Combining Photovoltaic Systems with ENERGY STAR® Homes: Lessons Learned from a Demonstration Program Focused on New Construction and Production Builders

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ABSTRACT

A demonstration program was initiated in 2002 to spur the installation of photovoltaic systems by production builders on new ENERGY STAR® homes. As enticement, an incentive of as much as $20,000 was offered for a 2-kilowatt PV system, if it were installed on an ENERGY STAR® Model Home in a subdivision of at least five ENERGY STAR® homes. Yes, this was essentially a free PV system and there were additional incentives for building to New York State ENERGY STAR® Labeled Home standards. Sounds like an offer that's too good to refuse, but it took two years to find six builder projects geographically distributed around the State. This paper will describe the hurdles faced in convincing production builders to participate in the demonstration program and subsequent PV system installation and interconnection agreement issues.

Another aspect of the demonstration program was the monitoring of the PV system performance. Results will be presented on the performance of the PV systems and the fraction of the occupied homes' electricity use that is met by the PV system. Thus far, three of the monitored PV homes are occupied and the annual solar fractions range from 30% to 50% of the household electricity use.

Background

In late 2001, the New York State Energy Research and Development Authority (NYSERDA) issued a request for proposals for "the implementation of a demonstration and awareness campaign, to inform builders, realtors, appraisers, bankers, consumers, and building code officials of the benefits of ENERGY STAR® homes and grid-connected photovoltaic (PV) systems for homes." This initiative was a merger between two distinct programs within NYSERDA – ENERGY STAR® and PV.

Earlier in 2001, NYSERDA had begun implementing the New York ENERGY STAR® Labeled Homes (NYESLH) program. In roughly a 6-month period, more than 60 builders had become program participants. Over 35 NYESLH had been built and another 130 homes were committed. A marketing campaign that included celebrity Steve Thomas of "This Old House" fame was initiated. When the demonstration project was first conceptualized, most of the program's participants were custom homebuilders. NYSERDA wanted to raise NYESLH program awareness and help establish the infrastructure to attract production builders and thus achieve subdivisions of NYESLHs.

The NYESLH program continues to grow. The proportion of new homes sold that are ENERGY STAR®-labeled has increased from 0.29% in 2001 to 9.0% in 2003 (NYSERDA 2005). By the end of 2004, over 4,950 homes had been built and labeled. Several production builders are enrolled in the program.

Since 2000, the goals of NYSERDA's PV programs have been to develop and strengthen New York's supply and service infrastructure, reduce barriers to installing PV, and build market demand for PV. This ENERGY STAR®/PV demonstration program represented an opportunity for the PV program to leverage the marketing and greater awareness of the NYESLH program. In the last three years, the NYSERDA PV program has provided incentives of $4 to $5 per watt for more than 400 system installations throughout the State. About 70% of those systems are residential systems and over 40 systems are installed on ENERGY STAR® homes (Ferrante). Most of the residential installations are sold directly to homeowners for older, existing homes.

A secondary benefit of this demonstration was the encouragement to install PV systems on homes that are energy efficient. A significant improvement in cost effectiveness is achieved when an integrated package of efficiency measures and renewable generation is considered. Others have demonstrated this benefit (Aldrich 2006). At the time that this demonstration program was initiated, NYSERDA's PV program incentives were uniform with no consideration of the efficiency of the buildings on which the systems were to be installed. As of the writing of this paper, PV program incentives provide an additional $0.50 per watt ($4.50 instead of $4.00) if the system is on an NYESLH.

Demonstration Project Objectives and Implementation

Steven Winter Associates, Inc. (SWA) and the National Association of Home Builders Research Center (NAHB-RC) were each awarded contracts by NYSERDA to implement this demonstration program. The primary task was the recruitment of qualifying builders and establishing the relationships between builders, raters, and PV system installers. Between the two contractors, SWA and NAHB-RC, twelve NYESLH subdivisions of at least 5 homes were to be established – two in each of six different utility service areas in New York State. At least one home in each subdivision was to have a PV system.

