Photovoltaic System Certification Process

Stephen Barkaszi, PE

Program Director

PV Test and Certification Department

July 9, 2014

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Florida Solar Energy Center

A Research Institute of
the University of Central Florida

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General Overview

- Energy institute of the State of Florida
  - Largest and most active in nation
  - 25+ year history of research and training excellence
- Approximately 130 staff
  - 80 professionals
  - 35 technical support and clerical staff
  - 15 graduate student assistants

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FSEC Program Areas

- **High-Performance Buildings**
- **Solar Thermal Systems**
- **Photovoltaics**
- **Testing & Certification**
- **Hydrogen and Fuel Cells**
- **Education and Training**
- **Electric Vehicle Transportation Center**

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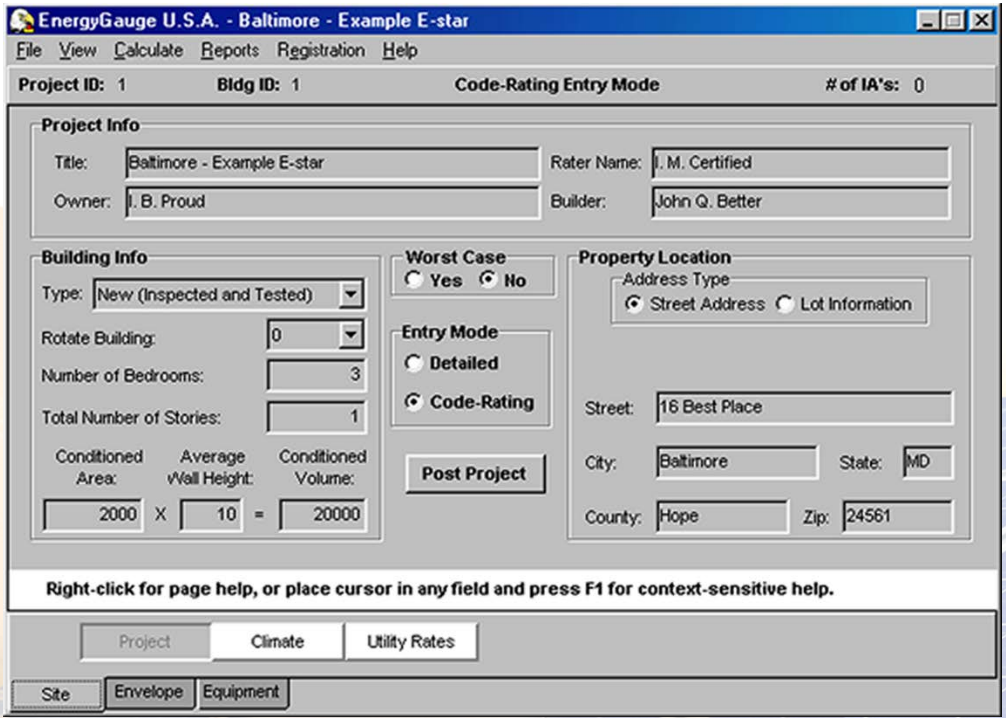
Education & Training




EnergyGauge® Software

- Florida's Energy Code compliance tool
- Plus . . .
  - Nationally accredited Home Energy Ratings (HERS)
  - Economic and financial analysis
  - HVAC system sizing
  - Pollution analysis
  - Automatic building optimization



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Solar Test and Certification at FSEC

- Florida law requires FSEC to develop and promulgate standards for solar energy systems (§377.705(4)(a), FS)
- Charged with establishing criteria for evaluating the performance of solar energy systems (§377.705(4)(b), FS)
- Requires that all solar energy systems sold or manufactured in Florida meet those standards
- "Such standards shall ensure that solar energy systems manufactured or sold within the state are effective and represent a high level of quality of materials, workmanship, and design"

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Solar Test and Certification at FSEC

- Standards developed put into effect by FSEC are subject to rulemaking under the Florida Administrative Procedures Act (Chapter 120, FS)
- This process requires notice to interested parties, workshops, and hearings in order to assure the standards are developed with industry input and consensus to the extent possible.
- The standards are then adopted by reference in the Florida Administrative Code (FAC) Rule Chapter 6C7-8
- There are no provisions for enforcement by FSEC

System Electrical

- Some lack of familiarity with NEC Article 690 by code officials, installers and design professional
  - Relatively new article
  - Frequent changes and additions initially
  - Relatively few installations in Florida
- Specific areas with frequent questions
  - DC rated equipment and components versus AC ratings
  - Temperature requirements (above 30°C)
  - Grounding, bonding, lighting protection confusion
  - Conduit types and applications
  - Labeling
  - Disconnect requirements
  - Adequate schematic drawings for permitting and installation

FSEC System Certification Process

- Process
  - Review PV system electrical plans
  - Verify UL listed components are used
  - Ensure code compliant electrical design of PV systems
  - Verify basic performance expectations
- Intent
  - Consumer protection
  - Safety
  - Value to owners, installers, and inspectors

Application

FSEC

Photovoltaic System Certification Application

v. 20130111

Applicant Information

Primary Contact (Required)

Name: Address:
Company: City: State: Zip Code:
Telephone: E-Mail: Web Site:

Technical Contact (If Different)

Name: Address:
Company: City: State: Zip Code:
Telephone: E-Mail: Web Site:

General

System Designation: Total Nameplate Rating: W
System Type: ◯ Utility Interactive ◯ Stand Alone ◯ Other:

Photovoltaic Array

Primary Module (Required)

Manufacturer: Model Number: Registration Number*: Nameplate Rating: W
Quantity: Number of Series Strings/Branch Circuits: Number of Modules per Series String/Branch Circuit:

Secondary Module (If Used)

Manufacturer: Model Number: Registration Number*: Nameplate Rating: W
Quantity: Number of Series Strings/Branch Circuits: Number of Modules per Series String/Branch Circuit:

*Modules must have an FSEC Module Registration Number. Registration Numbers can be found at: http://www.fsec.ucf.edu/en/certification-testing/PVmodules/certified_modules/
If a module is not listed, please refer to the module approval process found at: http://www.fsec.ucf.edu/en/certification-testing/PVmodules/

Power Conditioning

Primary Inverter (If Used)

Manufacturer: Model Number: Quantity: Type: ◯ Central Inverter ◯ Microinverter
Maximum DC Input Power: W Maximum DC Input Current: A DC Input Voltage Range: Min: Max:
AC Nominal Output Power: W AC Maximum Output Current: A at: ◯120V ◯208V ◯240V ◯277V

Secondary Inverter (If Used)

Manufacturer: Model Number: Quantity: Type: ◯ Central Inverter ◯ Microinverter
Maximum DC Input Power: W Maximum DC Input Current: A DC Input Voltage Range: Min: Max:
AC Nominal Output Power: W AC Maximum Output Current: A at: ◯120V ◯208V ◯240V ◯277V

Battery Back-Up

Charge Controller (If Used)

Manufacturer: Model Number: Listing to UL 1741 Verified: ◯ Yes ◯ No

Battery Bank (If Used)

Battery Manufacturer: Model Number: Type: ◯ Flooded ◯ Sealed ◯ GEL ◯ AGM
Total Number of Batteries: Number of Series Strings: Number of Batteries per Series String: Capacity (C/20 rate): Ah

Page 1 of 2

FSEC

Electrical Schematic

A **comprehensive** and **legible three line** electrical diagram **accurately representing** the **complete PV system** must be submitted in PDF file format.
As this is the most important document considered in the review, please check that it includes the following minimum requirements before submission:

- ☐ Manufacturer and model number of all PV modules, inverters, charge controllers, and batteries
- ☐ The size, type, and maximum run length of all conductors
- ☐ PV module wiring
- ☐ PV module equipment grounding
- ☐ System grounding
- ☐ Battery wiring (if applicable)
- ☐ The size/rating and location of all overcurrent protection devices (e.g. fuses and circuit breakers)
- ☐ The rating and location of all disconnects
- ☐ Point of connection to the utility (if applicable)
- ☐ Compliance with National Electric Code

Voltage Drop Table

Additional Documentation

Please submit the following required documentation in PDF file format with your application:

- ☐ Electrical schematic (as detailed above)
- ☐ Manufacturer's data sheet for all PV modules
- ☐ Manufacturer's data sheet for all inverters
- ☐ Manufacturer's data sheet for charge controller (if applicable)
- ☐ Manufacturer's data sheet for batteries (if applicable)

Submission Information

The completed application and documentation must be E-mailed in PDF file format to **pvsystem@fsec.ucf.edu**. If the Submit button below does not work with your browser, save this application to your computer and then fill it out using Adobe Acrobat Reader (available at **http://get.adobe.com/reader/**).

