large companies that are attempting to "develop corporate markets for 1,000 MW of new, cost-competitive green power by 2010"[5].

2.4 Green-e Standards for Tradable Renewable Certificates

Green-e is a program that provides product certification for green electricity products and has adopted disclosure standards for bundled and certificate-only based products. They have adopted a TRC (Tradable Renewable Credit) Standard as part of the Green-e Code of Conduct, found in Appendix B of the Green-e TRC Contract, which can be found at www.green-e.org.

The disclosure guidelines for PV were left sufficiently broad to enable others, including the Pace Energy Project's efforts in this paper, to refine the size, metering / verification, and claims issues related to PV.

2.5 Role of Subsidies for PV

Some discussion has surfaced as to whether certificates can be claimed from a system that has received additional subsidies for its installation. Other renewable technologies, including wind and biomass, also receive subsidies, in the form of production tax credits or production incentives. These technologies sell renewable certificates or command a premium for their power. Therefore, we do not believe there is any reason that PV systems whose capital costs have been partly subsidized should be treated any differently than other renewable technologies.

3. PRODUCTION VERIFICATION

When product differentiation is attempted with a commodity like electricity, the consumer needs information to have assurance that the extra "value" has been received from the extra dollars paid. With renewable energy or certificates, some type of verification is required.

3.1 Disclosure to Buyers

The National Association of Attorneys General (NAAG) has adopted a set of environmental marketing guidelines for electricity, and specifically discussed "tradable certificates" or "tagging" systems. The guidelines state that if tags are used to verify product claims, this must be disclosed to consumers and certificates cannot be double-sold.

Some states have also developed standards for "Power Content Labels", which define what must be disclosed to customers who purchase a renewable electricity product.

3.2 Disclosure to Sellers

For PV systems, disclosure extends to the sellers as well. The PV owner must realize that they might be giving up the "claiming rights" of the environmental attributes associated with the installation and are thus buying only the physical kilowatt-hours.

Because of the high expense and long payback for a residential solar system, many homeowners who make the decision to purchase a system do so because they want to improve the planet, rather than solely for economic reasons[6]. Many PV owners are homeowners or businesses that don't follow the details of the energy markets. Therefore, it is important they understand the certificates market before participating.

Commercial and industrial customers typically have more resources to investigate and understand the options. They may be more inclined to install a PV system for the peak energy savings, and sell off the environmental attributes to another entity to improve the project economics.

3.3 Double-Counting

Double-counting occurs if the same renewable certificate associated with a particular MWh of electricity production is claimed by multiple parties. The MWh of production are verified by meter reads and signed affidavits that the

associated renewable certificates have not already been sold to another party.

Specific PV-related double-counting issues arise because PV installations are often visible to the public. The question then arises, if a homeowner has a PV installation on their roof that their neighbors can see, does this prevent them from selling the associated renewable certificates? Our position is that homeowners can sell the certificates associated with their solar production without running into issues of double-counting of environmental claims. Commercial and industrial installations can sell their certificates if take the position that they are "hosting" a solar installation on their facility rather than saying they are "solar-powered".

3.4 Disaggregation of Certificates

Disaggregation of renewable certificates refers to breaking a certificate apart into its component parts. These parts include technology, water, land, and air-related avoided emissions attributes. Our position is that the certificate should remain whole at this point until further discussion and agreement about disaggregation has taken place.

3.5 Verification Needs

The development of certificates-based products points out the need for better verification methods. Some regional verification and tracking efforts are underway as part of RPS requirements. The need for a national database that can tie together the regional efforts is beginning to be recognized. A national database or regional databases that can share similar information is needed to track certificates from birth to retirement and maintain the integrity of this developing market.

4. METERING ISSUES

PV certificates are generated based on the meter reads of the PV systems. However, PV is often metered on the customer side of the meter, or net metered. Existing protocols that only consider renewable output as measured on the utility-side of the meter need to be modified to handle PV installations.

4.1 Net Metering (including Customer Side Metering)

Customer-side metering, which includes net metering, is common with PV systems, where the entire output of the PV systems is measured on the customer-side of the meter.

Net metering is a method for measuring the net energy consumption at a residential or commercial installation, where usage of electricity from the grid runs the meter forward, and delivery of excess PV-generated electricity into the grid runs the meter backward. During the monthly meter reads, only the net amount will be recorded. On an annual basis, there is a true-up and the customer pays the net due (if any) to the utility company.

There are currently 36 states that require utilities to offer net metering to their customers[7]. In some states, the net metering law allows for time-of-use pricing for determining the net price which can greatly improve the economics of an installation.

4.1.1 Claiming Issues with Net Metering

There is some debate as to whether all the electricity produced in a net metered installation has certificates associated with it, since some of the energy is used on-site.