The overall demonstration project objectives were to:

- Demonstrate NYESLH at the community or subdivision level.
- Install residential PV systems to develop market interest, demonstrate their performance and reliability, and document the process in terms of utility and code issues.
- Document the benefits of ENERGY STAR® and PV-equipped homes through homeowner interviews, monitoring and utility bill analysis.

The following incentives were available to NYESLH builders from the NYESLH program:

- $5000 for a NYESLH Model home that is unoccupied and open to the public for a minimum of 60 days.
- $1000 for each NYESLH sold.

In addition to these standard NYESLH program incentives, attractive PV system incentives were available exclusively through this demonstration project. For a grid-tied PV system on a NYESLH Model home, 100 percent of the installed cost would be covered up to the lesser of $10 per AC watt installed or $20,000. For the second and third PV systems to be installed in the same subdivision, the incentives were 75% and 60% of the installed cost. At the

time, market prices for PV panel systems were approximately $9/watt, installed. Thus, the demonstration project systems, in most instances, were 2.4 to 2.6 kW to receive the maximum incentive of $20,000. In summary, a free 2 kW system was available for a NYESLH Model and second and third systems could be installed in the subdivision for $5,000 and $8,000, respectively. The intent of the significant Model home incentive was to have installed PV systems be available for public viewing and promotion.

The standard PV incentive available from NYSERDA when this demonstration project was initiated was $4 per DC watt. Thus, the incentives available through this demonstration project were significantly higher for a modestly sized PV system. Currently, NYSERDA provides incentives of $4.50 per DC watt for PV systems on NYESLH homes. One builder that participated in the demonstration project has gone on to install larger PV systems on other homes and has applied for the standard incentive rather than the demonstration project incentive.

Finding Six Builder Participants

The primary task was to recruit six geographically distributed builder projects to participate in the demonstration program. SWA tried several approaches to finding candidate builders including cold calls using lists of builders enrolled in ENERGY STAR® and local HBA members, and contacting the NYESLH program regional account managers, PV installers, and HERS raters for builder project leads. Telephone and e-mail were used to make the initial contacts and face-to-face meetings were held with all builders that expressed interest in learning more about the demonstration program. SWA and NAHB-RC coordinated frequently to avoid recruiting, and potentially confusing, the same builders.

The primary challenges faced in establishing six builder projects were:

- A small speculative housing market in New York State. The few builders of larger subdivisions will construct a model home to be used as a sales office during the multi-year build out of the subdivision.
- Uncertain and ever-changing construction schedules. Timing was critical for finding projects at the appropriate stage with all approvals in place and the Model home yet to be built. In several instances for both SWA and NAHB-RC, candidate builder projects were found and tracked, but zoning approval or permitting issues delayed the projects significantly.
- The optimum lot for solar access may not be the most desirable lot for a Sales Model. The Sales Model homes are typically located on a prominent lot at the entrance to the subdivision – not necessarily properly oriented for an unobstructed southern exposure.
- The New York State Electric and Gas service area is rural with no major cities served and limited new construction. Ultimately, a grouping of homes by a builder on scattered lots was accepted in lieu of a subdivision.
- The aesthetic appearance of the PV panels was a concern to a few builders that were approached in the Hudson Valley area served by Central Hudson Gas & Electric.

Ultimately, over the course of two years, SWA successfully established six builder projects. Table 1 provides a summary of the builder project characteristics. They are listed in the order that they agreed to participate in the demonstration program.

