

PV WORKFORCE DEVELOPMENT AND THE MARKET FOR CUSTOMER-SITED PV

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ABSTRACT

This paper presents findings from research conducted for the New York State Energy Research and Development Authority (NYSERDA) relating to installer workforce development for customer-sited photovoltaic (PV) systems, installer certification by the North American Board of Certified Energy Practitioners (NABCEP), quality assurance of installed PV systems, and market development. Among the initial systems NYSERDA program-eligible installers put in, those of NABCEP-certified installers had fewer problems at time of system inspection than those of non-certified installers, a result that was statistically significant. Findings comparing 12 PV programs throughout the nation show that programs tend to ensure quality either through setting installer eligibility requirements or through one or both of the following: state-mandated licensing for PV installers and 100% inspection of installed systems. Finally, overall program budget and proportion of NABCEP-certified installers were the greatest predictors of annual market penetration of PVs (with a regression having R-square of 0.70 and significant coefficients).

1. INTRODUCTION

This paper presents findings that support elements of the program theory underlying New York State Energy Research and Development Authority's (NYSERDA) activities to promote customer-sited photovoltaic (PV) systems. Specifically, the paper discusses research relating to PV workforce development.

NYSERDA's PV program activities are funded by an electric distribution System Benefits Charge (SBC) and a Renewable Portfolio Standard (RPS) charge paid jointly

by customers of Central Hudson Gas and Electric Corporation, Consolidated Edison Company of New York, Inc., New York State Electric and Gas Corporation, National Grid, Orange and Rockland Utilities, and Rochester Gas and Electric Corporation. The PV program is available to all electric distribution customers that pay into the SBC and RPS, a population of over seven million ratepayers.

NYSERDA, a public benefit corporation established in 1975, began administering the SBC funds in 1998 through its **New York Energy SmartSM** Program. The 2006-2011 **New York Energy SmartSM** budget addresses PV workforce development and consumer information, of which the former is the focus of this paper. In 2007, the funding for customer incentives for PV installation shifted from the SBC to the RPS.

NYSERDA's PV activities are a subprogram of its Clean Energy Infrastructure Program. The PV program aims to contribute to the development of a sustainable market for PV technologies in many ways, including: requiring that customer incentives go through eligible installers on behalf of their customers who are purchasing new, high quality, grid-connected PV systems; supporting the development of accredited PV training programs; promoting and facilitating nationally recognized certification for PV installers; and providing business development and market support incentives for PV dealers and installers.

NYSERDA's PV program theory has four central propositions [2], three of which relate to this paper—that the demand for and supply of customer-sited PV can be increased in New York through: incentives for installations, workforce training and development, and quality review of projects and technology performance.

Perhaps because the PV program grew out of NYSERDA's research and development emphasis, the PV team has had a keen interest in research relating to its program processes and theory. The authors have conducted three research studies for the program (in 2005, 2007, and 2008) and are able to draw from all three studies to comment on the validity of the program theory.

Workforce development has become a "hot topic" and much has been written lately regarding the need for an expanded renewable efficiency workforce [1, 4, 8]; NYSERDA's program theory goes beyond the need for a larger labor pool and addresses the role that a highly skilled workforce plays in developing a market. The program intends to instill and strengthen consumer confidence in the relatively unfamiliar technology of PV by supporting the growth and maturation of a qualified and reliable PV workforce in New York that installs and maintains customer-sited PV systems.

The authors are aware of a single research report that has addressed the relationship between installer qualifications and installation quality [3]. This study analyzed different types of data than are dealt with in this paper. The study conducted on-site verifications of system performance and categorized systems as having been: self-installed; installed by an installer with 5 to 19 program installations; or installed by an installer with 20 or more installations. (The study intentionally did not investigate installations by a professional installer with one to four installations.) The study concluded: "The experience level of the installer does not noticeably affect the system performance."

2. NOMENCLATURE

The North American Board of Certified Energy Practitioners (NABCEP) provides *certification* for PV installers. The Institute for Sustainable Power Quality (IS PQ) has developed standards for *accrediting* programs and *certifying* teachers for PV instruction. The Interstate Renewable Energy Council (IREC) *manages* the program accreditation and instructor certification processes.

