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FLORIDA PHOTOVOLTAIC BUILDINGS PROGRAM Status Report, Observations and Lessons Learned

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Publication Number

FSEC-CR-1150-01

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FLORIDA PHOTOVOLTAIC BUILDINGS PROGRAM

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FLORIDA PHOTOVOLTAIC BUILDINGS PROGRAM

Status Report, Observations and Lessons Learned

March 1, 2000

EXECUTIVE SUMMARY

INTRODUCTION

The Florida PV Buildings Program is a collaborative effort among the Florida Energy Office of the Department of Community Affairs (FEO/DCA), Sandia National Laboratories, the photovoltaic industry, nine end-user groups, and the Florida Solar Energy Center. It complements the federal government's Million Solar Roofs Initiative (MSRI), which calls for one million solar installations in the U.S. by 2010. Based on the present level of activity and assuming a relatively small growth rate, it is estimated that approximately 140,000 solar pool and domestic water heating systems will be installed in Florida by 2010, as well as 20,000 utility-interactive rooftop photovoltaic systems.

The market for utility-interactive rooftop photovoltaic systems is expected to be largely subsidized until significant price reductions are achieved. Revenue sources include:

- *Photovoltaic system buy down* (from January 1999 through December 2001), in which funds are being used to buy down the cost of PV system installations and for performance monitoring. Buy-down funds are being distributed in two ways: 1) contract awards for projects involving multiple system installations based on proposals or letters of interest submitted in response to a formal solicitation, and 2) rebates for single system installations made directly to PV system suppliers for installations that meet program requirements. The supplier must apply for the rebate before installing the system.
- *Green pricing* (present to 2010 and beyond) is the linchpin of the entire Florida PV Buildings Program and involves marketing, promotion, public awareness campaigns and solar project implementation. Green pricing is long term in nature, can cover all system installation costs, and will produce significantly more revenue than is available for buy downs. Its success depends on active participation by investor-owned utilities, municipal utilities and rural electric cooperatives.
- *Buy up by end users* is dependent on the threshold price at which PV technology becomes economically attractive to various end users. This price might be \$3 per watt for a municipal electric utility; \$4 per watt for many energy conscious homeowners; and \$5 per watt for a large number of government agencies. This threshold price can only be estimated until much better data is available on costs for interconnection, insurance, operation and maintenance, etc., as well as data confirming the value to the end user of PV electricity produced over time.
- *Contracts, grants and other subsidies*, including long-term, low-interest financing. Examples include the UPVG TEAM-UP awards and a host of funded activities from the Florida Energy Office.

During the period of subsidization, the Florida program chooses to invest both time and money in learning and preparing for new markets based on value. Learning is achieved via application experiments with nine end-user groups, which include municipal utilities and rural electric cooperatives, commercial building owners and operators, government and public agencies, school and church organizations, manufactured building corporations, investor-owned utilities and energy service companies, commercial roofing companies, builders and developers, and homeowners and buyers. Of the nine end-user groups, utilities are encouraged to play leading roles in program implementation. Emphasis has been placed on reducing installation and other non-module costs; determining the impact of distributed generation on the utility grid; designing energy-efficient PV building systems; optimizing uninterruptible building power systems; evaluating desirable and cost-effective array-roof configurations; identifying better ways of integrating PV materials into buildings; and improving the reliability and durability of alternative inverter configurations. To improve and manage the quality of rooftop photovoltaic installations, FSEC provides comprehensive technical support services and offers training tied directly to the implementation of specific projects.

The data and information from the application experiments will allow different end users to assess the value of various photovoltaic building applications. It is important to note that the value many end users associate with photovoltaic systems may not be strongly tied to economics. Examples include the value associated with reduced greenhouse gases and a cleaner environment; the value of less dependence on imported and depletable fossil fuels; the value of a green image; the value of improved public relations; the value of having uninterruptible building power; and, in the case of utilities, the value of providing customers with the option to choose renewable resources to meet a portion of their energy needs. The data and information collected will help market-focused organizations prepare value propositions for a variety of PV building applications. End users will be much better prepared to establish performance expectations and make decisions concerning photovoltaic building systems. They will also have much better data upon which to base life cycle cost analyses and business planning.

SUMMARY OF OBSERVATIONS AND LESSONS LEARNED

This section summarizes the observations and lessons learned in implementing the Florida Photovoltaic Buildings Program after approximately two years of operation.

Conducting Application Experiments for Targeted End-User Groups

- The application experiment with the City of Lakeland combining a rooftop photovoltaic (PV) system, super energy-efficient building design, and peak load reduction is producing excellent data, has benefitted the municipal utility and the builder, and appears to be a potential high-value application for homeowners, commercial building owners and operators, and builders and developers.
- Almost all of the application experiments conducted thus far have involved utility-owned, distributed generation and should be useful in generating statistically-significant data for business planning purposes.
- At present, the most appealing application experiments involve distributed generation with utilities

owning, operating and maintaining PV systems on schools. These projects typically involve introducing solar and renewable curricula into the classroom.

- Three application experiments involving flexible photovoltaic laminates bonded to metal roofing are underway and should provide useful information on performance, aesthetic appeal, and alternative approaches to bonding.
- Of the nine targeted end-user groups, municipal utilities have shown the greatest interest in participating in the Florida program thus far. Because photovoltaic technology and grid-tied applications are new to many of them, project development and technical assistance have proven to be very beneficial in eliciting their participation.
- The present commitment from municipal utilities in Florida is for over 120 PV system installations with a total capacity of nearly 400 kW. These commitments are expected to increase dramatically in the near future.
- Participation of the four investor-owned utilities has been limited but is expected to increase over the next couple of years. (Note: Investor-owned utilities operate under many more constraints than municipal utilities and rural cooperatives. Constraints include state regulation, responsibilities to their shareholders and, in some cases, the size and management structure of the organization.)
- A better approach needs to be used in developing application experiments with commercial building owners and operators than that used so far, which has involved working with energy and facilities managers. Whereas this group is very responsive to energy efficiency, conservation, and economically attractive renewable technologies, they are less responsive to grid-tied PV because of high costs and because their jobs are to reduce costs. Only two commercial systems have been installed to date.
- Greater effort needs to be expended in working with government agencies. Only two systems have been installed for government agencies (one in Pennsylvania).

