LOCAL CODES ISSUES RELATED TO PHOTOVOLTAIC SYSTEMS

Gobind H. Atmaram[1], Ph.D., Bill Brooks[2], P.E, Colleen M. Kettles[3], J.D., Stephen Barkaszi[1], P.E.
[1]Florida Solar Energy Center, Cocoa, FL. 32922, [2]Brooks Engineering,
[3]Florida Solar Energy Research and Education Foundation,

ABSTRACT

With wider utilization of photovoltaic (PV) applications, spurred by federal tax credits, state-funded and utility rebates, the local codes issues related to the installation of PV systems are becoming increasingly important. The Solar America Initiative's (SAI) Solar America Board of Codes and Standards (Solar ABCs) Project promotes development, implementation and dissemination of solar PV codes and standards in many different categories, and thereby enhances responsiveness, effectiveness and accessibility of codes and standards to U.S. stakeholders at all levels. The Solar ABCs project consists of four coordination panels, two implementation panels and four study panels. The Local Codes Study Panel investigates and deals with critical issues on local codes related to installation of PV systems, including permitting, fees, liability insurance, solar access, solar rights, ordinances, statutes, regulations and other related issues.

INTRODUCTION

The Local Codes Study Panel is led by the Florida Solar Energy Center (FSEC) and Interstate Renewable Energy Council (IREC) with direct assistance from the North Carolina Solar Center (NCSC). Three topics have been prioritized for one-year study by the Local Codes Study Panel with stakeholders' input: Expedited Permitting, Solar Access and Solar Rights Laws, High Wind Loads and Model Code.

Other issues such as building and electrical codes for seismic areas and liability insurance are likely to be referred to the Solar ABCs Steering Committee for Gap Analysis. Interconnection and Net Metering issues --- while they are local code issues --- are mostly dealt with by the Interconnection and Net Metering Panel of the Solar ABCs Project. Fire protection, management and mitigation are referred to the California Fire Marshals, and also to the Solar ABCs Building Electrical Codes Panel for consideration and for Gap Analysis.

EXPEDITED PERMITTING

The work on Expedited Permitting focuses on developing the procedures and recommendations to facilitate timely and efficient permitting of PV systems by building inspectors and other jurisdiction officials. These procedures and recommendations are mostly based on FSEC's *PV System Design Review and Approval* process and Brooks Engineering's *Inspector Guidelines for PV Systems*. FSEC's *PV System Design Review and Approval* process starts with the submittal of application, including the three-line electrical schematic of the PV system, information on PV modules, inverter, batteries and charge controller (if applicable), wiring and other balance-of-system (BOS) components, grounding scheme, and list of parts specifications. The *Design Review* focuses on the electrical schematic and checks for compliance with the National Electrical Code Article 690 and other relevant articles; use of industry-accepted design practices; UL 1703 listing and compliance with IEC 61215 (for crystalline silicon) or 61646 (for thin-film) qualification of modules; UL 1741 listing and IEEE 1547 compliance of the inverter; UL listing of batteries and charge controller (if used); grounding of modules, equipment and PV system; type, rating and lengths of dc and ac conductors; and rating and locations of fuses, circuit breakers and disconnect switches. If the PV system meets all the essential requirements, a *PV System Design Approval Certificate* is issued to the applicant. This certificate can be submitted to the local Authority Having Jurisdiction (AHJ), along with installer information to demonstrate that the PV system meets the necessary requirements and to facilitate timely and efficient permitting of the PV system.

The *Inspector Guidelines for PV Systems* provides a framework for speedy permitting for the installation of safe PV systems by providing instructions, a checklist, and a well-defined process for plan review. The *Inspector Guidelines* inform contractors what they need to include in their applications for permits, tell building officials what they need to review in the plans, and provide check-list for inspectors as to what they need to check at the site. Two sets of guidelines are included, since jurisdictions normally treat the process in two stages: The first set is for plan review prior to granting a permit for accuracy and completeness, and the second set is for field inspection to check for agreement with the approved plans and compliance with all relevant codes.