Net metering is the customer metering process that enables customers with PVs to pay only for the electricity they consumed in excess of that which they produced, regardless of the coincidence of the production and consumption, and to be paid for any production in excess of consumption.

3. RESEARCH METHODS

As part of research completed for NYSERDA's PV program in 2005 [5], the evaluators conducted telephone surveys with 33 customers that had PV systems installed through the

program and a web survey of 34 participating installers. As part of research completed in 2007 [6], the evaluators conducted in-depth interviews and surveys by telephone with 43 people who attended the NYSERDA-sponsored 2006 *Renewable Energy & Energy Efficiency Workforce Education Conference*, as well as with 17 training contactors, most of whom were conference speakers. The study also included a web survey of 40 participating installers, as well as other data collection. The methods used for the 2008 study [7] are described in more detail below.

The 2008 study sought to better understand linkages between PV installer workforce development activities and PV system outcomes in New York State. The first research objective examined the influence of workforce development training programs that had received NYSERDA support to develop or enhance their PV curricula. The second research objective investigated whether a statistical association might be found for NYSERDA's PV program between installer training and certification, and PV project design and installation quality. Finally, the study explored how PV incentive programs around the country address issues of workforce development and assurance of PV project quality.

The first and third research objectives employed in-depth telephone interviews and secondary research; the second research objective employed review, coding, and analysis of NYSERDA's installer eligibility applications, and of PV project review documents.

For the first objective, the research team conducted in-depth interviews with 8 of the 10 organizations that have received assistance from NYSERDA to develop training capabilities (hereafter referred to as "NYSERDA partners") and with 5 of the 8 organizations that have expressed an interest in partnering with NYSERDA to develop PV training capabilities, but have not actively pursued such assistance (hereafter referred to as "interested institutions"). The institutions offer Bachelor degrees, Associate degrees, or certificates of training, which are offered by Boards of Cooperative Educational Services (BOCES) and International Brotherhood of Electrical Workers (IBEW) chapters.

For the second objective, the research team developed protocols to score the installers' applications to NYSERDA for program eligibility and to score quality assurance findings as determined from PV system design reviews and installation inspection reports. The latter protocol was developed in collaboration with a PV consultant under contract to NYSERDA to conduct design and installation reviews, as well as provide other support services. A key characteristic scored for installers was whether they were a NABCEP-certified PV installer. The research team used the installation scoring protocol to analyze written reviews of

projects completed by PV professionals under contract to NYSERDA; the written reviews are part of NYSERDA's quality assurance activities. The research team scored design reviews for 32 projects and installation inspection reviews for 29 projects, for a total of 61 projects. Projects selected were among the first three an installer did in the PV program. The sample provides 90/10 confidence/precision overall, and 90/15 for each type of review (design and installation).

For the third objective, the research team conducted in-depth interviews with program managers of 12 PV incentive programs around the country, including the NYSERDA program manager. The selection of programs for comparison considered such factors as installer requirements, type of incentive offered for PV installations, size of program relative to customer base, program inception date, market sector targeted, net metering, other related programs in the state, and program activity level. The final selection was the outcome of extensive preliminary research on 34 programs selected in consultation with the PV manager.

Ten of the 12 programs reviewed serve most of the customers in their states, while 2 of the programs are run by city-owned utilities. The presentation of findings refers to the programs by the state or city name, since that is the most succinct label; the readers should not infer from this nomenclature that the programs are government sponsored. The programs are identified in the following list, which gives the state/city, the implementing organization, the program name, and year of inception:

- (1) Austin: Austin Energy, *Solar Rebate Program*, 2004
- (2) California: California Investor-Owned Utilities, *California Solar Initiative (CSI)*, 2007
- (3) Connecticut: Connecticut Clean Energy Fund, *Solar PV Rebate Program*, 2004
- (4) Maine: Efficiency Maine (for the Maine Public Utilities Commission), *Solar Energy Rebate Program*, 2004
- (5) Massachusetts: Massachusetts Renewable Trust, *Small Renewables Incentive*, 2002
- (6) Nevada: Sierra Pacific and Nevada Power, *SolarGenerations*, 2004
- (7) New Jersey: New Jersey Board of Public Utilities, Office of Clean Energy, *Customer On-Site Renewable Energy (CORE) Program*, 2001
- (8) New York: NYSERDA, *PV Incentives for Eligible Installers*, 2003
- (9) Oregon: Energy Trust of Oregon, *Solar Electric Program*, 2003
- (10) Tucson: Tucson Electric Power, *SunShare PV Buydown*, 2001
- (11) Vermont: Vermont Energy Investment Corporation, *Solar and Small Wind Incentive Program*, 2003

(12) Wisconsin: Focus on Energy, *Solar Electric Incentive Program*, 2002

Program inception year coincides with the first offering of continuous incentives for PV, with the exception of California and New York. In California, a prior statewide program was administered by the California Energy Commission. In New York, PV incentives were paid beginning in 1999, on a case-by-case project demonstration basis until a continuous incentive program began in 2002, with the first such incentives paid in 2003. Both Massachusetts and New Jersey have recently changed their programs, and so the research also investigated Massachusetts' *Commonwealth Solar* (2008) and New Jersey's 2007 *SREC Pilot* and 2008 *SREC Program* (full-scale).

4. FINDINGS

The three research efforts discussed in this paper had differing objectives, with only the 2008 research exclusively focused on workforce development. This paper presents, from the 2005 and 2007 research, only the findings that were pertinent to PV workforce development generally and NYSERDA's workforce development activities specifically.

4.1 Selected Findings from 2005 and 2007 Research

The 2005 research concluded, on the basis of participating customer surveys, that among NYSERDA's activities to foster consumer confidence in PV installations, of most value to customers were the five-year system warranty required by the program and the fact that NYSERDA requires installers to qualify as a prerequisite for eligibility to participate in the program. Two-thirds of customers indicated that the warranty increased their confidence in the installation "a lot" and over half of customers said the same for the installer eligibility requirements.

The 2007 interviews with attendees and trainers at NYSERDA's 2006 workforce development conference identified the difficulty of providing hands-on training as a key barrier to teaching PV installers. Such training necessitates students have access to PV systems (one system per small group of students), access to tools and equipment (such as meters), and access to a roof (preferably, just a few feet off the ground) on which systems can be installed. These materials can be expensive to assemble and require storage space unavailable in most classrooms. In addition to these barriers to teaching PV installation, the lack of internships or a masters' apprentice program was cited as a barrier to professional development subsequent to classroom training.

4.2 Findings from 2008 Research on NYSERDA’s PV Training Partners and Interested Organizations

The NYSERDA partners are actively involved in training students to design and install PV systems, although the scope of their training activities varies. Two-year colleges, four-year colleges, and BOCES report a high demand for PV courses, and each estimates they have trained to date a total of between 100 and 300 students, for an estimated total of approximately 700 students trained statewide. On the other hand, IBEW chapters report less demand for PV installer courses, and one chapter has placed its course offerings on-hold, referring interested members to training offered by other IBEW chapters.

Most training partners reported interest in attaining ISQP accreditation for their PV curricula, which is one of NYSERDA’s goals for its partners. The training partners did not report any particular barriers to attaining accreditation, but rather expressed the view that it would simply take time.

Contacts at both training partners and interested institutions mentioned the relatively low demand for PV systems as a barrier to establishing or expanding training, with the IBEW contacts expressing this view most strongly. Some contacts characterized NYSERDA’s total program budget as not large enough to stimulate market demand.

This view is supported by considering that contacts indicated they had trained to date perhaps as many as 700 students in PV. Installer responses to survey questions in the 2007 research suggest that their firms employ, on average, about four people involved in PV projects. The total number of PV-related employees for installer firms working with NYSERDA would be about 250. That number is an upper limit, as the question posed to installers did not ask them to restrict their response to PV activity conducted for NYSERDA’s program, nor to full-time PV activity. It is also an upper limit considering the volume of NYSERDA projects to date and the number of eligible installers—82—with whom all PV-related employees must be affiliated to work for NYSERDA.