Creating Effective Partnerships and Identifying Financial Resources

- The principal organizations involved in the Florida Photovoltaic Buildings Program are the Florida Energy Office of the Department of Community Affairs, the U.S. Department of Energy through Sandia National Laboratories, nine end-user groups, the photovoltaic industry, and the Florida Solar Energy Center.
- All organizations played key roles in developing the program plan and providing the technical, financial, management and organization resources necessary to implement the plan.
- The key to the early success of the program has been the role of the Florida Municipal Electric Association (FMEA) and participating utilities. Through the SunSmart Community Partnership, FMEA has been the focal point for communication among its member utilities, and for getting cooperation in marketing green pricing programs. Presently, eight municipal utilities have committed to PV projects involving over 100 systems. (For a description of SunSmart, see the section **Creating Partnerships and Identifying Financial Resources**.)
- The leveraging of state funds, which were provided by the Florida Energy Office of the Department of Community Affairs, has worked well to kick start the program. For every dollar the state invested, four dollars were raised by the partners.
- The process of issuing a Request for Proposals (RFP) led to contracts of \$100,000 each with two

different municipal utilities. However, a disadvantage of this approach was that (once the RFP was issued) it did not allow FSEC to assist organizations that were interested in participating but did not have the necessary resources or experience to prepare a competitive proposal.

- Because of the limitations of the RFP approach, FSEC more recently issued requests for Letters of Interest. This approach is less intimidating and one that is recommended.
- The Florida Power & Light Company green power solicitation was successful in raising sufficient funds for the installation of a 10-kW grid-tied system at their Martin County facilities.
- Other green programs are under consideration and development by utilities in Florida.
- Very little response has been received to the FSEC rebate program, which is designed to buy down the costs of individual installations at a rate of \$2 per watt. Given problems related to interconnection requirements and prices, this is understandable.
- As a strong participant in the Florida program, the City of Lakeland was successful in their proposal to the Utility Photovoltaics Group (UPVG) TEAM-UP program. Seventeen systems were installed on portable classrooms in Polk County.
- The Legal Environmental Assistance Foundation (LEAF) is working with all the investor-owned utilities, the Florida Public Service Commission, FMEA and community groups to get them to make greater investments in renewable technologies, including photovoltaics. These efforts are complementary to the goals of the Florida Photovoltaic Buildings Program and should lead to many more system installations.
- The solar industry expressed serious concerns about the initial requirement that installed system prices be limited to \$7 per watt. These concerns were well founded given the high transaction costs and variations in the PV system packages that were being offered. This requirement has since been dropped.

Overcoming Barriers

- The single greatest barrier to the development of a market for customer-owned, grid-tied PV systems is the problem associated with cumbersome and inappropriate interconnection requirements, which include technical, insurance, metering and billing issues.
- Via workshops and direct communication, FSEC believes it has been successful in communicating the relevant technical information regarding personnel safety, equipment protection, power quality, and reliability of service to utilities.
- The response of Florida utility companies to the IEEE P929 has been documented and has been overwhelmingly favorable.
- Delays of nearly a year in getting IEEE P929 approved by the IEEE Standards Board may have jeopardized the prospects of establishing appropriate interconnection requirements in Florida within a reasonable time frame.
- Rather than concerns over the technical issues, some utilities have stated that their most serious concerns are over precedence setting and liability.
- Some utilities, both in Florida and throughout the U.S., are using the liability insurance issue to stymie PV system installations.
- Utilities have also expressed major concerns about net metering and appear unwilling to yield.
- Net metering should be viewed as an incentive (possibly only an early incentive) to promote the

- development of renewable technologies, the use of which is in the long-term interests of society.
- Direct sales of multiple systems to utilities from photovoltaic manufacturers should help to bring costs down.
- The standardizing and packaging of PV systems should help to bring installed prices down. There is still room for significant improvements in the packaging of systems.
- At the present time, transaction costs for individual sales of grid-tied PV systems are very high and make the technology relatively unattractive to many potential end users.
- Installation costs have been reduced significantly by the City of Lakeland. After completing FSEC's training course and performing multiple installations of the same configuration, Lakeland installed their last ten systems for under \$1/ Watt (installation labor costs only).

Ensuring and Improving the Quality of System Installations

- The requirement that photovoltaic modules be tested and rated appears to be a reasonable requirement because of some large discrepancies between manufacturers' ratings and actual measured performance. Large discrepancies lead to poor designs and dissatisfied customers.
- The measured performance of some manufacturers' modules were close to their *nominal* nameplate ratings. However, for some modules, the measured values were actually below *guaranteed* levels of output.
- Another important reason for requiring FSEC-approved module ratings is because of the Florida buy-down program, in which awards are based on power ratings.
- Module ratings, based on FSEC testing, have been validated using round-robin testing of the same groups of modules by Sandia National Laboratories and the National Renewable Energy Laboratory (NREL).
- The documentation of module test results, by FSEC and other laboratories, needs to be improved, and the development of associated procedures and databases is being pursued.
- In general, system designs are poorly documented by suppliers. Poor documentation of designs invariably leads to problems over time. This situation is unacceptable with any PV system, but especially so when the system is connected to the utility grid. Consequently, FSEC requires system design review and approval to receive buy-down funds.
- The Siemens Earthsafe systems were the first to be reviewed and approved by FSEC. Others are in the process of being reviewed.
- The design review and approval process is new and needs to evolve, including better definition of committee makeup, approval criteria, operating procedures, communications with industry, notification, reporting, website information, and procedures for dealing with design deficiencies.
- Training programs have been developed for PV system designers, installers and code officials. Although significant progress has been made in terms of materials and hardware, FSEC is continually trying to improve the content, organization, delivery and audience participation (practice, exercises, quizzes, etc.).
- The requirement for installers to take an authorization examination (to receive buy-down funds) recognizes that grid-tied PV applications are new to most solar and electrical contractors, and is an attempt to help ensure compliance with all relevant articles of the National Electrical Code. The number and type of questions for the examination need to be expanded, more figures and illustrations