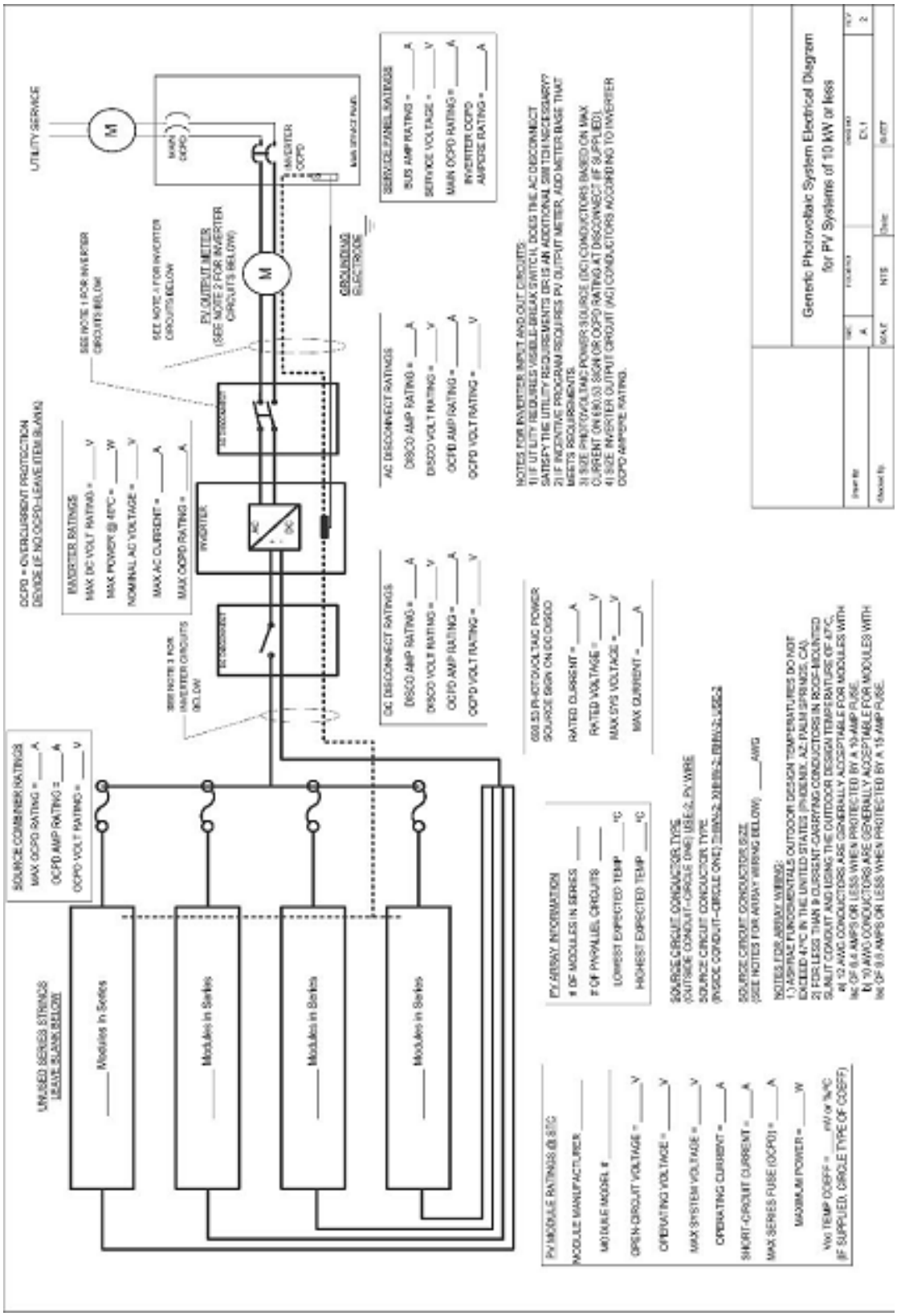

Fig. 1 Simplified Electrical Schematic of a PV System to Facilitate Building Inspectors with Code Compliance

The *Design Review* process is more comprehensive and inclusive, while the *Inspector Guidelines* provide relatively simplified approach, which is applicable to typical grid-connected, monopolar residential PV arrays in the range of 2 to 10 peak kilowatts (kWp) and without battery storage (over 80% of all residential PV systems fall in this category). Both the methods check for the compliance with the National Electrical Code (NEC), UL 1703 (soon to be replaced by UL/IEC 61730) listing of PV modules, UL 1741 listing of inverters, and use of industry-accepted design practices. However, the *Design Review* process also checks for PV module qualification testing per IEC 61215 or IEC 61646, and compliance with IEEE 1547 for grid interconnections of PV systems. In addition, it is also appropriate to different types of PV systems, including bipolar PV arrays, stand-alone PV systems, grid-connected PV systems with and without battery storage, and up to 100 kWp PV arrays. Neither of the two methods, directly covers the PV system mechanical design because of wide variability of local building codes, caused due to different structural, wind loading and seismic requirements in different geographical areas. However, the FSEC *Design Approval*, covers it indirectly with the prerequisite that the mechanical design be approved by a professional engineer for the FSEC certification.