Training contacts at interested institutions also cited funding, training space, and PV materials as barriers to PV training program development. All contacts indicated a need for internship opportunities and job placement support.

4.3 Findings from 2008 Research on Installer Qualifications and Installation Outcomes

Regarding the investigation into the relationship between installer qualifications and installation outcomes, the analysis found NABCEP-certified installers had fewer

problems during the installation inspection review, as identified by the PV consultants in their review reports. NABCEP-certified installers had 0.17 problems on average, compared with 0.47 problems for installers lacking certification—a result of the latter group having both more installations with problems (29% versus 17%) and a greater number of problems in those problematic installations (1.6 versus 1.0 problems on average). This finding was statistically significant ($p < 0.05$).

The research did not find a relationship between NABCEP-certification and the number of problems identified in the design reviews, as only a single problem was identified (for an uncertified installer) in the scoring of 32 design reviews. In discussions between the research team and NYSERDA’s PV consultant during the development of the scoring protocols, the PV consultant described the design review process as a back-and-forth exchange between the reviewer and installer. Identified problems typically are resolved during the design review process. The outcome of the design review scoring suggests the review reports do not document problems present in the initially proposed designs, but rather only problems remaining at the end of the negotiations between the installers and the reviewers.

4.4 Findings from 2008 Research on Comparative PV Program Workforce Development and Quality Assurance Practices

The 12 PV programs reviewed, including NYSERDA’s, vary widely in the PV training offered or supported through funding, as illustrated in Table 1.

TABLE 1: PV TRAINING OFFERED BY REVIEWED PROGRAMS

Training Activity	Number of Programs
Provide program-sponsored technical training	4
Fund training organizations to develop and offer PV training	4
Provide student scholarships	3
Conduct ad hoc training in response to problems that arise	3

Four PV programs sponsor technical training, ranging from one day to one week. Four programs are providing funding to schools or renewable energy industry organizations to develop and offer PV training, with one of these efforts patterned on NYSERDA’s activities. Other training-related activities include providing student scholarships and conducting training on an ad hoc basis. Of the four programs that have none of these elements, three

programs have funding they are considering allocating to training.

Programs assure the quality of installed systems in a variety of ways: requiring installers to meet specified criteria; relying on state-mandated licensing requirements for PV installers; reviewing site analyses and system designs prior to designating projects eligible for incentives; inspecting systems, either on a random basis or 100% of installations; and reducing incentives for systems with output less than optimal, as determined from system design reviews (for capacity-based incentives) or from metered output (performance-based incentives).

Most programs review the site analyses and system designs and use one or two of the other quality assurance activities. Only one program had all five of those activities. NYSERDA designates eligible installers, reviews system designs, and conducts random system installation inspections (historically, on about 35% of projects). Six programs, including NYSERDA's, require installers to meet varying requirements for certification, education, experience, and references. Of the six programs that did not set installer requirements, all had state-mandated licensing requirements and four inspect 100% of installations.

Nearly half of the program contacts reported they are reconsidering their installer requirements, illustrating that program managers are keeping an eye on the market and adjusting program requirements, as well as incentives, as needed. One program that is among those with the strictest installer requirements is considering changes that would allow more entrants; four other programs are considering adding installer requirements or are in states contemplating licensing requirements for PV installers. Thus, 10 of the 12 programs either have or are considering adopting installer requirements for program eligibility.

As shown in Table 2, NYSERDA's program has installed the fewest number, second to Maine, of systems per year per 100,000 eligible customers—2.4 systems, as compared with the programs in Austin, Texas, with 30.2 systems and California with 24.5. NYSERDA's program ranks tenth in the list of 12 in terms of annual budget per eligible customer (\$0.98 per eligible customer, as compared to the leader, California, with \$17.09).

A regression analysis to predict the number of systems installed annually found that the annual budget and number of NABCEP-certified installers (per 100,000 eligible customers) are significant predictors (with an equation R-square of 0.70). Binary variables for program-sponsored training and program-specific installer requirements make positive contributions to number of systems installed, although the effects do not reach significance.