Do not send payment until an invoice has been received. After an application packet is received and passes a basic check for completeness, FSEC will return an invoice by E-mail. Payment of the non-refundable certification fee is required to start the design review process. To ensure proper credit, the invoice number must be referenced on any form of payment. The fee schedule is available at: **http://www.fsec.ucf.edu/en/publications/pdf/PV_Test_Cert_Fees.pdf**

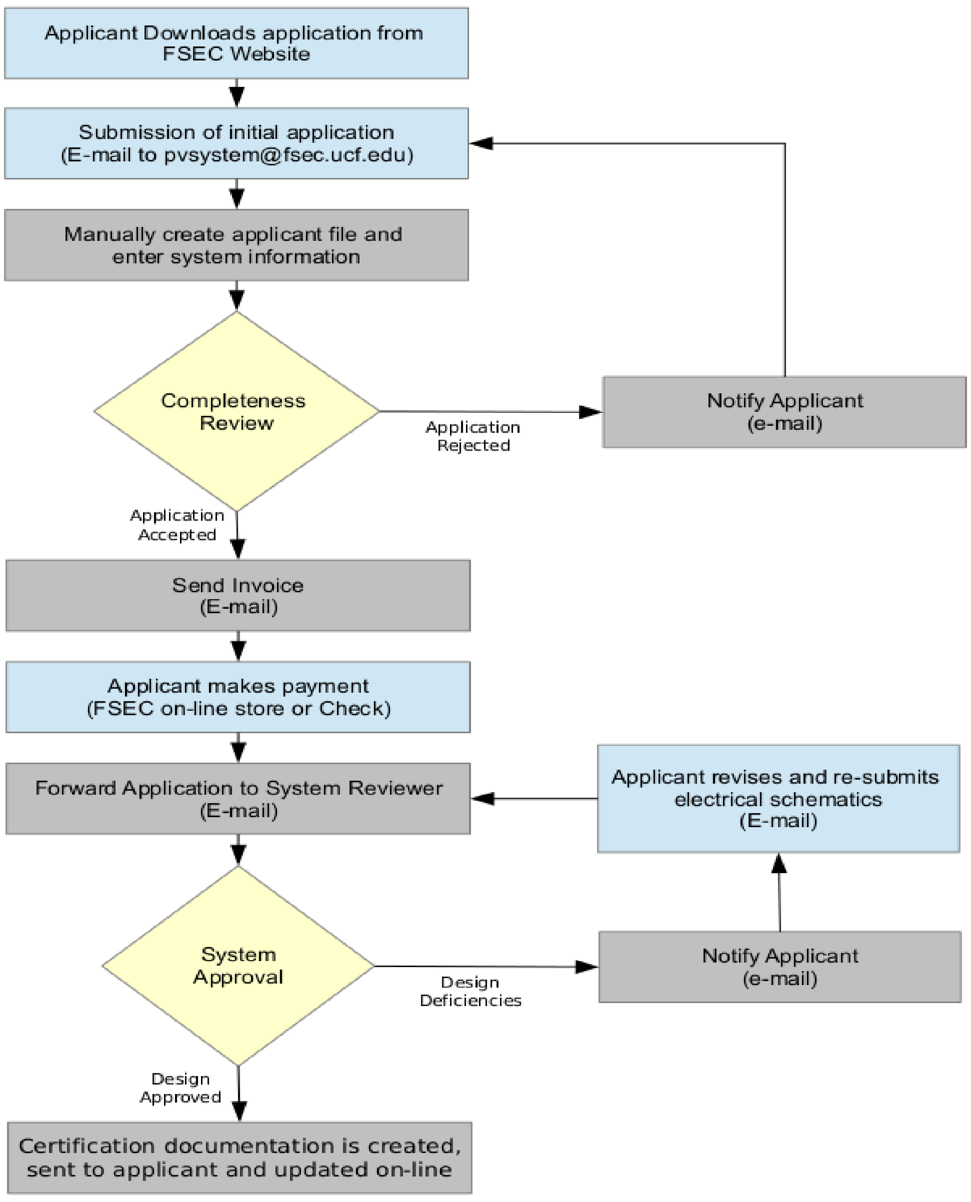
Upon receipt of the completed application, all data sheets, the electrical schematic, and full payment, a response will be provided within twenty business days (not including holidays or any other days during which FSEC is closed.) The response time starts anew upon each submitted revision.

Submit

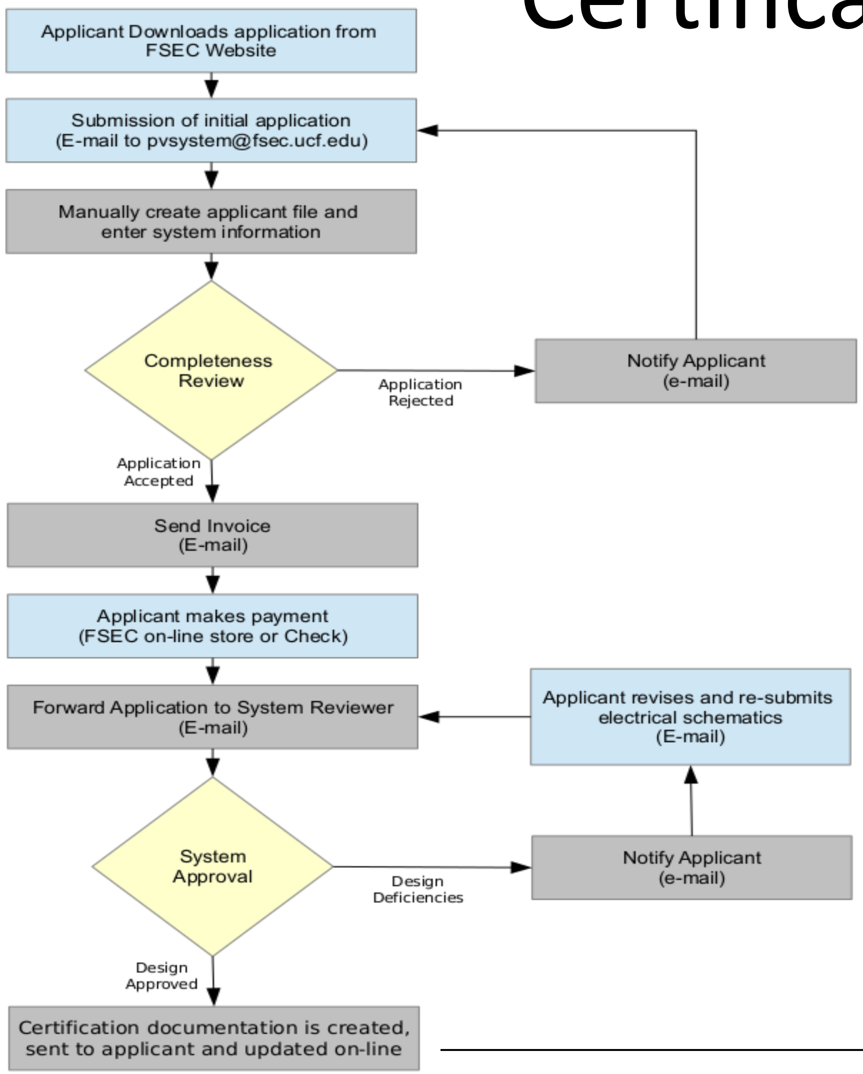
Page 2 of 2

Certification Process

- Multiple steps involving frequent communication with the applicant
- Currently the process is all electronic by utilizing pdf applications, e-mail communicatio and data entry.