The recommendations of the Expedited Permitting study encourage use of *Design Review* process for helping in timely and efficient approval of permits by building departments for installation of residential PV systems. They also support extending the approval authority beyond FSEC to other experienced agencies/ organizations, including Southwest Technology Development Institute (SWTDI), Brooks Engineering, BEW Engineering, Sandia National Laboratory and National Renewable Energy Laboratories (if they are willing), possibly to the NABCEP-certified engineers in future, and others. The study also recommends use of a simplified electrical schematic of PV system (with the specified requirements on the ratings of system components), as proposed by Brooks Engineering and shown in Figure 1, whenever applicable, to facilitate verification of code compliance by building inspectors and other jurisdiction officials.

SOLAR ACCESS AND SOLAR RIGHTS

The Solar Access and Solar Rights study involves a comprehensive review of solar access and solar rights laws in the United States. The study will identify favorable state solar rights and access statutes, develop a model statute covering solar access and solar rights for promotion in key target states, and will consider optional methods for protecting solar rights and access at federal, state, local and community association levels. At the federal level, a law modeled after the federal satellite dish law may be developed. At the state level, the model statute will address state and local practices for deployment of solar energy equipment. It will include prescriptive measures, such as community design, solar easements, permitting fees and processes, standards and certification (IEEE, IEC, UL, SRCC and FSEC). It will also address measures that limit the use of solar energy, such as restricting placement of solar panels on the roof, orientation requirements, screening devices and other prohibitive tactics.

At the local level, efforts will be focused on implementation and enforcement of state laws, adoption of solar codes and standards, and requirements that site plan review and approval include an element to address the current and future use of solar energy (such as solar easements, landscaping, building height restrictions and orientation). The efforts will also be directed towards reducing permitting fees, streamlining the approval process, and establishing distinct solar permits rather than separate electrical, plumbing and roofing permits.

Community associations are largely unregulated and have the authority as well as the responsibility to preserve property values, community interests and common property. Model language will be developed to include in private land use regulations, such as Covenants, Conditions and Restriction, Declarations and Bylaws, with criteria and recommendations for solar energy system design practices to maximize aesthetics. Condominiums may be addressed as a distinct entity, as they are typically more regulated by the states, and common property may be subjected to other specific issues.

The basis for this study is the premise that as demand for solar energy increases, institutional barriers must be removed to assure the rapid, smooth deployment of the technology. The issues identified above have been identified as current barriers to the installation of solar energy. For example, there is no inherent right to sunlight that is transmitted over another person's property. This rule of law was established by the courts in a Florida lawsuit between two Miami Beach hotels, and has held up over numerous challenges. As a result, any rights to sunlight must be established by law.

In addition, state and local governments have the authority to regulate building construction, community development, and other matters that fall within their municipal home rule powers. As such, the project may consider establishing model solar contractor licensing laws and rules, incorporating NABCEP installer certification or equivalent requirements as a baseline where no solar contractor licensing exists, or where NABCEP can provide a higher tier of expertise.

Finally, community associations are largely unregulated and have the authority as well as the responsibility to preserve property values, community interests, and common property. Those subject to community association rule must respect those rules, and have the power, both collectively and independent of the association, to enforce those rules against those who violate the rules. The project will develop model Covenants, Conditions and Restrictions; Declarations; Bylaws; and Architectural Review Board criteria and applications for the installation of solar energy systems. Also, recommended solar energy system design practices to maximize aesthetics will be established. The Community Associations Institute, the trade association for homeowner and condominium associations, will be consulted to assist in implementation of model standards.

The preliminary review of state solar access and solar rights laws indicates a real need for simplified enforcement of the protection afforded by solar rights laws. In addition, the voluntary nature of solar access laws makes them useless to property owners that have neighbors unwilling to provide a solar easement.

Thirty four states (and a handful of municipalities) have some kind of protection for solar access* or solar rights**. That leaves 16 states that have no protection. Some of the state's lacking solar access or solar rights laws are surprising, given the other pro-solar/renewable energy policies in the state: Connecticut, Illinois, Pennsylvania, Texas, Vermont, for example. However, even those states that do have solar rights or solar access laws have enforcement issues that can render the laws ineffective or subject to expensive litigation to enforce.