TABLE 2: PROGRAM BUDGETS AND SYSTEMS NORMALIZED BY NUMBER OF CUSTOMERS

Location	Annual Budget Per Eligible Customer	Annual Systems Per 100,000 Customers
Austin	\$7.73	30.2
California	\$17.09	24.5
Connecticut	\$4.79	4.8
Maine	\$0.16	1.6
Massachusetts	\$6.52	4.5
Nevada	\$1.40	5.5
New Jersey	\$14.03	8.7
New York	\$0.98	2.4
Oregon	\$5.23	10.5
Tucson	\$5.33	15.2
Vermont	\$2.83	14.5
Wisconsin	\$0.47	2.6

The researchers considered the possibility that annual budget drives the number of NABCEP-certified installers, yet these two variables were found to be independent of each other, as is optimal for two explanatory variables in a regression equation.

Tables 3 and 4 provide more detail on the data used in the analysis. Although the data in Table 3 count budgets and customers using "millions" as the unit, this convention is for presentation only; the data analyzed were the precise figures as provided by the program contacts. In Table 3, the number of eligible customers was reported by program contacts or taken from 2006 EIA/DOE data of the program-eligible customer classes for the utilities served by the program.

TABLE 3: PROGRAM BUDGETS AND CUSTOMERS

Location	2008 Annual Budget	Eligible Customers
Austin	\$3.0 M	0.4 M
California	\$189.7 M	11.1 M
Connecticut	\$7.2 M	1.5 M
Maine	\$0.1 M	0.8 M
Massachusetts	\$17.0 M	2.6 M
Nevada	\$1.6 M	1.1 M
New Jersey	\$54.0 M	3.8 M
New York	\$6.9 M	7.0 M
Oregon	\$6.8 M	1.3 M
Tucson	\$2.0 M	0.4 M
Vermont	\$1.0 M	0.3 M
Wisconsin	\$1.2 M	2.5 M

In Table 4, the number of systems installed are program totals, typically as of the end of 2007, as provided by program contacts. The numbers of NABCEP-certified installers are the numbers residing in the state, per the

NABCEP website as of the end of 2007. Note that an installer, whether certified or not, may work in states other than the state he or she resides in, so the numbers of NABCEP-certified installers presented in the table may underestimate the numbers working for a given program.

TABLE 4: NUMBER OF SYSTEMS INSTALLED AND NABCEP-CERTIFIED INSTALLERS

Location	Number of Systems Installed	NABCEP-Certified Installers
Austin	469	13
California	2,719	159
Connecticut	292	3
Maine	37	8
Massachusetts	700	13
Nevada	248	4
New Jersey	2,351	17
New York	834	34
Oregon	680	10
Tucson	400	8
Vermont	250	20
Wisconsin	382	17

5. DISCUSSION

Programs adopt a variety of methods to assure quality of installed PV systems. The methods have the appearance of a trade-off, although this statement is not intended to imply that program managers explicitly trade off various methods in designing their programs. Nine of the 12 reviewed programs fit the pattern of either having program-specific installer requirements or state-mandated licensing required for PV installers (e.g., licensed electrician, licensed contractor, OSHA PV license), but not both. Eight programs have either program-specific installer requirements or inspect 100% of systems, but not both. Five programs have either program-specific installer requirements or adjust incentives for lower than optimal output (expected or metered), but not both. Of course, some programs have both elements described here as trade-offs, and some programs have neither.

All of the program approaches to quality assurance seem reasonable, although only the efficacy of one of the approaches was tested—program-specific installer requirements; only a single element of that approach was tested—encouraging NABCEP-certification; and only for one program—NYSERDA’s. The research confirmed the validity of this quality assurance approach. The initial program PV installations of NABCEP-certified installers had fewer problems than those of non-certified installers, a statistically significant finding.

It appears PV programs may be moving toward program-specific installer requirements. Six of the reviewed programs currently have such requirements and another four are considering adding them or operate in states that are contemplating licensing requirements for PV installers. Only one program—among those with the strictest installer requirements—is considering changes to allow more entrants.