Certification Process



- This only accounts for the FSEC certification of electrical designs
- Several additional steps from the contractor are still required for system approval

Structural Design

Local Permitting Processes

Utility Net Metering Agreements

Inspections

System Design Approval

- FSEC certification ensures NEC compliant design that performs as expected.
- CRITERIA FOR SYSTEM DESIGN (ELECTICAL) APPROVAL
  - Module specifications, array design and inverter compatibility
  - Wire type, gauge, lengths
  - Conduit type, size, lengths
  - Voltage sizing, voltage drop
  - Disconnect rating, location
  - Overcurrent protection rating, location
  - Combiner/junction box rating, location, NEMA rating
  - Grounding type, placement, wire gauge
  - Appropriate ground fault protection
  - Service panel requirements
  - Appropriate markings and labels

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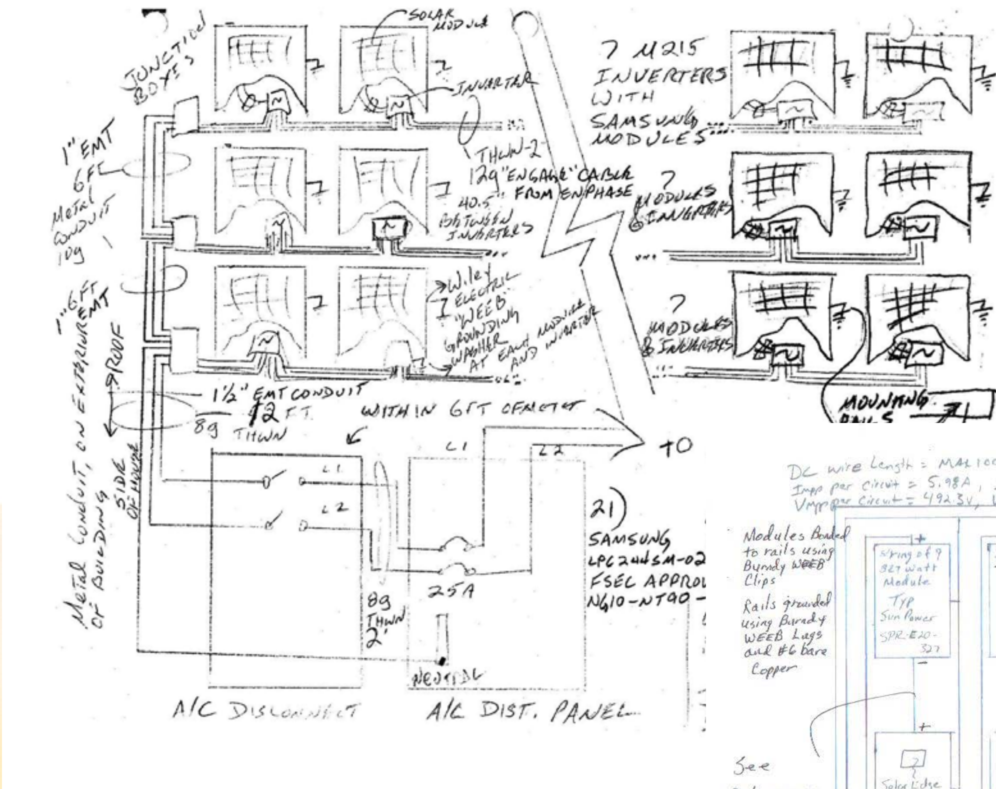
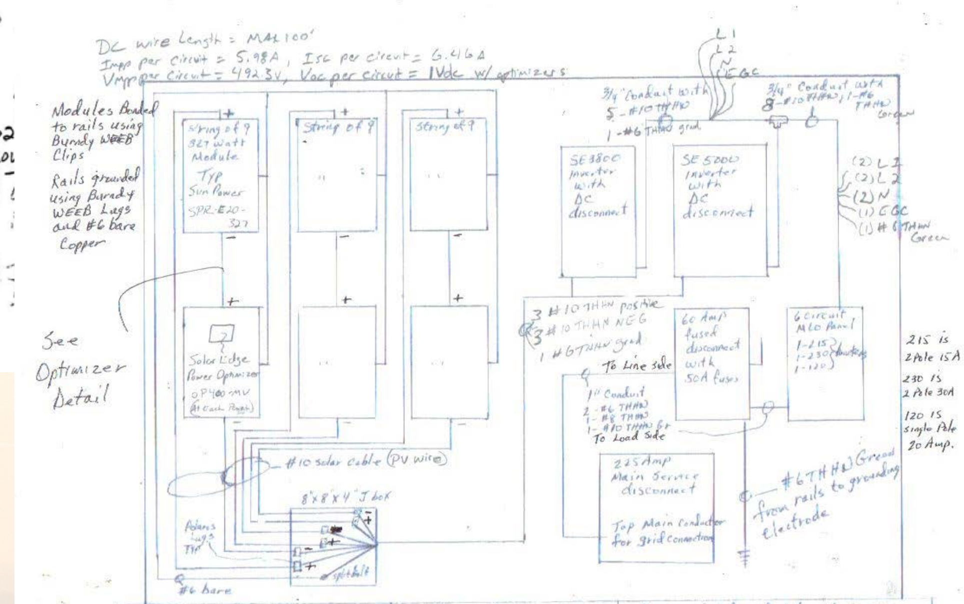
FSEC Experience

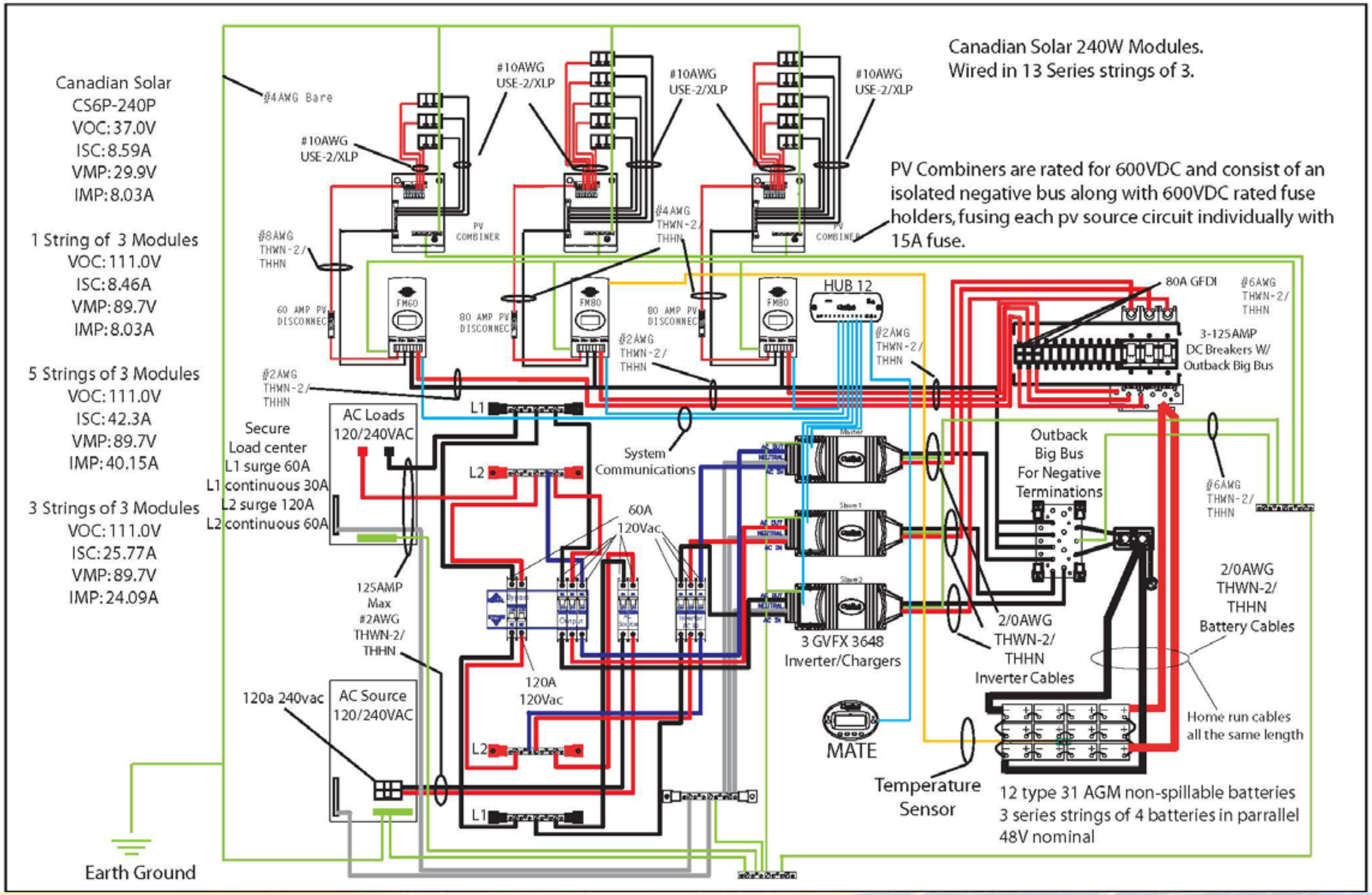
- Wide variety of electrical schematics submitted
- Variations in layout, symbols, notation, etc.
- Often requires several interactions between the system reviewer and the applicant to arrive at a complete and code compliant design.
- A more standardized electrical schematic will streamline both the certification, permitting and inspection processes.