We take the following position. All of the kWhs or MWhs generated by the solar system have associated PV certificates. The owner of the solar facility can make claims to all of these certificates, whether or not it is a net metered facility. The solar production reduces the need for the utility to produce polluting power to serve this load, therefore the environmental attributes associated with the solar production have value. The utility is paying the full retail rate for the solar production, which includes not only the commodity value of the power, but also the transmission, distribution, and other portions of the rate. However, the utility is receiving the power in the distribution system, and is receiving the additional benefits of a distributed generation resource[8]. In essence, the utility is paying a royalty to the solar owner for hosting this generation out in the distribution system, similar to how a rancher receives a royalty for hosting wind turbines on his/her ranch. Therefore, assuming the PV owner does not have a sign on his/her building claiming that it is "solar-powered", all of the solar production has certificates associated with it which the PV owner can claim.

4.1.2 Metering Options Associated with Net Metering

Since net metering systems will not show the cumulative total of PV generated during any particular time period from a site, additional measurement is required to determine the total PV generation and associated PV certificates from a net metered site. The goal is to determine the total AC output delivered to the grid and on-site loads.

For PV systems that do not have batteries associated with them, the solution can be simple. Some inverters have accumulators that keep a running total of the kWh that have passed through the inverter. Others zero out the production every day. For those systems where an accumulator is not present, a simple utility style meter can be installed between the inverter and the utility meter to cumulatively measure the total AC output of the PV system in kilowatt-hours before it is delivered to any on-site loads or net

metered to the utility. These can be installed for about $150 - $200 and manually read as needed.

Some grid-connected PV systems have battery backups so the power will stay on in the event of the utility grid going down. The selected circuits backed up by the batteries will continue to have power, and the PV will continue to operate to re-charge the batteries and power the backup circuits. However, the overall measurement of PV output is more complicated. Measurements can be made on the AC side, or on the DC side with loss factors applied. Since the AC deliveries to the grid are how the certificates are measured, measurement of the output on the AC side is the preferred method.

For measurement on the AC side, two meters are required as there are two AC outputs from the inverter. One needs to measure the AC output between the inverter and the backup circuit panel and the other needs to measure the AC output between the inverter and the utility meter. The total AC output is the sum of these two meter reads.

Measurement on the DC side ignores operational variables surrounding inverter efficiency, battery maintenance and performance, and other operational aspects of the system. If one assumes that the batteries are performing and maintained properly, and the inverter is set properly, certain scaling factors can be derived. The DC output can be scaled by 85% for a battery-based system with a MPPT charge controller or 80% for a battery system without a MPPT charge controller[9].

There is then the question as to who will read the meter and verify the validity of the PV certificate claim. We suggest that the homeowner read the meter annually for calculating the number of certificates generated, with the certificate aggregator periodically checking the meter read. Based on the size of the system, the aggregator will know whether the homeowner's meter read is in the range of reasonable values.

4.2 Utility-Side Metering

Utility-side metering of PV systems removes the problems cited above with net metering, as the entire AC output of the PV system is going into the grid, and the utility company or a neutral third party can read the meter. PV certificates can be generated directly from this meter read.

5. PV CERTIFICATES: STANDARD SIZING AND PRICING

There is only a small amount of photovoltaic capacity operating compared to other renewable technologies, and measurement is typically in terms of kilowatt-hours. However, power and certificates from all other technologies are generally traded in MWh blocks. The cost premium that photovoltaics requires compared to other technologies make it a more difficult sell, even though surveys indicate that consumers prefer, and will pay extra, for solar energy over other renewable technologies.

PV installations that can participate in the certificates market range from small residential systems to large commercial installations. In discussions with retailers, the wholesale price paid for PV certificates has ranged from $20/MWH to $125/MWH. Since PV certificates are typically blended with other renewables to produce a reasonably priced retail product, a wholesale price of about $50/MWh is likely to be most realistic. For a 2.5 kW residential system, this would result in an additional $228/year of revenues, assuming an annual average of 5-hours/day full solar insolation (0.0025 MW * 5 hrs/day * 365 days/year * $50/MWh). For a 10 kW commercial system, this could bring in $913/year. And for a 500 kW industrial system, the certificates would have a value of $45,125. If PV certificates can be sold for a $50/MWh (5 cents/kilowatt-hour) premium, this produces an income stream high enough to justify installing a separate meter to measure the PV production, even for small net-metered residential systems.

Table 3 provides some information on selected utility green pricing programs, to show the range of premiums that are being paid for bundled solar power products (energy and attribute). As shown in the right-most column, the equivalent $/MWh prices range from a low of $30/MWh to a high of $564/MWh.