- need to be introduced, and a study guide with sample examination questions needs to be developed.
- FSEC also requires that installed systems pass acceptance testing before buy-down funds are awarded. This requirement has proven to be effective in ensuring that the installed system is consistent with the design specifications, that the systems and components are functioning properly, that electric power output is consistent with predictions, and that the system installation complies with local codes.
- Acceptance testing is especially important because code officials are unfamiliar with PV applications, and the acceptance tests help provide an added degree of assurance of code compliance. (Note: FSEC plans to combine acceptance testing with on-site instruction for code officials.)

Providing Sufficient Information for Business Planning and Decision Making

- Collecting performance data is necessary to get an accurate measure of the economic value and benefits of PV building systems.
- FSEC believes it is important to have some level of monitoring on every grid-tied PV system, with the most common level being the monitoring of the energy output of the inverter in kilowatt-hours. This can be done with a common utility watt-hour meter or using the recording capability of some of the new inverter designs. In either case, this information should be collected on a monthly basis.
- In addition to simple metering of inverter output in kilowatt-hours, FSEC uses two more sophisticated levels of monitoring, one designed to meet the primary needs of utilities and one designed to meet the needs of the research and design communities.
- Utility-level monitoring yields time-of-day electric power production and solar irradiance data, and is useful in evaluating the overall impact of distributed generation and its impact on meeting peak demand.
- In most cases, utilities are more interested in power production versus time, especially during the peak demand period, than in kWh production.
- Homeowners and other end users without time-of-day electricity pricing are usually only interested in energy production and the associated savings, and are not particularly interested in power production versus time.
- In addition to measuring performance, it is important to develop qualified databases documenting the costs of buying, installing, interconnecting, operating and maintaining the system.
- Cost-benefit analyses, based on the combination of real performance and reliability data collected over a sufficient period of time, are needed by business planners, investors and consumers for value assessments and prudent decision making.

Sharing Information, Learning and Improving

- It is important to learn quickly from both successes and failures so the former can be replicated and the latter avoided. Modern telecommunications, especially the Internet, should be employed to make information as readily accessible as possible and accelerate the learning process.
- The solar and renewable energy curricula, teaching materials, and teacher training activities used in Florida have been well received by the educational community and efforts in these directions should be expanded.

- The creation of an advisory committee to provide guidance on the implementation of the Florida Photovoltaic Buildings Program has been recommended by the national laboratories but has not yet been established.
- The Photovoltaic Systems Data Network has proven to be extremely useful to both the research community and the user sector. It is continuously being updated.
- Plans call for an annual review of the Florida Photovoltaic Building Program for all Florida stakeholders, the U.S. Department of Energy and regional offices, the national laboratories, other states and interested parties.

FLORIDA PHOTOVOLTAIC BUILDINGS PROGRAM: DESCRIPTION AND STATUS

UNDERLYING ASSUMPTIONS AND BASIC PREMISES

The Florida Photovoltaic Buildings Program is based on the following underlying assumptions and basic premises:

- Photovoltaic technology has the potential to make a significant contribution to electric power production in Florida and the U.S. in the twenty-first century.
- Emphasis should be placed on identifying potential end users of the PV technology and delineating high-value applications for each end user, especially for the grid-tied market.
- The development of a sustainable market for grid-tied PV building applications depends on significant price reductions for system installations or equivalent subsidies, and on the removal of other major barriers to commercialization.
- It is important to meet or exceed customer and end user expectations for PV building applications. This requires consistent success in implementing a large number of solar projects.
- The value of PV applications must be readily apparent to potential end users. This requires information and statistically-significant data based on actual experiences.
- For broad acceptance by the building community, new building-integrated products that are attractive and easily assimilated into the building construction process must be developed.
- Widespread markets for grid-tied photovoltaic systems will develop most rapidly if the technology is accepted and embraced by the electric utility industry.
- Regardless of economic value, customers should be able to choose photovoltaic or other renewable energy technologies to meet a portion of their energy needs.

PROGRAM GOALS AND OBJECTIVES

The primary goal of the Florida Photovoltaic Buildings Program is to establish a solid foundation for a sustainable market for grid-tied systems in Florida. To support this goal, the program has adopted the following objectives:

- Create effective partnerships.
- Generate sufficient revenue and financial resources to support and subsidize applications.

- Overcome major barriers to commercialization.
- Develop a diversity of high-value applications for potential end-user groups.
- Ensure and improve the quality of installed systems.
- Provide sufficient information and data for business planning and decision making.
- Share information, accelerate learning, and improve products and services.

DEVELOPING THE CORE TEAM

The core team involved with implementing the Florida Photovoltaic Buildings Program consists of the following organizations:

- The Florida Energy Office of the Department of Community Affairs
- The U.S. Department of Energy through Sandia National Laboratories
- Nine end-user groups
- The photovoltaic industry and the Florida Solar Energy Industries Association
- The Florida Solar Energy Center.