Sample Electrical Diagrams





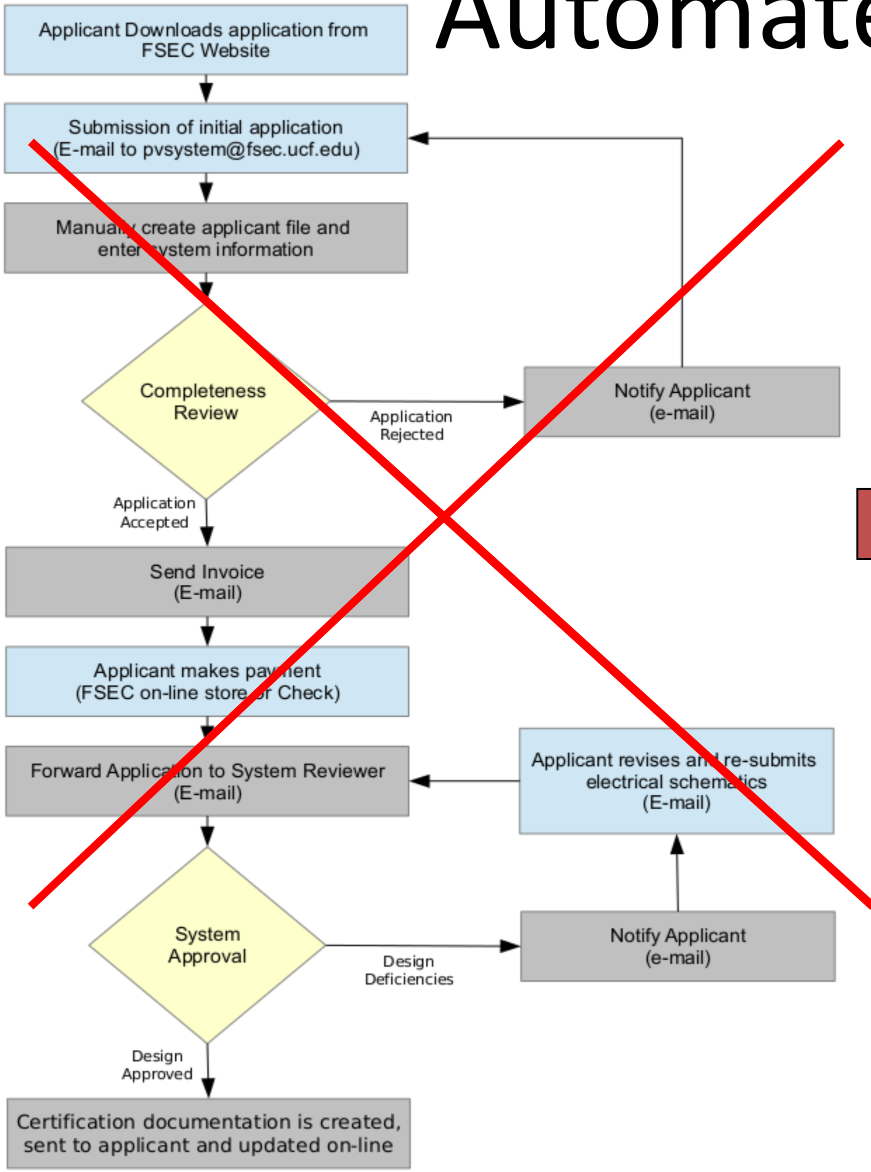
Varying Complexity

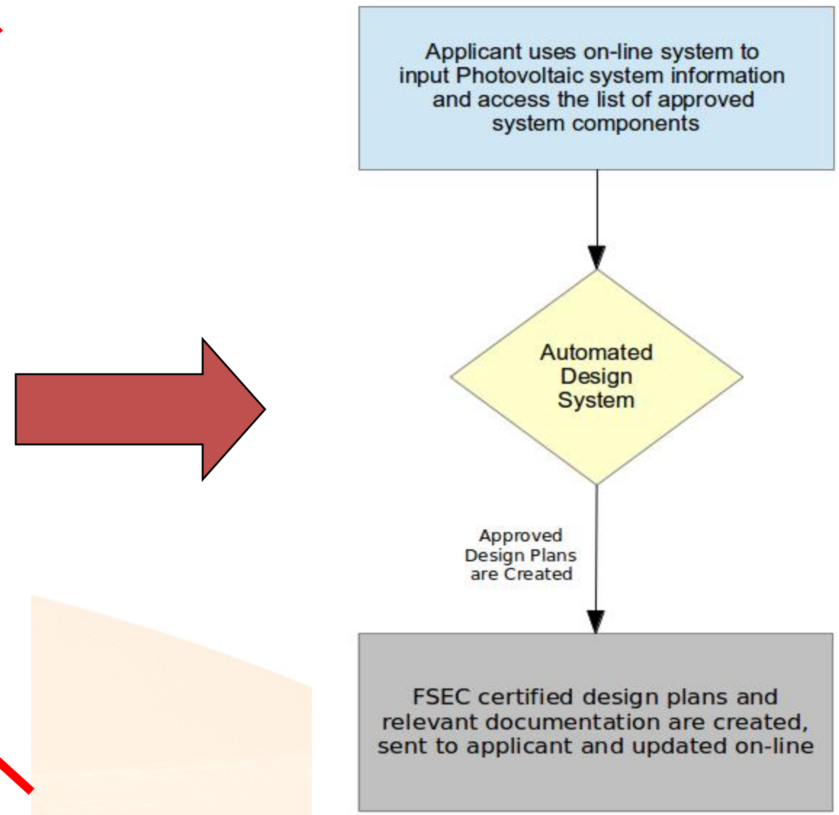


Automated Design Tool

- Our goal is to develop design software in which the applicant can input system information, design requirements, choose from a database of approved components (modules, inverter, etc.), and receive a set of custom plans.
- All design aspects will be calculated using the NEC, FL Building Code, ASCE 7, and all relevant code requirements.

Automated Design Tool





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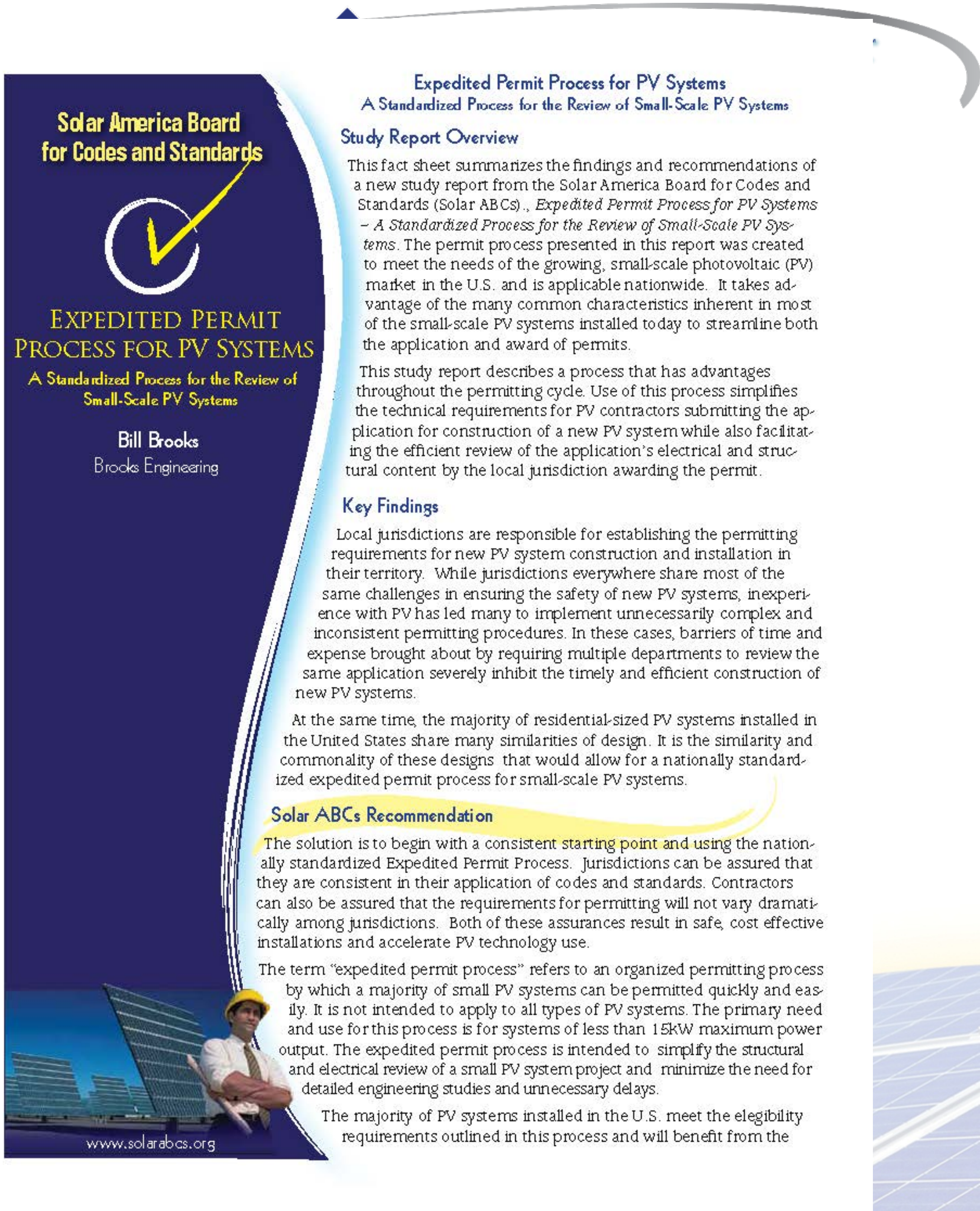
Electrical Code Compliance