Table 1. Six Builder Project Participants

Project	Location	Utility	Homes	HVAC	PV System
Regional production builder's 18-lot third phase of a 63-home community	Syracuse	Niagara Mohawk	2-story, approx. 2000 sf plus full basement	Direct vent gas furnace, 94 AFUE; ERV; SEER12 AC	2.4 KW AstroPower
Smaller builder with a 24-lot plot within a larger subdivision, plans to build out over several years	Rochester	Rochester Gas & Electric	2-story, approx. 3500 sf plus full basement	Direct vent gas furnace, 92 AFUE; no AC	2.4 KW AstroPower
40 3-family townhouses, affordable housing	Bronx	Consolidated Edison	3-story, 3100 sf buildings, owner's unit and two apartments in each building	Direct vent gas boiler, 87 AFUE; hydronic baseboard; window AC units	2.2 KW AstroPower
3 adjacent duplex homes, affordable housing	Yonkers	Consolidated Edison	2-story, 1300 sf, 2 bdrms. plus full basement	Direct vent gas boiler, 84 AFUE; hydronic baseboard; window AC units	1.2 KW AstroPower on each duplex
Regional production builder, 24-lot community w/ 2-acre zoning, two-year build out	Cornwall	Central Hudson Gas & Electric	2-story, 4500 sf, upscale	Direct vent gas boiler, 93 AFUE; SEER12 AC	2.6 KW AstroPower
Log home manufacturer with a small in-house construction group and a 13-home community nearby	Fleish-manns	New York State Electric & Gas	1-story, homes range in size from 2000 sf to 4000 sf including a finished basement	Direct vent propane boiler, 84 AFUE; radiant heat; no AC	2.6 KW GE/Astro-Power

Implementation Hurdles

Once a builder agreed to participate in the demonstration program, the next step was to facilitate the construction of the home with all of the necessary parties involved. Some projects went relatively smoothly while others faced a few challenges related primarily to the PV system installation.

Project Timing and Responsibilities

In more than one instance, the completion of the electrical inspection was delayed because the electrical permit had been pulled without indicating the presence of a PV system. This may have been because the decision to install a PV system came later in the process or, more likely, the electrician overlooked the need to modify the permit application.

For the six builder projects, two different PV contractors were used and both requested that the homes' electrical contractor have a role in the installation. The electrical contractors were responsible for running the conduit from the PV panels to the inverter, installing disconnects, and connecting the inverter to the electrical panel. The builder compensated the electrical contractor for this within the total project cost.

In two instances, one with each PV installer, this arrangement involving the electrical contractor caused delays because of improper installation and lack of performance by the electrical contractor. As the number of PV installations increases, electrical contractors will become more familiar with the installation requirements, but until then, the PV contractors need to play a more active oversight role in this aspect of the installation. However, it is required that the electrical contractor be responsible for this aspect of the installation and the electrical inspection in new construction projects.

New York State Interconnection Requirements

In an attempt to simplify the process, New York State has established standardized interconnection requirements for small (2 MW or less) distributed generators that are connected in parallel with utility distribution systems (New York State). This is a 32-page document that details the application process, design requirements, verification test protocols, and a 10-page agreement between the system owner and the utility. While this document likely alleviated many barriers, it also presented some hurdles.

Certified interconnection equipment. Within the standardized interconnection requirements is the recommendation that inverter equipment be selected from the "Certified Equipment" list maintained by the Public Service Commission. This language presented a challenge for one of the first PV systems to be installed in this demonstration program. The process from applying for an interconnection agreement to PV installation acceptance and operation took five months to complete.

The problems arose when a utility representative visited the site to conduct an inspection and an inconsistency was found between the installed inverter firmware and that listed on the Certified Equipment list. After several telephone and e-mail communications with the PSC and inverter manufacturer, the firmware issue was resolved.

The purpose of the Certified Equipment list is to assure that system components meet certain standards of performance. Manufacturers need to recognize the importance of having their equipment, including all upgrades and models, included on this list. The Certified Equipment list issue only occurred for one of the six demonstration projects, but it required the involvement of SWA, as demonstration project contractor, to resolve.

Insurance requirements. For another project, insurance requirements were an issue. The utility told the builder that his insurance did not satisfy the interconnection agreement requirements and insisted on an insurance certificate from the homeowner. This presents a significant barrier to a builder's ability to install a PV system prior to the homeowner being identified.