IDENTIFYING APPLICATIONS FOR VARIOUS TARGET GROUPS

The Florida Photovoltaic Buildings Program has identified nine groups as potential end users of photovoltaic systems on buildings:

- Municipal utilities and rural electric cooperatives
- Commercial building owners and operators
- Government and public agencies
- School and church organizations
- Manufactured building corporations
- Investor-owned utilities and energy service companies
- Commercial roofing companies
- Builders and developers
- Homeowners and buyers.

Of these groups, the municipal utilities, through the Florida Municipal Electric Association and the SunSmart Community Partnership, have played key roles in implementing the Florida program. The City of Lakeland Department of Electric and Water Utilities was the first active participant and has the largest number of rooftop PV installations, as well as utility-owned solar water heating systems. The City of New Smyrna Beach Utilities Commission has made a major commitment in terms of numbers of systems, will be offering very low-priced systems to their customers, and has attractive financing and service packages available. The JEA (formerly Jacksonville Electric Authority) has made a strong initial commitment to PV applications, including many systems for schools, and has plans to significantly expand their long-term commitment to renewable energy applications. Because municipal utilities are publicly owned, they are strongly responsive

to their customers and community, and are less constrained by regulatory requirements than investor-owned utilities.

Often projects involve more than one end user. For example, the Lakeland residential system projects involved the City of Lakeland, Rick Strawbridge Builders and the homeowners. The Lakeland portable classroom systems involved the utility and the Polk County School District.

The Florida program involves nine different rooftop applications, which are referred to as *application experiments*. These are not experiments with unproven technologies. Rather, they are simply different PV installations from which performance and reliability data is being collected over time so that potential end users and investors will have sufficient information for business planning and decision making. The nine application experiments involve:

- Distributed generation
- Community developments
- PV and energy-efficient buildings
- Fault- and weather-tolerant buildings
- Durable array-roof configurations
- PV laminates bonded to metal roofing
- Building-integrated photovoltaics (BIPV)
- Factory-installed PV systems
- Alternative inverter configurations.

The following table is a compilation of activities currently taking place or planned for next year as part of the Florida Photovoltaic Buildings Program. The table is divided into target groups and individual project partners.

| Target Group | Involvement | Total kW | No. of systems |
|---|--|----------|----------------|
| Municipal Utilities | | | |
| City of Lakeland Electric & Water Utilities | <i>Utility-interactive PV Residences.</i> As part of a research project, FSEC assisted Lakeland in the installation and monitoring of 3 PV systems on homes in Lakeland, Florida. One of the homes, the Lakeland PV-RES house, combines the best of both energy-efficient building and solar technologies to create an energy-efficient, power-producing dream home. More information about this project is available from our website, www.fsec.ucf.edu . | 7.8 | 3 |

| Target Group | Involvement | Total kW | No. of systems |
|--|---|----------|----------------|
| City of Lakeland Electric & Water Utilities | Portable Power PV Classrooms. As part of a Utility-Photovoltaic Group (UPVG) project, FSEC provided funds and technical assistance to Lakeland for the installation of PV systems on portable classrooms in Polk County. The systems will be owned by the utility and used as educational tools by the schools. FSEC is providing installation training to utility staff members and other potential PV installers. | 30.6 | 17 |
| Utilities Commission, City of New Smyrna Beach | Green Utility Program. The City of New Smyrna Beach is providing its customers with two options for participating in its solar program. The City will install PV on public buildings as part of its green pricing contribution program. Residents may elect to pay \$5 or \$10 dollars per month for a currently unspecified time period to participate in the program. The City of New Smyrna Beach also offers the option to buy a PV system through its own buy-down program, which includes a customer loan with extremely favorable rates. Customers who elect to purchase a system will pay less than \$2 per installed Watt (dc). To date, one public PV system and one privately-owned PV system have been installed as part of this program. FSEC provided buy-down funding for this project. | 152 | 60 |
| JEA (formerly Jacksonville Electric Authority) | Solar on Schools. JEA is installing utility-interactive PV systems on 22 schools and 2 facility buildings in Duval County. The utility will maintain ownership of the systems, but will allow the power produced by the systems to be credited to each school. Currently, 5 PV systems have been fully or partially installed as part of JEA's program. FSEC provided buy-down funding for this project. (Note: In January 2000, JEA announced its intention to install 2 MW of PV by 2007. Details have not been released.) | 96 | 24 |
| Florida Municipal Electric Association | SunSmart Community Partnerships Program (See GENERATING REVENUE). | 0 | 0 |
| Florida Municipal Power Association | FMPA has committed to assist its member utilities with the acquisition of PV hardware for community solar projects. | 0 | 0 |
| Gainesville Regional Utilities | Solar for Schools. GRU has committed to the installation of eight 4 kW PV systems on local area schools and two 4 kW PV systems on local government buildings. FSEC will assist Gainesville in developing an implementation plan for the program and provide GRU with curriculum materials and teacher training. FSEC will also provide GRU with buy-down funds once these systems are installed. | 40 | 10 |