Solar America Board for Codes and Standards

EXPEDITED PERMIT PROCESS FOR PV SYSTEMS

A Standardized Process for the Review of Small-Scale PV Systems

Bill Brooks

Brooks Engineering

www.solarabcs.org

Expedited Permit Process for PV Systems

A Standardized Process for the Review of Small-Scale PV Systems

Study Report Overview

This fact sheet summarizes the findings and recommendations of a new study report from the Solar America Board for Codes and Standards (Solar ABCs)., *Expedited Permit Process for PV Systems – A Standardized Process for the Review of Small-Scale PV Systems*. The permit process presented in this report was created to meet the needs of the growing, small-scale photovoltaic (PV) market in the U.S. and is applicable nationwide. It takes advantage of the many common characteristics inherent in most of the small-scale PV systems installed today to streamline both the application and award of permits.

This study report describes a process that has advantages throughout the permitting cycle. Use of this process simplifies the technical requirements for PV contractors submitting the application for construction of a new PV system while also facilitating the efficient review of the application's electrical and structural content by the local jurisdiction awarding the permit.

Key Findings

Local jurisdictions are responsible for establishing the permitting requirements for new PV system construction and installation in their territory. While jurisdictions everywhere share most of the same challenges in ensuring the safety of new PV systems, inexperience with PV has led many to implement unnecessarily complex and inconsistent permitting procedures. In these cases, barriers of time and expense brought about by requiring multiple departments to review the same application severely inhibit the timely and efficient construction of new PV systems.

At the same time, the majority of residential-sized PV systems installed in the United States share many similarities of design. It is the similarity and commonality of these designs that would allow for a nationally standardized expedited permit process for small-scale PV systems.

Solar ABCs Recommendation

The solution is to begin with a consistent starting point and using the nationally standardized Expedited Permit Process. Jurisdictions can be assured that they are consistent in their application of codes and standards. Contractors can also be assured that the requirements for permitting will not vary dramatically among jurisdictions. Both of these assurances result in safe, cost effective installations and accelerate PV technology use.

The term "expedited permit process" refers to an organized permitting process by which a majority of small PV systems can be permitted quickly and easily. It is not intended to apply to all types of PV systems. The primary need and use for this process is for systems of less than 15kW maximum power output. The expedited permit process is intended to simplify the structural and electrical review of a small PV system project and minimize the need for detailed engineering studies and unnecessary delays.

The majority of PV systems installed in the U.S. meet the elegibility requirements outlined in this process and will benefit from the

Standard Design Plans

- Standardizing the way in which plans are constructed with consistency in layout, notations, and symbols
- This will reduce the time required to read and understand system design plans.
- Potential for faster approval processes and inspections.
- Produce electrical diagrams that allow for simple and straight forward inspection process
- Creation of a single database for all certified PV components.

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Standard Design Plans

EQUIPMENT SCHEDULE

TAG	DESCRIPTION	PART NUMBER	NOTES
1	SOLAR PV MODULE	–	APPROVED BY GO SOLAR
2	PV ARRAY	–	APPROVED BY GO SOLAR
3	J-BOX (IF USED)	–	PER NEC
4	COMBINER (IF USED)	–	PER MFG. (MAY BE IN INVERTER)
5	DC DISCONNECT	–	PER MFG. (MAY BE IN INVERTER)
6	DC/AC INVERTER	–	PER MFG.
7	GEN METER (IF USED)	–	PER MFG.
8	AC DISC (IF USED)	–	SHALL COMPLY WITH NEC 690.15,16,17
9	SERVICE PANEL	–	200A, 240V

(SEE NOTE 5 FOR INVERTER OCPDS, ALSO SEE GUIDE SECTION 9)

Plan Review	App. By	Date
Building	NA	05/30/ 2013
Electric	T. DEVIER	05/30/ 2013

Note: This plan is invalid unless accompanied by a Go SOLAR permit card and Go SOLAR permit document. Plans must be on job before any inspection will be made.

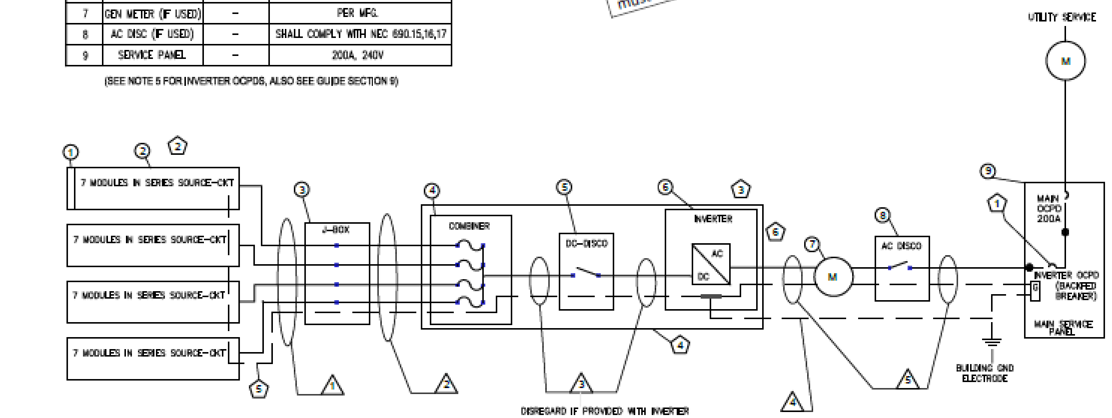
ENRIQUE SOSA JR. LICENSE No. 53885 STATE OF FLORIDA PROFESSIONAL ENGINEER

DN: c=US, st=Florida, l=Coral Gables, email=enrique.sosa@tylin.com, o=TY Lin International, cn=Enrique Sosa
Date: 2013.05.30 11:40:40 -04'00'

7 MODULES IN SERIES SOURCE-CKT

NO. OF STRINGS	NO. MODULES	WATTS	VOLTAGE TYPE	Voc
1 STRING	7 MODULES	1750 W	TOTAL Voc	259 V
	EA/MODULE	250 W	Voc PER MODULE	37 V
1 STRING	7 MODULES	1750 W	TOTAL Voc	259 V
	EA/MODULE	250 W	Voc PER MODULE	37 V
1 STRING	7 MODULES	1750 W	TOTAL Voc	259 V
	EA/MODULE	250 W	Voc PER MODULE	37 V
1 STRING	7 MODULES	1750 W	TOTAL Voc	259 V
	EA/MODULE	250 W	Voc PER MODULE	37 V

1,750 WATT SYSTEM
4 STRINGS AND 7 MODULES
AMPS = 36.4 A



(SEE GUIDE APPENDIX C FOR INFORMATION ON MODULE & ARRAY GROUNDING)

KEY NOTES:

1. SIZE BACKFED BREAKER PER MFG. ALL BACK FED BRK. SHALL BE LINE-LINE LISTED. BACKFED BRK. SHALL NOT BE MORE THAN 20% OF BUS
2. MODULES SHALL BE LISTED TO UL STANDARDS 1703
3. INVERTERS SHALL BE LISTED TO UL STANDARDS 1741.INVERTER TO BE WITHIN 10' OF SERVICE, WITHIN SIGHT OF INVERTER OR LOCKABLE
4. COMBINER, DC-DISCONNECT AND INVERTER MAY COMBINE WITHIN ONE INVERTER UNIT
5. EQ. GND. COND. (EGC) SHALL BE SIZED PER NEC 690.45 (A)
6. INVERTER OUTPUT CONN. SHALL BE SIZED PER NEC 690.64(B)(7)

CONDUIT/CONDUCTOR SCHEDULE

TAG	DESCRIPTION	CONDUCTOR TYPE	CONDUCTOR GAGE	COND. TYPE	NOTES
1	EA/MODULE TO JBOX	USE 2 OR PV WIRE & EGC	1 #10 & 1#10 GND	PER NEC	EGC SMALLER THAN #6 AWG SHALL BE PROTECTED NEC 250.120C
2	JBOX TO COMBINER	THWN-2/XHHW-2/RHW-2 & EGC	1 #10 & 1 #10 GND	PER NEC	(IF COMBINER USED, OTHERWISE GO DIRECTLY FROM JBOX TO INVERTER)
3	TO/FROM DC DISCONNECT	THWN-2/XHHW-2/RHW-2 & INSULATED EGC	1 #6 & 1 #6 GND	PER NEC	(IF DC DISCONNECT USED, OTHERWISE GO DIRECTLY FROM JBOX TO INVERTER)
4	MAIN OCPD TO INVERTER	DC GROUNDING ELECTRODE CONDUIT	1 #6 & 1 #6 GND	PER NEC	EQ. GND. COND. (EGC) SHOULD BE SIZED NEC 690.45 (A)
5	TO/FROM AC DISCONNECT	THWN-2/XHHW-2/RHW-2 & INSULATED EGC	1 #6 & 1 #6 GND	PER NEC	(IF METER NOT USED GO DIRECTLY FROM INVERTER TO AC DISC.)

NO.	DATE	REVISIONS	BY	CHK	APRV

T.Y. LIN INTERNATIONAL
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www.tylin.com

SEAL

DESIGNED BY SM | DRAWN BY SM | CHECKED BY ES | PRJ. ENG. GV

7 KW PV SYSTEM ELECTRIC DIAGRAM
EXPEDITED PERMIT FORM

BROWARD COUNTY

GO SOLAR PROJECT

SCALE: AS SHOWN
CONTRACT NO.: N/A
DRAWING NO. | SHEET NO.

100% PLANS

A New Model

SITE INFORMATION

Existing Service Panel Information

Voltage Level: [ ]

Maximum Current Rating: [ ]

Location: [ ]

Minimum Operating Temp: [ ]

Maximum Operating Temp: [ ]

MODULE INFORMATION

Manufacturer: [ ]

Model: [ ]

MODULE CALCULATIONS

Max Operating Voltage: [ ]

Min Operating Voltage: [ ]

Max Open Circuit Voltage: [ ]

Min Open Circuit Voltage: [ ]

Nominal Power Rating: [ ]

Operating Voltage: [ ]

Operating Current: [ ]

Open Circuit Voltage: [ ]

Short Circuit Current: [ ]

Temperature Coeff of Vmp: [ ]

Temperature Coeff of Voc: [ ]

Temperature Coeff of Imp: [ ]

Temperature Coeff of Isc: [ ]

Temperature Coeff of Power: [ ]

INVERTER INFORMATION

What type of power conditioning is being used for this system: [ ]

Manufacturer: [ ]

Model: [ ]

Power Rating: [ ]

Max. DC Input Current: [ ]

Max. DC Input Voltage: [ ]

Min. Peak Power Tracking Voltage : [ ]

Max. Peak Power Tracking Voltage: [ ]

DC Startup Voltage: [ ]

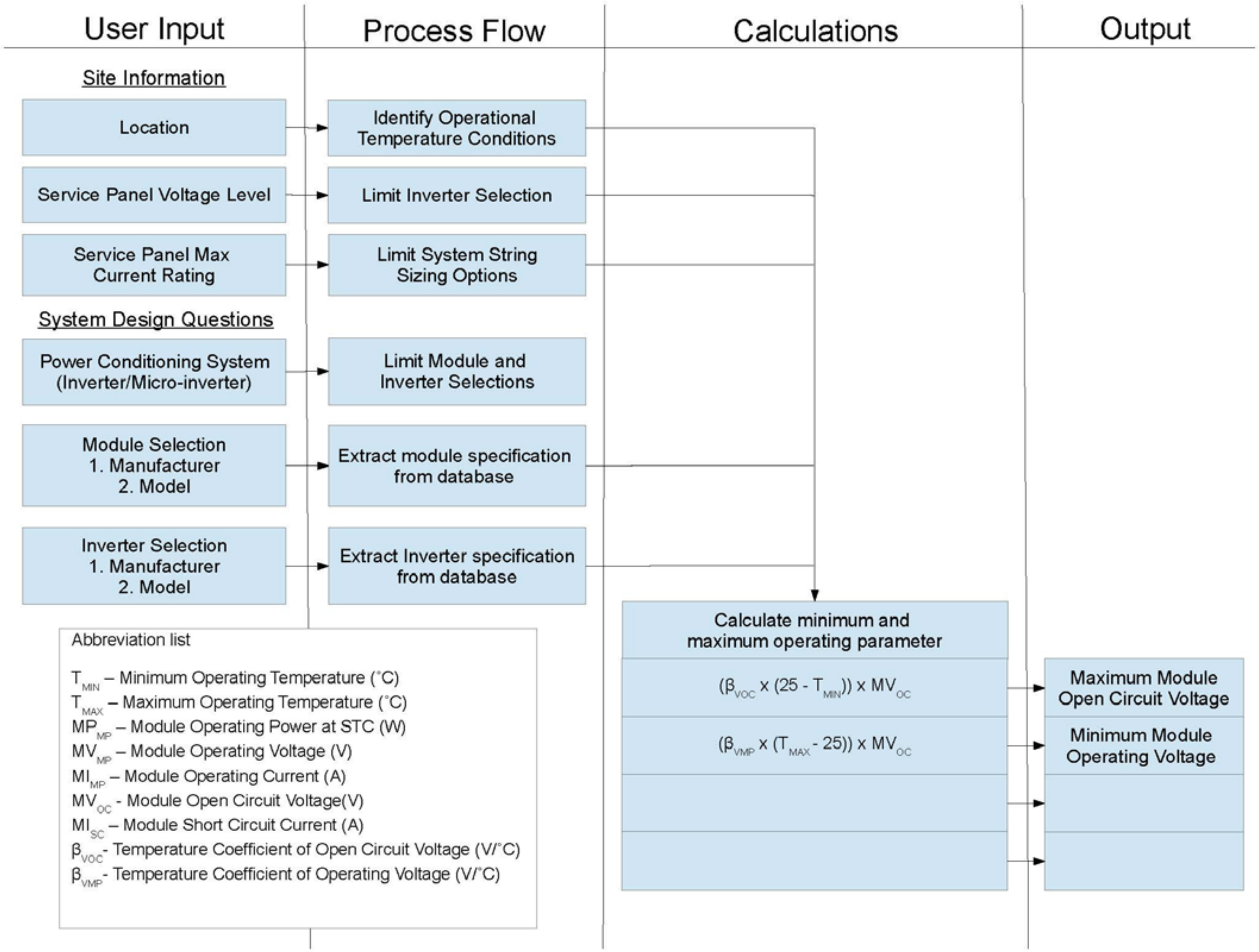
Number of DC Input Terminals: [ ]

Number of Independent Peak Power Tracking Inputs: [ ]

[Generate Array Options]

Hide Calculations: [ ]