There are essentially two models, which have perpetuated over more than two decades that attempt to protect the right of homeowners to install solar energy systems. The first model addresses local government ordinances; the second model addresses private land use restrictions, such as covenants, conditions and restrictions in deeds, as well as declarations in condominium documents. Some states address both.

The standard language for statutes addressing ordinances is: "The adoption of an ordinance by a governing body which prohibits or has the effect of profiting from the installation of solar collectors is expressly prohibited."

The standard language for statutes addressing private land use restrictions is: "Any covenant, restriction or condition contained in any deed, contract, security agreement or other instrument affecting the transfer or sale of or any interest in real property which effectively prohibits the installation or use of a solar energy device is void and unenforceable."

Some states distinguish their laws from others by defining a solar energy device, providing or prohibiting retroactive effect, defining "effectively prohibiting" (usually by assigning a cost of compliance with a requirement). For the most part, the laws apply strictly to residential buildings, including condominiums.

Solar access laws have very common elements, and virtually all are "voluntary," meaning that a solar owner cannot require that their neighbor agree to a solar easement. The standard elements of a typical solar access law are that it must be in writing, be recorded (as any other real property interest); express the horizontal and vertical angles of the easement; include provisions relating to the grant or termination of the easement; and provide for any compensation arrangements to the grantor for maintaining the easement or to the grantee in the event of interference.

Short of mandating solar easement, one approach used by a state includes a registration process that allows a solar owner to register their solar system with the local governing body, essentially putting their neighbors on notice that the solar system is in place. In that event, a solar owner can, in essence, impose a solar easement on the neighbor. This is a very unique and potentially effective, solar access tool. There are also states that direct the local governing body to require a solar access element in subdivision or development plans submitted for their review and approval.

There are a series of elements of an effective solar rights and access law that should be considered when developing the model statute. The preamble should state the public purpose of the statute to assure the constitutionality of the law. A policy statement in support of solar energy is necessary to allow the law to be retroactive, as a constitutional challenge based on the impairment of contracts can be overcome with policy arguments. The legislative intent becomes important when it comes to interpreting the statute in individual cases. Definitions are necessary to indicate what solar energy devices are governed by the law, whether it is all solar technologies, solar hybrid, and passive solar or renewable energy devices in general.

---

* Refers to the ability of one property to continue to receive sunlight across property lines without obstruction from another's property (buildings, foliage or other impediment).

** Refers to the ability to install solar energy systems on residential and commercial property that are subject to private restrictions, i.e., covenants, conditions, restrictions, bylaws, condominium declarations as well as local government ordinances.

What end users are subject to protection should be clear, such as all buildings or parcels of land, or specific types of buildings (i.e., residential, commercial, multi-family, condominium). The specific legal instruments that are governed by the law should be identified, including, covenants, conditions and restrictions, sales contracts, condominium declarations, ordinances, building codes, and permit requirements. A method of enforcing the protections afforded by the model statute needs to be explicit and might include litigation, prevailing party legal fee awards, penalties, and code enforcement mechanisms. Finally, the section of state statutes where the law should be codified should be identified and may include a constitutional amendment, municipal law section, building code section, condominium regulation section, and homeowner association section.

HIGH WIND LOADS AND MODEL CODE

The High Wind Loads and Model Code study covers a review of the wind loading requirements for Florida, the Gulf Coast, and Eastern seaboard regions and their applicability to PV array attachments, designs and installation methods. The focus is on identification of generalized wind force resilient and wind permeable designs that allow adjustments of design loads relative to the simplified procedures in the current code. Selected structural design concepts will be evaluated for their adaptability in the model code. The Study Panel will closely work with Miami-Dade County Building Code Compliance Office (BCCO) and Florida International University's (FIU) International Hurricane Research Center (IHRC). Existing and prototype designs will be evaluated at the IHRC Wall of Wind facility to collect empirical data relating to wind forces on PV modules, arrays, and mounting systems attached to roofs. Data collected will be used to assess current design values and calculation methods. The Miami-Dade BCCO will assist with developing procedures and protocol for submitting PV mounting systems for product approval which serves as a 'blanket' approval for permitting and structural code compliance. Industry partners will be identified to assist with general information, samples, and hardware.