| Target Group | Involvement | Total kW | No. of systems |
|---|---|-----------------|-----------------------|
| Ft. Pierce Utility | <i>Solar on Public Buildings.</i> Ft. Pierce has recently committed to the installation of at least 10 kW of PV as part of a green pricing program. | 10 | 2 |
| City of Tallahassee | <i>Solar on Public Buildings.</i> Tallahassee has committed to the installation of a 10 kW PV system on a public aquatic gymnasium as well as an additional 50 kW on other public buildings as part of a green pricing program. FSEC will assist Tallahassee in developing an implementation plan for the program and provide them with buy-down funds once the systems are installed. | 60 | 10 |
| Orlando Utilities Commission | OUC has made an unspecified commitment to install grid-connected PV as part of a community green pricing program. | 0 | 0 |
| Subtotal for Municipal Utilities | | 396 | 126 |
| Investor-Owned Utilities | | | |
| Florida Power & Light (FPL) | <i>Technical Assistance.</i> FPL recently signed a formal agreement with the Legal Environmental Assistance Foundation (LEAF) to investigate the feasibility of a green energy program in its territory. If its research indicates that a green energy program is appropriate, it will go forward with the program and include a minimum 150 kW of PV for every 10,000 subscribers. FSEC intends to offer PV technical support to FPL in the event that they carry out this green energy program. | 150 | TBD |
| Tampa Electric Company (TECO) | <i>Technical Assistance.</i> TECO recently signed a formal agreement with LEAF to investigate the feasibility of a green energy program in its territory. If its research indicates that a green energy program is appropriate, it will go forward with the program. Tampa Electric's tentative objective is 50 kW of PV by the year 2004. FSEC intends to offer PV technical support to TECO in the event that they carry out this green energy program. To date, TECO has requested buy-down funds for one utility-owned PV system that has been installed on a museum. | 50 | TBD |
| Gulf Power | <i>Technical Assistance.</i> Gulf Power has recently signed a formal agreement with LEAF to provide the results of a recently tested green energy research project in its territory. If its research indicates that a green energy program is appropriate, it will finalize the PV rate rider currently under development and may include as much as 1 MW of PV power by the year 2004. FSEC intends to offer PV technical support to Gulf Power in the event that they carry out this green energy program. | 1,000 | TBD |

| Target Group | Involvement | Total kW | No. of systems |
|--|---|-----------------|-----------------------|
| Florida Power Corporation (FPC) | <i>Technical Assistance.</i> FPC recently signed a formal agreement with LEAF to investigate the feasibility of a green energy program in its territory. If its research indicates that a green energy program is appropriate, it will go forward with the program. The program will include a minimum 150 kW of PV by 2004 if the program obtains 10,000 subscribers. FSEC intends to offer PV technical support to FPC in the event that they carry out this green energy program. Included in this agreement is an 8 kW project that involves PV on manufactured buildings. FSEC is currently assisting FPC with this portion of its R&D effort. | 150 | TBD |
| Subtotal for Investor-Owned Utilities | | 1,350 | TBD |
| Commercial Building Owners | | | |
| The Nature Conservancy/ Disney Wilderness Preserve | <i>The Nature Conservancy/Disney Wilderness Preserve.</i> FSEC is providing technical support to FPC and the Nature Conservancy for this project, which includes two arrays of USSC PV laminate modules bonded to standing seam metal roofs. FSEC is also providing monitoring assistance and data collection instrumentation for the project. | 7 | 2 |
| Energy Managers' Workshop '99 | FSEC hosted a workshop for commercial energy managers in March 1999. The workshop attracted more than 60 attendees with interests in PV and energy efficiency for buildings. FSEC provided detailed presentations from national energy experts and offered technical support services to attendees. Many companies, including Burger King Corporation, Eckerd Drugs, and Outback Steakhouse, showed interest in pursuing PV projects in the near future. | 0 | 0 |
| Energy Managers' Workshop 2000 | FSEC hosted a second workshop for energy managers that built on the interest generated from the previous year's event. Companies such as Staples and Jack-in-the-Box indicated a great deal of interest in pursuing PV. It is anticipated that several new commercial PV buildings projects will result, and will likely include participation of FMEA member utilities. | 0 | 0 |
| Subtotal for Commercial Building Owners | | 7 | 2 |
| Government Agencies | | | |

| | | | |
|-------------------------------------|--|-----------------|-----------------------|
| Alachua County | <i>Kanapaha Botanical Gardens Summer House.</i> This collaborative project involves the design and installation of an energy efficient PV exhibition building for a local botanical garden. This project is of particular interest to the local utility, Gainesville Regional Utilities (GRU), and will be the first utility-interactive PV system tied to the municipal's grid that is not owned by the utility. | 3.2 | 1 |
| Target Group | Involvement | Total kW | No. of systems |
| State of Pennsylvania | <i>Technical Support Services/Training.</i> FSEC provided PV installation training for a low-income housing weatherization project in the State of Pennsylvania. | 7.2 | 1 |
| National Park Service | <i>Technical Support Services.</i> FSEC provided technical support services to NPS for PV projects in the Southeastern U.S. FSEC recently provided these services to a park site at Horn Island, Mississippi, and has plans to assist with a stand-alone PV project at an observation tower in Everglades National Park later this year. FSEC also assisted Sandia National Laboratories in preparing a renewable energy assessment for Katmai National Park in Alaska. | - | - |
| Florida Counties and Municipalities | <i>SunSmart Local Government Partnerships.</i> FSEC plans to expand its existing SunSmart program to a second phase that will provide training and project development assistance to local governments in Florida. FSEC plans to partner with the Florida League of Cities and the Florida Association of Counties to complete this project. This project has not yet received funding. | - | - |
| Schools and Churches | | | |
| Brevard County | FSEC is working with the Brevard County School Board to develop a Solar for Schools program. This program will include PV system installations, as well as curriculum materials and teacher training for each participating school. FSEC is still awaiting final approval of the project and resolution of interconnection issues before proceeding with a proposal to fund this project. | 8 | 8 |
| Duval County | Through its work with JEA, FSEC is assisting Duval County Schools by providing educational materials to 24 high schools selected to receive PV systems on their roofs. Teacher training and a high school level solar energy textbook will be included. | - | - |

| | | | |
|-------------|---|---|---|
| Polk County | In conjunction with the Lakeland portable classrooms project, FSEC and FlaSEREF have provided educational materials and teacher training to Polk County employees on solar energy in schools. On January 29, 2000, members of FlaSEREF, the City of Lakeland, and FSEC held a one-day teacher-training workshop on solar energy for 26 Polk County educators representing 11 different schools. The workshop was well received. | - | - |
|-------------|---|---|---|