Design Tool Calculations



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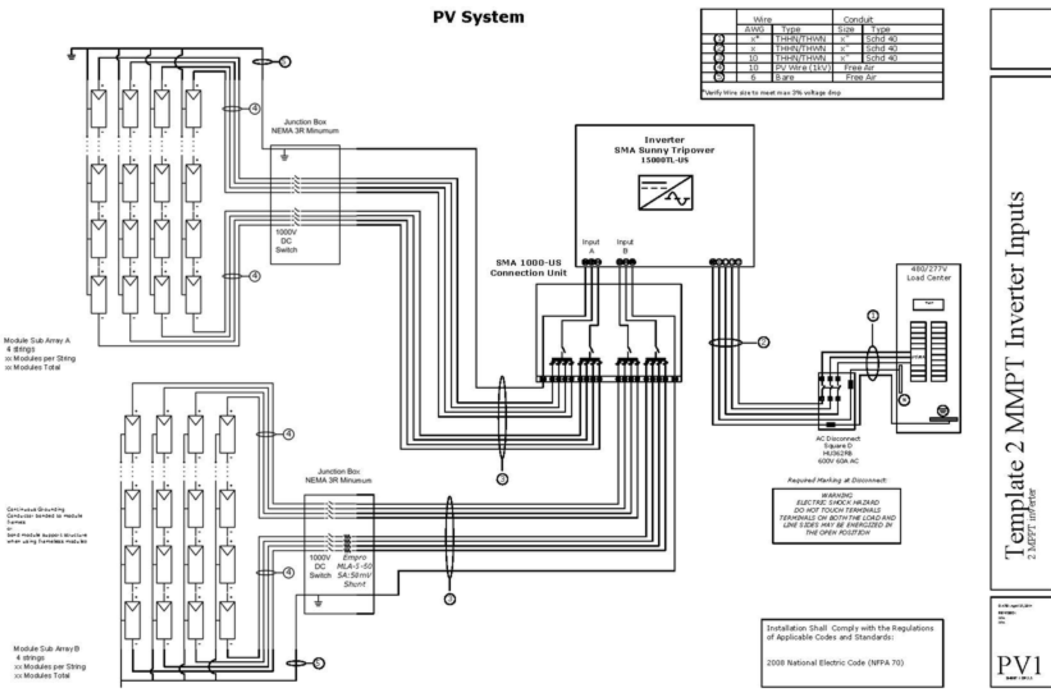

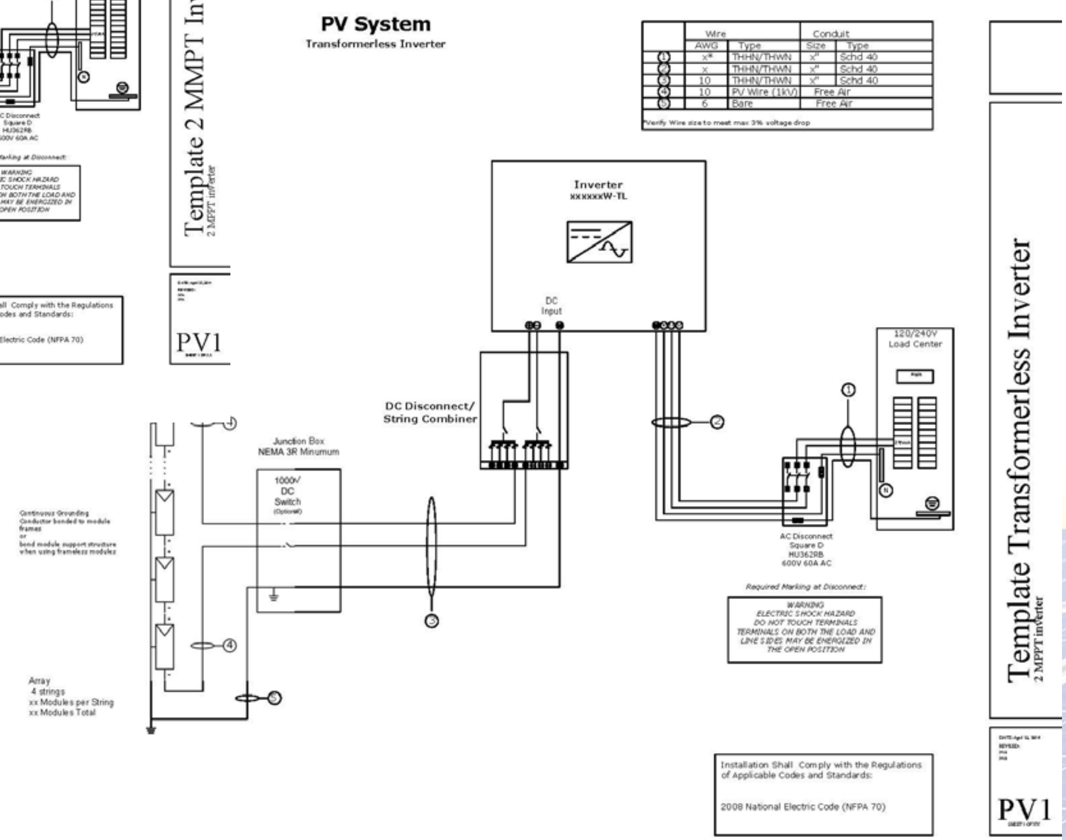

Standardized Output

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Automated Design Tool

- The expected users are residential/small commercial photovoltaic installers.
- The system will produce code compliant plans that are easily understood and include all required notations.
- The system will be maintained to accommodate code changes and updates.
- Requires feedback from code officials during development and buy-in for implementation.

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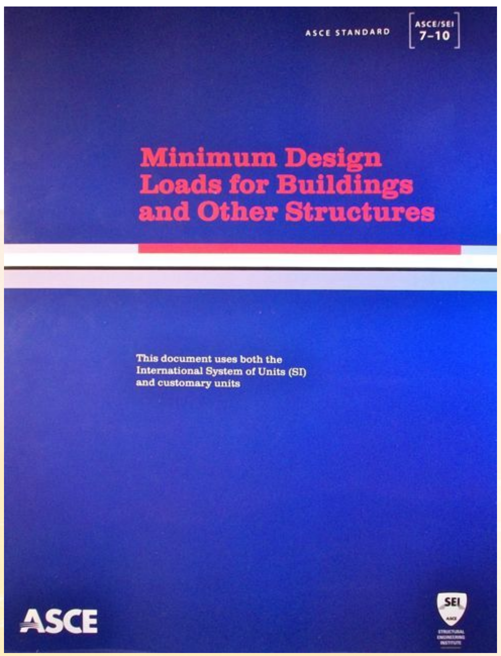
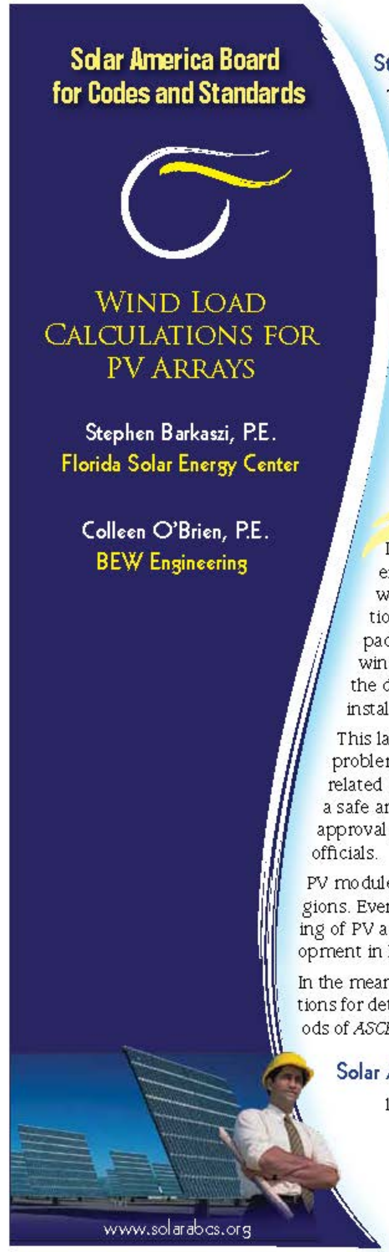
Wind Loads and Structural Code Compliance





Solar America Board for Codes and Standards

WIND LOAD CALCULATIONS FOR PV ARRAYS

Stephen Barkaszi, P.E.
Florida Solar Energy Center

Colleen O'Brien, P.E.
BEW Engineering

www.solarabcs.org

Wind Load Calculations for PV Arrays

Study Report Overview

This fact sheet summarizes the findings and recommendations for the Solar America Board for Codes and Standards (Solar ABCs) Study Report, *Wind Load Calculations for PV Arrays*.

Today's photovoltaic (PV) industry must rely on licensed structural engineers' interpretations of various building codes and standards to design PV mounting systems able to withstand wind-induced loads. However, the safety and sufficiency of structural attachments for PV arrays are not adequately addressed within any codes or standards. The result is a diversity of code interpretations from different individuals and groups, often yielding different design loads for the same design specifications.