The Standard Interconnection Agreement language clearly states that general liability insurance coverage for operation of a PV system is not required. However, the Agreement does include the following statement:

> *Due to the risk of incurring damages, the Public Service Commission recommends that every distributed generation system customer protect itself with insurance, and requires insurance disclosure as part of this agreement.*

The customer, or PV system owner, must check off a box indicating whether he does or does not have general liability insurance.

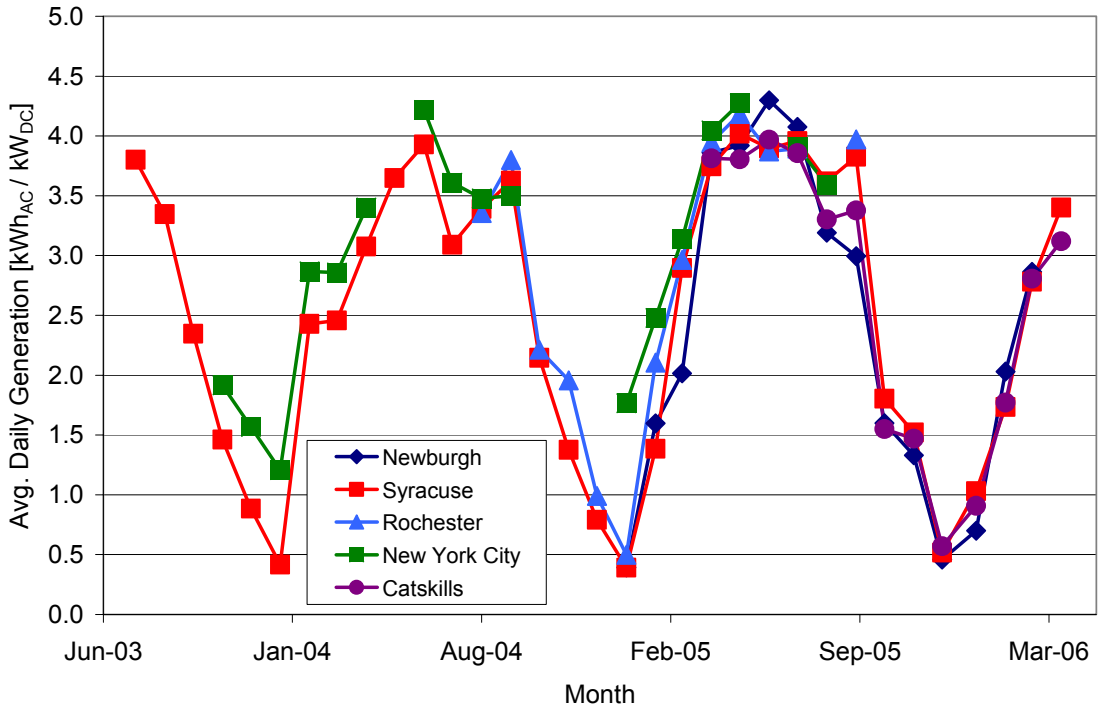
Fortunately, no damages have been incurred and no insurance claims have been made, but one has to wonder how appropriate this language is for the situation where a builder is transferring the agreement at the home's closing.

PV Systems and Installed Performance

After the PV systems were installed on the Model homes, monitoring equipment was installed to record the systems' performance over time. In five homes, DC and AC generation from the PV systems (and sometimes household electricity consumption) have been recorded at 15-minute intervals. Figure 1 compares the performance of the PV systems throughout the project contract period. To compare the systems effectively, these data have been normalized by plotting energy generated (kWhAC) per installed PV capacity (kWDC). All of the systems are roof-mounted with due-South orientation except for the Newburgh system which is oriented towards the West. Each of the five operating PV systems has produced 2300 to 2600 kWh annually. This performance is in fairly good agreement with predicted estimates.

Monitoring was performed at only five of the six builder projects because construction was completed on the affordable duplex homes too late in the project contract period to warrant monitoring. Construction began in 2003, but this project fell victim to the limits of volunteer services and a constant turnover of construction managers.