| Target Group | Involvement | Total kW | No. of systems |
|--------------------------------|--|---------------|----------------|
| Builders and Developers | | | |
| PV Rebate Applicants | FSEC currently offers a \$2/Watt rebate for installing utility-interactive PV systems on buildings in Florida (See Homeowners section). In addition to this amount, installations on model homes receive another \$2000. FSEC is currently working with the City of Lakeland and two builders in Polk County to develop three model homes that will contain both PV and solar thermal systems. These model homes are expected to be completed by September 2000, and will be eligible for the additional \$2000 in rebate funds. | 5.6 | 3 |
| Homeowners and Buyers | | | |
| Homeowners | Information Dissemination. FSEC receives numerous requests for information about photovoltaics from Florida homeowners each month. FSEC has created a question and answer primer, which is available on our website, to handle many of these questions. FSEC also offers an enormous links page for those individuals needing more information about a particular topic or PV manufacturer. More detailed requests are handled personally by FSEC staff. | - | - |
| Homeowners | Rebate Funds. Rebates to system suppliers for single system PV installations on Florida buildings are available from FSEC. The rebate is offered at a rate of \$2/Watt up to a maximum award of \$8,000 without battery storage, and \$8,500 with battery storage. Although this rebate is given directly to the system supplier, the intent is for the supplier to pass the savings on to the customer. To date, two applications have been received from homeowners. | 4 | 2 |
| TOTALS | | 1,781* | TBD* |

* Contingent upon utility customer response.

CREATING PARTNERSHIPS AND IDENTIFYING FINANCIAL RESOURCES

SunSmart Community Partnerships Program

Through a partnership among FSEC, the Florida Municipal Power Association (FMPPA), the Florida Municipal Electric Association (FMEA) and its member utilities, the SunSmart Community Partnerships Program provides the opportunity to educate and offer solar technologies to over one-million electric ratepayers in Florida.

The ultimate goal of the SunSmart Community Partnerships Program and its companion programs is to

develop long-term sustainable markets for solar energy systems in Florida. Specifically, SunSmart aims to enhance prospects for the successful deployment of a sustainable solar market in Florida by developing strong partnerships within local communities throughout the State. These partnerships are molded around FMEA member utilities, and may include interactions with local businesses, schools, builders and developers, homeowners, government organizations and special-interest groups. Public outreach and educational activities focus on revealing the value of solar energy technologies to each partnership group. The program is administered cooperatively among its three main partners, FEO/DCA, FSEC, and FMEA.

The SunSmart Community Partnerships Program will run for a period of two years, during which it will increase community awareness of existing local green power programs, educate the public on the merits of solar energy in Florida, provide additional labor and resources to program participants, coordinate and streamline marketing activities between participating municipal utilities and link potential community and end-user groups to local green power activities. To date, five municipal utilities in Florida have made formal commitments to the program and are currently taking steps to pursue green pricing programs in their service areas.

Florida Photovoltaic Buy-down Funds

Buy-down funds for photovoltaic (PV) systems on buildings in Florida are being distributed by the Florida Solar Energy Center (FSEC) under contract with the Florida Energy Office, Department of Community Affairs (FEO/DCA). The buy down is an important part of the Florida Photovoltaic Buildings Program, which is a collaborative effort among FEO/DCA, U.S. Department of Energy, Sandia National Laboratories and FSEC. The buy down is scheduled for three years, ending December 31, 2001. FEO/DCA has provided \$525,000 to be distributed through this program. The buy-down rate is \$2 per installed Watt and can only be used for the purchase of photovoltaic hardware. All funds are leveraged with outside funding. FSEC reimburses buy-down participants at the \$2/Watt rate only after the PV hardware has been purchased. Invoices are required in order to receive the reimbursement. This money is being dispersed in the following ways:

- \$77,000 of cost sharing for the UPVG TEAM-UP contract with the City of Lakeland Department of Electric & Water Utilities for PV systems on portable classrooms.
- An open request for proposals for photovoltaic buildings projects (two contracts have been issued for a total of \$200,000)
- A less formal request for applications for utility photovoltaic buildings projects (agreements have been made with the City of Tallahassee and Gainesville Regional Utilities)
- Rebates to PV system suppliers.

To date, FSEC has leveraged funds through its \$2 per Watt buy-down program with three municipal utilities in Florida. Below is a table of the total funds dedicated to PV projects through the Florida PV Buildings Program.

| Utility | FSEC Contribution | Leveraged Contribution | Total Project Cost |
|---------------------------|--------------------------|-------------------------------|---------------------------|
| Lakeland Electric & Water | \$77,000 | \$249,000 | \$326,000 |
| JEA | \$100,000 | \$233,828 | \$333,828 |
| New Smyrna Beach | \$100,000 | \$645,278 | \$745,278 |
| Totals | \$277,000 | \$1,128,106 | \$1,405,106 |

Florida residents, developers, government agencies, utilities or commercial businesses who choose to install solar photovoltaic (PV) equipment on buildings in Florida may qualify for FSEC's PV rebate. Presently, there is approximately \$130,000 available for rebate applicants.

Rebate amounts are based on the total dc power output of the PV array at standard test conditions (STC). Recipients are offered \$2 per installed peak dc Watt up to a maximum rebate of \$8000 for a typical grid-tied system. Larger rebates are available for systems on model homes (an additional \$2000) and those having battery back up (an additional \$500). Therefore, the maximum possible rebate is \$10,500.