6. MARKETING AND AGGREGATION OF PV CERTIFICATES

One of the biggest challenges to marketing PV certificates for any potential seller is aggregating enough certificates to make it financially worthwhile. It could be very cumbersome and expensive for a broker or retailer to contract with every individual owner to sell certificates from small residential systems. However, as there are increasing numbers of these systems, their aggregate will start to represent a sizable number of kilowatt-hours. If there is an entity willing to aggregate a collection of residential systems, a market could be developed for the certificates generated from these small systems. For the larger commercial systems, the task is less onerous to develop a certificate product and improve the economics of the installation.

Selling only the renewable certificates from PV installations can be easy and flexible. The PV installation does not need to be located in a deregulated electricity market area and the certificates can be offered to a buyer in any geographic area, provided this is properly disclosed. Two levels of companies are required to turn this concept into a reality: 1) solar aggregators or other companies

familiar with solar that will work with homeowners, and commercial and industrial installations to a) sign contracts, b) measure production, and c) aggregate certificates at a wholesale level; and 2) utilities offering green pricing programs or LSEs, that will sell the aggregated certificates to buyers. Verification is needed to assure that double-counting does not occur.

TABLE 3: SOLAR GREEN PRICING PROGRAMS

Utility Company (Solar Installed)	Size of Block	Equivalent Price in $/MWh
Southern Company (1 MW)	100 kWh	$60
Arizona Public Service (172 kW)	15 kWh	$176
Salt River Project (100 kW)	100 kWh	$30
Detroit Edison (100 watt block)	12 kWh/ month[10]	$549

Another possible vehicle for selling PV certificates is through groups that have fund-raising needs. For example, a school that installs a PV system could sell PV certificates to the school families and the community as a PTA fundraiser to help fund the installation. This is equivalent to a group buy of certificates, but with the added benefit that the purchasers are permanently retiring the certificates with no plan to offset other emissions.

7. CONCLUSIONS

A number of general findings and key principles have been identified throughout the paper that define the important issues when configuring PV certificates. The next step is to initiate a pilot PV certificates program. Specific action items have been identified on the supply- and demand-side.

On the supply-side, we propose finding two companies to take on the role of solar aggregator, preferably one on each coast. PV certificates will be aggregated from multiple installations, representing residential net-metered systems, commercial systems, and large-scale utility-metered systems. Measurement methods will be evaluated and implemented for each system type that participates in the pilot program. A verification process will be instituted to provide the production, claiming rights, and disclosure substantiation required by a buyer.

On the demand-side, buyers will be needed to purchase the aggregated certificate supply. Buyers will be sought from multiple categories, including LSEs offering bundled green products, utilities participating in green pricing programs, certificate-only based retailers, certificate brokers, and corporations/organizations seeking one-time purchases. A satisfactory price will be negotiated between the buyers and sellers. Publicity about the project will be made to try to spur additional demand for PV certificate-based products. Additionally, any institutional or regulatory barriers will be identified that specifically inhibit PV participation in emerging renewable certificate markets.

8. REFERENCES

(1) This paper summarizes the findings of work sponsored by the Pace University Energy Project. The complete paper can be obtained from the authors or found at the Pace website (www.law.Pace.edu/env/energy).
(2) Swezey, Blair and Lori Bird, "Estimates of Renewable Energy Developed to Serve Green Power Markets", National Renewable Energy Laboratory, January 2002.
(3) ISO-New England "Generation Information System" (GIS) will use certificates to track fuel resource mix of all generation, including renewables.
(4) States with RPS requirements include CT, ME, MA, NJ, TX, WI, and PA (portions).
(5) www.thegreenpowergroup.org
(6) Based on author's experience marketing solar systems to interested homeowners.
(7) States with net metering programs include AZ, AR, CA, CO, CT, DE, DC, GA, HI, ID, IL, IN, IA, KS, ME, MD, MA, MN, MT, NV, NH, NJ, NM, NY, ND, OH, OK, OR, PA, RI, TX, VT, VA, WA, WS, WY. Source: www.eren.doe.gov/greenpower/netmetering/nmtable.shtml.
(8) Farmer, Brian K, Howard Wenger, Thomas Hoff, Charles Whitaker, "Performance and Value Analysis of the Kerman 500 kW Photovoltaic Power Plant", American Power Conference, April 1995, and Shugar, Daniel, "PV in Utility Distribution Systems", *Solar Today*, ASES, September/October 1992, pp. 20-21.
(9) Discussion with Dave Lehmicke, Electrical Engineer, EcoEnergies, Inc., March 2002. MPPT refers to a Maximum Power Point Tracking charge controller that adjusts inverter operation to maximize output of the PV system.
(10) Each customer "owns" a 100-watt block of a central station PV installation. Assuming an average of 4 hours/day of solar insolation, the monthly production would be 100 watts * 4 hours/day * 30 days/month = 12,000 watt-hours (12 kWh) per month.