Figure 1. Photovoltaic System Production Normalized for System Size



Figures 2 and 3 compare household average daily electricity use to the electricity produced by the home's PV system on a monthly basis for two of the occupied homes. While the PV system production is comparable, the solar fractions are quite different. Natural gas serves the space and domestic water heating loads for both of these homes.

The home in Syracuse became occupied in late May 2005. The 2600 square foot home with four bedrooms received a classic HERS score of 87 with a condensing gas furnace, power-vented water heater, and central air conditioning. In September, the PV system met all of the household's electricity use and sent 12 kWh of energy to the grid. For the 11 occupied months monitored, the PV system met 50 percent of the household's electricity needs.

The home in South Bronx became occupied in early 2004. The owner's unit within the townhome includes the basement, first floor, and half of the second floor. The townhomes have hydronic baseboard heating served by an 87 AFUE gas-fired boiler that also serves the domestic hot water load via an indirect tank. The HERS score for the townhome was 89. Window air conditioners were installed and their summer time use is apparent in the graph. Even so the non-summer electrical use for the home is approximately 15 kWh/day, significantly higher than for the larger Syracuse home. The PV system provided approximately 30% of the home's annual electrical use.

As indicated in the graph, the PV system was disconnected for a couple months. It is believed that a security contractor turned off the PV breakers in the main panel when working on the homes security system. The homeowner was completely unaware of the problem until told by SWA during a visit to retrieve data from the logger.

Figure 2. Syracuse Household Electricity Use and PV System Generation

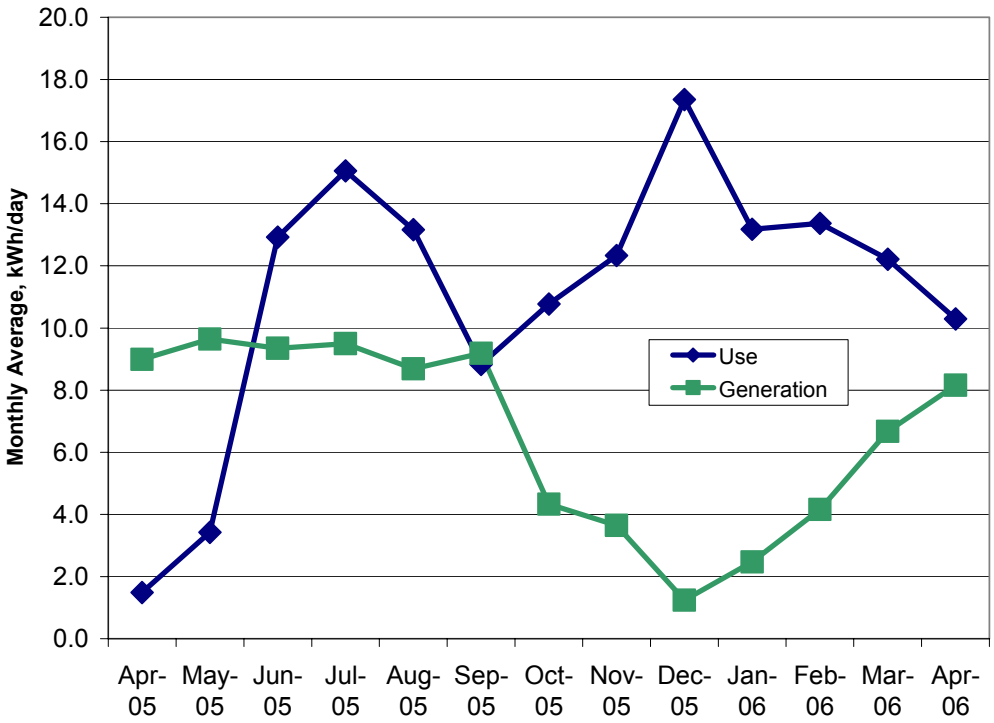
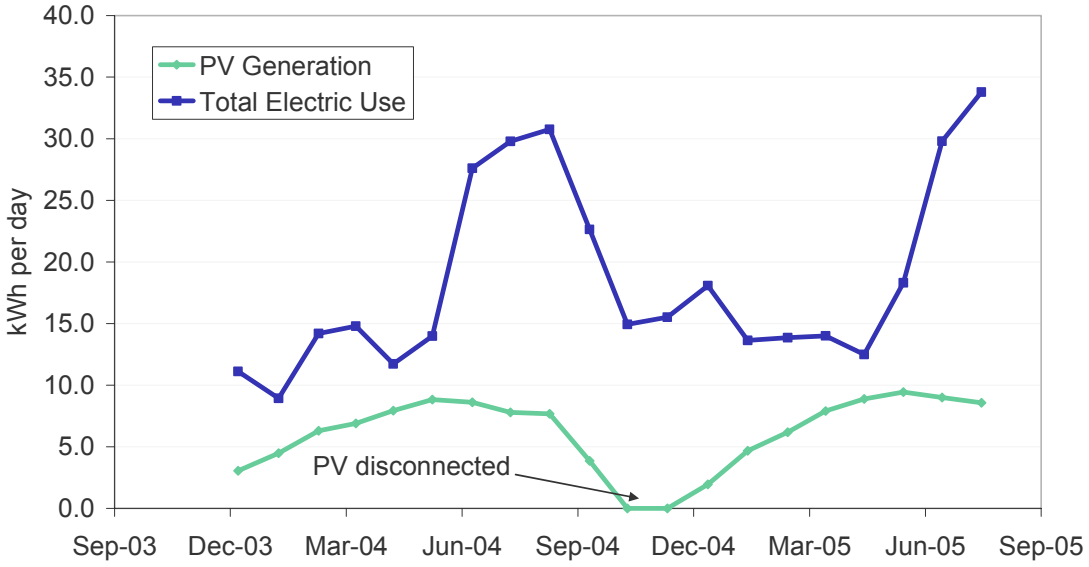