The rebate application form must be completed by the solar contractor/installer. The rebate is then passed through to the customer from the installer. Applicants must submit the rebate form and required items before the installation has been completed. Prior to processing the rebate, the following items are required:

- A signed interconnection agreement with the local utility
- Copies of all mechanical and electrical drawings for the system
- An end-user agreement that permits system monitoring and data collection
- A copy of the invoice for the equipment purchase/installation fee showing system size, equipment type, etc. (systems should be at least 1 kW at STC)
- Proof that the installer has passed FSEC's installer authorization exam
- A copy of the system warranty (must be at least a 2-year warranty for parts and labor in addition to component warranties).

Once the system has been installed, an acceptance test of the system must be performed. Rebates will not be sent to the system installer/supplier until the system has passed the acceptance test. The following should be noted:

- Upon receipt of an invoice from the system supplier/installer showing the full price of the hardware and the amount due from FSEC based on the power output of the array, FSEC will issue the rebate to the installer/supplier.
- If the building owner is doing his or her own PV installation or purchasing the PV hardware from someone other than the installer, the rebate will be sent to the module supplier since FSEC can only

- issue rebates with an invoice showing proof of purchase.
- The installer/supplier should deduct the rebate amount from the total purchase price that the system owner would normally pay.
 - When preparing to make the PV hardware purchase or when choosing a system installer, the building owner or purchaser should provide the system supplier/installer with FSEC's contact information to expedite the rebate application process.

OVERCOMING BARRIERS

Interconnecting with the Utility Grid

A number of events have occurred over the past 18 months affecting future decisions on interconnection requirements in Florida. FSEC developed and offered a workshop on October 22, 1998 that dealt with barriers to PV interconnection with the utility grid. Based on the results of that workshop, FSEC submitted both a position paper and a model interconnection agreement to the Florida Public Service Commission (FPSC). On August 25, 1999, the FPSC hosted a staff workshop to address new questions and concerns related to the interconnection of PV systems to the grid. FSEC participated and later submitted comments that specifically addressed issues raised at the workshop. Specifically, FSEC addressed the effects of the current \$1 million liability insurance requirement on the economics of utility-interactive PV in Florida and utility concerns about safety. It is hoped that FPSC will take action on the interconnection issue sometime in early 2000. In late December 1999, FSEC published an updated position and recommendations on interconnecting small PV systems to Florida's electric utility grid. This document includes recommended requirements for standard and code compliance, liability insurance, metering and billing, and documentation.

ENSURING AND IMPROVING THE QUALITY OF SYSTEM INSTALLATIONS

To ensure and improve the quality of PV system installations, the Florida plan includes four requirements that must be met to receive buy-down funds, and four other technical support services that can help improve the quality of the products and the capabilities of the practitioners. The four requirements are:

- Testing and rating of PV modules
- Reviewing and approving PV system designs
- Examining and authorizing PV system installers
- Performing acceptance tests on installed PV systems.

The four technical support services include:

- Offering training programs for PV system designers, installers and code officials (and on-site

- assistance to code officials upon request)
- Providing assistance in developing technical specifications for procuring PV systems, including checklists and an easily applied template
 - Providing assistance with site surveys and analyses, including checklists
 - Testing, evaluating and troubleshooting existing PV system installations.

PV Module Ratings

FSEC characterizes the performance of photovoltaic modules using both indoor and outdoor testing. For indoor testing, module electrical output characteristics are determined using a new Spire SPI-SUN 660 flash simulator. FSEC is collaborating with Sandia National Laboratories and the National Renewable Energy Laboratory on round-robin testing of selected modules to ensure consistency in testing methods, translation algorithms, and results. Module ratings will not be posted until further testing has been completed and concurrence of manufacturers has been obtained.

Design Review and Approval

As part of the PV Buildings Program, FSEC requires system design review and approval. Siemens Earthsafe grid-connected system was the first design to be reviewed as part of the Florida Photovoltaic Buildings Program. FSEC plans to contact the PV module manufacturers directly to inform them of the design review and approval requirements and process.

Installer Training and Authorization

A week-long PV installation training course covers the design and installation of grid-connected photovoltaic (PV) systems, and involves the actual hands-on installation of typical systems in Florida. This program is intended for electric utilities, electricians and solar contractors, with an overall goal of developing "system-knowledgeable" certified professionals to help ensure the safety and quality of PV system installations.

The course format includes both classroom instruction and hands-on exercises. These exercises involve the complete step-by-step process of designing and installing grid-connected PV systems, and are intended to develop the participant's working knowledge of PV systems and equipment. An emphasis is placed on code compliance and accepted industry design and installation practices.

On the final day of the training program, an authorization exam is administered to system installers who wish to participate in the Florida PV Buildings Program. FSEC has developed this examination to assess the knowledge level of installers of utility-interactive photovoltaic systems, with emphasis on rooftop applications.

Installers who successfully pass this examination are "authorized" by FSEC to install utility-interactive photovoltaic systems as part of the Florida PV Buildings Program. Successfully passing the exam is a mandatory requirement for receiving buy-down funds or other PV system subsidies from FSEC. However,

it is not a requirement for installing non-subsidized systems as long as these installations are consistent with state laws and regulations.

The FSEC authorization of installers is in addition to requirements for licensure of solar or electrical contractors by the Florida Construction Industry Licensing Board, the Florida Electrical Contractors Licensing Board, or local government licensing authorities.

Since the course's inception, FSEC has administered seven authorization examinations as part of the Florida Photovoltaic Buildings Program. To date, 49 installers have successfully completed the training course and passed the examination. It is anticipated that approximately one course and examination will be offered each quarter depending on enrollment levels and available staff.

Acceptance Testing

An acceptance test is conducted after a PV system has been completely installed. Acceptance testing is used to determine if the installed system and its components are consistent with the approved design and are operating properly, and to compare performance with design expectations. An FSEC-developed checklist is used as an aid in conducting acceptance tests.