Current Codes and Standards: The SEI/ASCE 7-05 Standard "Minimum Design Loads for Buildings and Other Structures" is widely accepted in the US as the principal standard for guiding the design of structures and building components for wind resistance. Because of the great variability in types and unique designs of structures, the code must be generic in nature. Roof mounted PV modules have specific geometries that are not addressed by this standard, although it is accepted by design professionals and code officials as applicable through interpretation. Lacking explicit design methods and tables, engineers must make numerous assumptions when applying SEI/ASCE 7 to PV mounting system designs. Because guidance is lacking in the Standard, these assumptions can vary significantly from one designer to another, resulting in a wide range of design load estimates. Building officials may have little or no experience with PV systems and may be inclined to question the engineering analysis or question reference to sections of code that may not be applicable.

Design Wind Loads for the Eastern Seaboard and Gulf Coast Regions: Structural attachment methods for (PV arrays on rooftops have been attracting more attention from designers and code officials. As markets develop in high wind regions such as the Gulf Coast, Florida, and the Eastern Seaboard, it is becoming evident that the existing building codes do not adequately, or at least do not directly, address the structural attachment of modules and arrays to the exterior of buildings. This creates confusion for designers and code officials and creates a barrier for suppliers and consumers.

Current Test Methods: Most manufacturers state structural load values in compliance with IEC or UL standards. However, these test methods are conducted with static loads and are primarily applicable for ice and snow accumulations. In contrast, wind loads can be very dynamic and the design forces are derived from the three-second gust speed. Some dynamic loading and wind tunnel tests have been conducted, but the majority of this information is proprietary and is not available for more broadly applicable analysis. This makes the calibration of any models of wind forces on PV modules and arrays very difficult.

Design Guidelines Based on Current Code: PV arrays are typically installed in two primary configurations on rooftops. These include:1) above and parallel to the roof slope on moderate to high slope roofs and 2) at a fixed tilt other than the roof slope for low slope and flat roofs. Although the current codes do not specifically address the structural connection for either configuration, the parallel arrays may present a simpler case that can be addressed under the existing standards as components and cladding. Tilted arrays present a more complicated situation as the direction of the wind relative to the back or front of the module can dramatically affect the uplift and overturn forces in the attachment system. Tilted arrays will experience much higher forces than parallel arrays. However, it may be possible to address these arrangements as roof mounted equipment, similar to rooftop air conditioning units, under the existing standards.

Future Work: PV modules and arrays present a unique design challenge for high wind regions and the

structural attachment of this equipment to roofs is not adequately addressed at this time. Guidance is lacking for design professionals. Codes and Standards will need to specifically address the mounting of PV arrays to rooftops to eliminate potential barriers to market development in high wind regions. Wind tunnel testing is an important tool that will be required to assist in the understanding of the dynamic loads on the modules, interactions with the air flow around the building, and the transmission of loads to the building structure. With a fundamental understanding of the wind forces for basic configurations, numeric models can be developed further to evaluate other geometries that can be used to simplify and add confidence to the design process.

SUMMARY

The Solar ABCs Local Codes Study Panel members and stakeholders (including PV manufacturers, users, electric utilities, funding institutions, government agencies and others) have prioritized three local codes topics related to the installation of PV systems for the first year study: Expedited Permitting, Solar Access and Solar Rights Laws, and High Wind Loading on PV Array Installations. The final reports on these three topics are in preparation and will be uploaded on the Solar ABCs website: http://www.solarabcs.org/documents

The expected dates for the final reports being available on the website are: Solar Access and Solar Rights Laws in August 2008, Expedited Permitting in October 2008, and High Wind Loading on PV Array Installations in December 2008. These reports will describe the details of studies, recommendations, a model ordinance for solar access and solar rights, and development of a model code for high wind locations.

ACKNOWLEDGEMENTS

These studies are sponsored by the U.S. Department of Energy (DOE) under the Solar America Initiative's (SAI) Market Transformation (MT) Program Cooperative Agreement on the Solar America Board of Codes and Standards (Solar ABCs) Project. The authors greatly appreciate the advices and suggestions of Larry Sherwood (Solar ABCs Project Administrator), Bob Reedy (FSEC), Jerry Ventre (Engineering Consultant), Jane Weissman (IREC) and Colleen O'Brien (BEW Engineering) on the content of these studies.

REFERENCES

[1] Brooks Engineering, *Inspector Guidelines for PV Systems*, Version 2.1, Published by Pace University, March 2006.

[2] FSEC Standard 203-05, *Procedures for Photovoltaic System Design Review and Approval*, May 2005.

[3] Damian Pitt and Christopher Cooper, Taking the Red Tape Out of Green Power, Published by the Network for New Energy Choices, July 2008.