Relating to this issue, more than half of NYSEDA’s early program participants reported their confidence in the PV installation was increased “a lot” by NYSEDA’s steps to designate eligible installers. The effect of installer eligibility requirements on market penetration was explored in a regression analysis and its effect was positive, yet insignificant.

The reviewed programs have a variety of approaches to installer training; overall, the trend appears to be toward increased training efforts. Eight of the 12 reviewed programs do one or more of the following: conduct technical training on a regular or ad hoc basis; support PV training programs through funding; and/or provide student scholarships. Of the four programs that do not engage in any of these activities, three are considering supporting training.

An important research finding is that overall program size, as measured by budget per eligible customer, is a significant predictor of market penetration—i.e., the average annual installations of PV through the program (per 100,000 eligible customers). This finding helped the research team understand an opinion expressed by training contacts in the 2008 research, and by installers surveyed in both the 2005 and 2007 research: the view that NYSEDA’s “incentives” were too low. As a comparison of PV program per-watt incentives in all 50 states shows that NYSEDA’s incentives are not low, the research team initially interpreted the remarks as grouching—indicative that everyone always wants more money. The regression research, however, led the evaluators to reinterpret the comments. Likely, the contacts meant the total budget for incentives was too low to attract a large number of installers into the program. Installers will concentrate their sales activities in states like New Jersey and California that have comparatively very large annual program budgets on a per capita basis.

6. CONCLUSIONS

The research yields the following main conclusions.

- (1) A well-qualified workforce, as evidenced by NABCEP certification, leads to higher quality PV installations and contributes to the development of a market for PV.

- (2) Workforce development activities and system-specific installation incentives are not sufficient, in themselves, to develop a market for PV. Total annual program budget (normalized per eligible customer) appears to send a strong signal to the PV installers regarding the potential rewards to be reaped from aggressive marketing.
- (3) Program-subsidized workforce development activities (conducted by the program sponsor or by independent training organizations) are common and appear to be increasing.
- (4) A key barrier to establishing and expanding PV training is the expense of the facilities and equipment necessary to support a hands-on learning environment. Key barriers in the professional development of PV installers are limited field training and job placement opportunities.
- (5) The PV programs reviewed use a variety of methods to ensure quality control, including: program-specific installer requirements; state-specific installer licensing requirements; inspections of up to 100% of systems installed; and adjustment of incentives based on expected or actual performance. Typically, installer requirements offset other methods of ensuring quality, with more stringent installer requirements coupled with less stringent other methods, or vice versa.
- (6) Half of the reviewed PV programs have installer requirements. Installer requirements—either imposed by the program or the state, through licensing—appear to be increasing.

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8. REFERENCES

- (1) L. Baker, "Green-collar jobs: Can cleantech put America to work?," *Sustainable Industries*, September 2007, p. 23
- (2) GDS Associates, Inc., *Program Theory and Logic Model Activities for the New York Energy SmartSM Program: End-Use Renewables Program*, prepared for the New York State Energy Research and Development Authority, 2004
- (3) KEMA, Inc., *Emerging Renewables Program Systems Verification Report, 2004-2005*, prepared for the California Energy Commission, CEC-300-2005-019, 2005
- (4) R. Margolis and J. Zuboy, *Nontechnical Barriers to Solar Energy Use: Review of Recent Literature*, prepared for the National Renewable Energy Laboratory, NREL/TP-520-40116, September 2006
- (5) Research Into Action, Inc., *Process Evaluation: End-Use Renewable Photovoltaic (PV) Incentive Program*, prepared for the New York State Energy Research and Development Authority, 2005
- (6) Research Into Action, Inc., *Process Evaluation: Photovoltaic Program Component of the Clean Energy Infrastructure Research and Development Program*, prepared for the New York State Energy Research and Development Authority, 2007
- (7) Research Into Action, Inc., *Process Evaluation: Workforce Development and the Photovoltaic Program Component of the Clean Energy Infrastructure Research and Development Program*, prepared for the New York State Energy Research and Development Authority, 2008, forthcoming
- (8) J. D. Wolfe, "Training the Renewable Energy Team: The looming shortage of trained workers threatens to slow the booming renewable energy industry," *Solar Today*, Vol 21, No. 5, September/ October 2007, p. 24