Technical Specifications

FSEC provides both forms and templates to greatly simplify the process of developing technical specifications for PV systems. The specifications may be used for procurement or as part of the documentation for design review.

Site Surveys

FSEC's site survey procedures and checklist are being used in conjunction with technical support activities in Florida. Currently, the New Smyrna Beach Utilities Commission has adopted the checklist as part of its selection process for homes that will receive PV systems through its new Renewable Energy Program.

System Test, Evaluation and Troubleshooting

As part of the Florida Photovoltaic Buildings Program, FSEC has developed a checklist for testing, evaluating and troubleshooting utility-interactive photovoltaic systems. The procedures and checklist have been used for PV installations in Lakeland and New Smyrna Beach, and for systems belonging to Florida Power and Light and JEA. The checklist simplifies the process of evaluating previously installed systems.

PROVIDING SUFFICIENT INFORMATION FOR BUSINESS PLANNING AND DECISION MAKING

Performance Monitoring

As part of the Florida Photovoltaic Buildings Program, all installed PV systems must include some form of performance monitoring. Monitoring options include: a) simple metering for monthly energy production, b) time-of-day production of PV electricity, and c) detailed performance data for PV system and building components and appliances. FSEC provides documentation on each level of monitoring equipment to simplify performance monitoring procedures. Each project is assessed to determine which level of monitoring is appropriate. All non-proprietary Florida PV Buildings Program data will be made available on the FSEC website from the web data page (www.fsec.ucf.edu/PVT/te/webdata.htm).

Reliability Data Collection

The purpose of collecting reliability data is four-fold: 1) to evaluate system performance and to identify and communicate problems to component manufacturers, system integrators, and installers, 2) to statistically measure component reliability (e.g., percentages of specific problems, percentages of failures, availability, downtime, mean time between failures), 3) to obtain a more accurate assessment of the operation and maintenance (O&M) costs of photovoltaic systems, and 4) to ultimately improve component and system reliability and lifetimes. FSEC requires that reliability data be collected for each of the PV Buildings Program's system installations. End users are asked to log events as soon as they are noticed and to perform various inspections on a monthly basis. The monthly reliability reports are then forwarded to FSEC and the appropriate databases are updated.

Clean Power Estimator

FSEC has acquired the rights to use an economic analysis software tool called *Clean Power Estimator* as part of the Florida PV Buildings Program. This tool, developed by Dr. Tom Hoff of Clean Power Research, allows an individual in Florida to calculate the potential costs or savings derived from the purchase of a PV or solar thermal system. The program uses robust economic modeling and incorporates comprehensive information relative to Florida, including local utility rates, irradiance levels and weather data. This program is available on the FSEC website (www.fsec.ucf.edu) for public use.

SHARING INFORMATION, LEARNING AND IMPROVING

Updating Databases and Sharing Lessons Learned

This effort involves disseminating the results and sharing the lessons learned from the Florida Photovoltaic Buildings Program. To be effective, the communication process must properly target all stakeholders, appropriately package the information to be disseminated, and deliver it in a timely manner. Toward this end, the following activities are planned:

- An annual review and update of the Florida Photovoltaic Buildings Program. In addition to the Florida stakeholders, representatives of the DOE regional support offices and other states interested in PV building applications will be invited.
- Continuous updating of the FSEC photovoltaic website. Technical publications and system and component databases will be added to the website as they become available. For some of the PV building application experiments, real time or near real time access to data will be provided.
- Presentations at selected solar and other appropriate forums. These forums include the annual NCPV photovoltaic performance and reliability workshops, Soltech, ASES conferences, and building-related meetings such as the annual Southeast Builders Conference. The table below describes events at which details and/or progress of the Florida PV Buildings Program were presented this year.
- Solicitation of advice and guidance from respected professionals. An advisory committee is planned to provide both programmatic and technical inputs. Programmatic inputs are used to make course corrections and re-target the PV Buildings Program. Technical inputs are requested for reviewing important documents, evaluating proposals, improving technical support services, and possibly assisting in some experimental designs. Members of the advisory committee will be respected professionals from the photovoltaic industry, Florida Energy Office, U.S. Department of Energy, Sandia National Laboratories, National Renewable Energy Laboratory, utilities, other state organizations, and selected end users.

| DATE | AUDIENCE | LOCATION |
|--------------------|---|-----------------|
| Ongoing | Public | FSEC website |
| October 4, 1998 | NCPV Performance and Reliability Workshop | Cocoa Beach, FL |
| November 16, 1998 | Florida Solar Energy Industry Members | FSEC |
| January 28, 1999 | Florida Energy Office | Tallahassee, FL |
| February 8-9, 1999 | PV System Design Workshop | FSEC |
| February 15, 1999 | Orlando Utilities Commission | Orlando, FL |
| February 16, 1999 | Florida Municipal Electric Association (FMEA) | FSEC |
| March 26, 1999 | Energy Managers' Workshop | FSEC |
| June 12, 1999 | Interstate Renewable Energy Council | Portland, ME |
| July 9, 1999 | Florida Utilities/Potential Partners | FSEC |
| July 23, 1999 | Southeast Builders Conference | Orlando, FL |
| September 29, 1999 | Florida Solar Energy Industries Association | FSEC |
| October 3, 1999 | UPVG Conference (Meeting with MSRI Representatives) | Tucson, AZ |
| October 27, 1999 | Annual FMEA Conference | Orlando, FL |

| | | |
|---------------------|--|-------------|
| January 18-21, 2000 | Florida Planning and MSRI Meetings; Workshop on Implementing a State or Community PV Buildings Program | FSEC |
| February 7-8, 2000 | Greenprints 2000 (Sponsor: Southface Institute) | Atlanta, GA |
| February 7-11, 2000 | Installing Grid Connected PV Systems Course | FSEC |