Figure 3. South Bronx Household Electricity Use and PV System Generation



Discussion

Even though only a small number of production builders and new construction projects were involved, the implementation of this demonstration program has provided several insights for NYSERDA to possibly consider in the development and administration of residential efficiency and renewable programs for this market sector. The following are some of the more significant observations made during the implementation of this demonstration project:

- The development and construction of residential subdivisions, in some instances, is a multi-year process from zoning approvals through to home occupancy. Decisions on site planning that are critical to providing solar access for homes happen very early in the process. Incentive programs that can influence these decisions need to be stable and long term so that a multi-year long commitment can be made.
- Builders do not appear to be willing to risk adding the cost of a PV system to a speculative home for fear that potential buyers will not recognize the value. Few builders and/or realtors are knowledgeable enough and/or will take the time to educate buyers on the value.
- Establishing an interconnection agreement between the utility and the builder that will be transferred to a homebuyer within months is awkward.
- Because of orientation and shading from trees and other structures, the performance and thus appropriateness of a PV system is not the same for all homes within a subdivision. A possible remedy is to identify the "PV friendly" lots on the site plan in the sales office. Buyers interested in the PV option would then only select from those lots. Electrical permit applications for homes on those lots would indicate an optional PV system.
- Selling speculative homes with PV systems to buyers that do not appreciate their value can result in unrealized benefits. This was the case for both of the affordable housing installations. The PV system had no influence on the buyer's decision to purchase the home and thus, they are not concerned if the system is not functioning properly. This

situation could also occur for a Model home that is the last home to be sold in a desirable subdivision.

A possible remedy to several of these market issues is to establish marketing relationships between builders and PV contractors rather than contractual. The PV contractor provides the marketing materials for the builder to offer a PV option. Any homebuyers that show an interest are put in direct contact with the PV contractor. This allows the more knowledgeable and motivated PV contractor to sell the concept and the contract is then established directly between the homebuyer and the PV contractor. The builder does little more than generate leads for the PV contractor, but can market themselves as environmentally friendly. This is the approach being taken by the log home manufacturer.

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