This report provides sample calculations for determining wind loads on PV arrays based on *ASCE Standard 7-05*. The report focuses on application of PV arrays mounted parallel to the roof slope and relatively close (3 to 6 inches) to the roof surface. The report does not address other array configurations or building-integrated PV.

Key Findings

It is necessary to evaluate equipment and attachment methods to ensure that PV equipment will remain attached to structures during windstorm events and that the additional loads or load concentrations produced during these events do not exceed the structural capacity of the building. *ASCE Standard 7-05* is the standard for evaluating wind forces on structures, but it does not provide sufficient guidance to the design professionals and code officials to assess wind loads on PV installations.

This lack of guidance creates obstacles for the PV industry. The resulting problems include frustrated installers, dissatisfied customers, and wind-related structural failures. In addition, uncertainty about what constitutes a safe and secure installation for a given wind load can slow or stop the approval process for PV installations and complicates the training of code officials.

PV modules and arrays present a unique design challenge in high wind regions. Eventually, codes and standards will be updated to address the mounting of PV arrays to rooftops thus eliminating potential barriers to market development in high wind regions.

In the meantime, this report provides design guidance including sample calculations for determining the wind loads on PV arrays based on the recognized methods of *ASCE Standard 7-05*.

Solar ABCs Recommendations

1. Base the structural design of roof-mounted PV systems on the *ASCE Standard 7-05* as follows:
   a. Section 6.5.12.2, main wind-force resisting system (MWFRS), is the recommended starting point for designing the PV mounting structure, with the PV module oriented above and parallel to the roof surface.

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Guidance is Lacking

Frustration, uncertainty, inconsistency, and gross negligence will result from the current lack of guidance.

ASCE 7 does not currently address solar equipment

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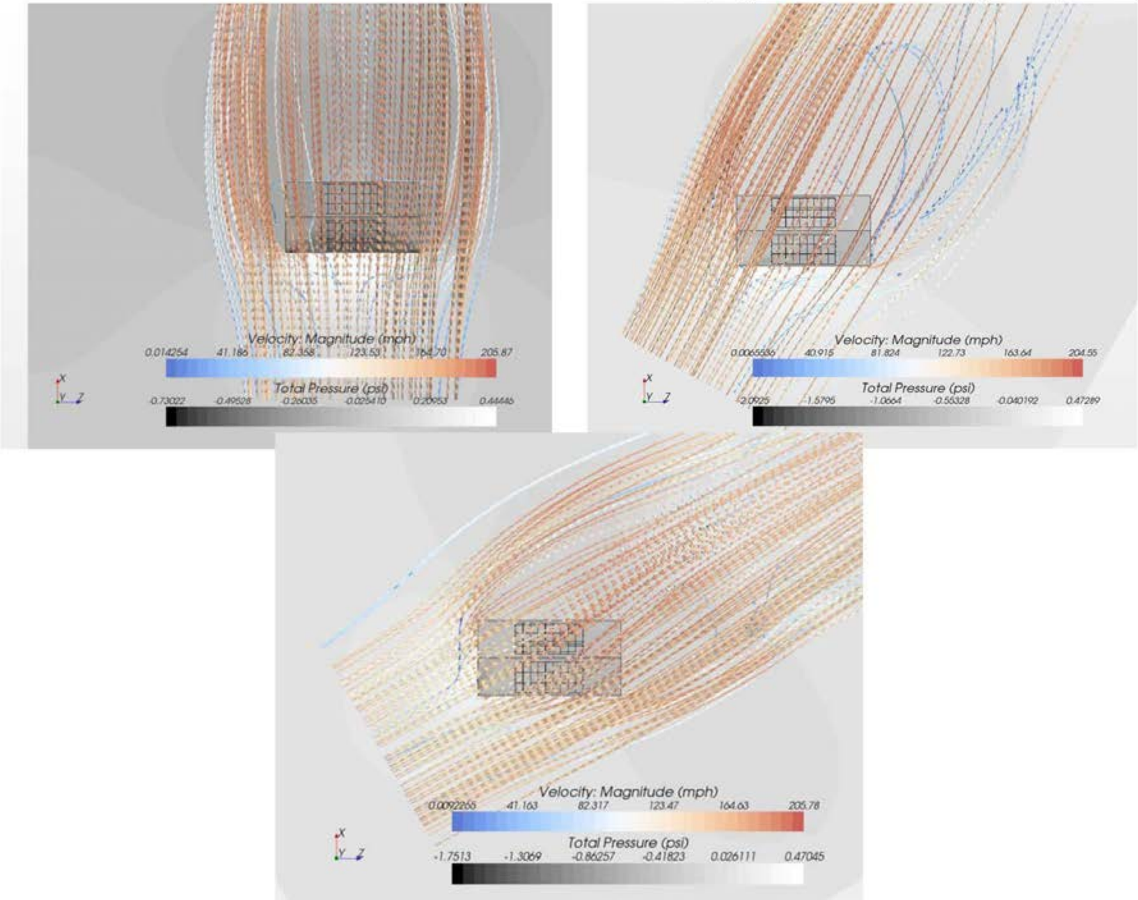
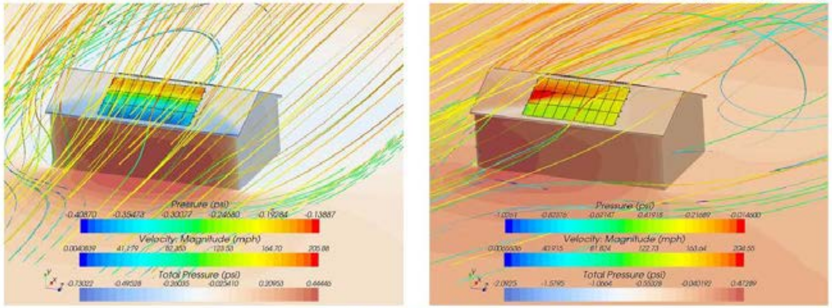
Computational Fluid Dynamics Model

Centecorp

Award Number: DE-SC0010161
Project Title: "Real-time POD-CFD Wind-Load Calculator for PV Systems"
Company Name: Central Technological Corporation (CENTECORP)



Wind Load Calculator



Award Number: DE-SC0010161
Project Title: "Real-time POD-CFD Wind-Load Calculator for PV Systems"
Company Name: Central Technological Corporation (CENTECORP)

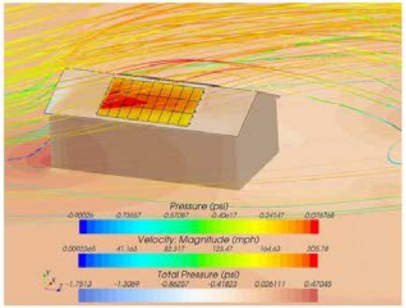


Figure 7: Streamlines colored by velocity and pressure contour plot of panel assembly, roof, and ground.

Configurations are: 0° (Top Left), 30° (Top Right), 60° (Bottom). 3D view.

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Real-time POD-CFD Wind-load Calculator for PV Systems

A web-based calculator which utilizes Computational Fluid Dynamics (CFD) and Proper Orthogonal Decomposition (POD)

Wind loading calculations for structures are currently performed according to the ASCE 7 standard. The values in this standard were calculated from simplified models which do not account for turbulence generation and dissipation, 3D effects, as well as minor effects. Attempts to apply this standard may lead to significant design errors as wind loads are incorrectly estimated.

A real time response framework based on the Proper Orthogonal Decomposition (POD) method is used to provide a solution that would not only take advantage of the great detail and accuracy of a grid-converged 3D CFD analysis, but also calculates in real-time the loads that result from wind-induced drag and lift force on PV systems.

The key is to generate beforehand an off-line extensive set of solutions using CFD within our defined design space (various modules sizes, wind speed, topography, roof dimension and pitch, etc.) and store them in a database.

The web-based wind-load calculator would then access the database of known solutions, and generate in real-time an approximated solution by means of the POD method, which can be thought of as a multifaceted interpolation that preserves the physics of the problem.

Because the POD method can produce a low-order approximation of the solution field with minimal loss of accuracy and fidelity, it serves as a reliable, fast and accurate response surface within the design space than can enable a real-time web-based calculator.

In addition. The POD algorithms rely uniquely on algebraic manipulation of previously generated field data, the entire POD modelling framework can be implemented in modest platforms such as laptops and tablets while allowing for 'true' real-time prediction of design parameters.

Centecorp
Central Technological Corporation

DOE Award 2013
Real-time POD-CFD Wind-load Calculator for PV Systems

SATOP Award 2011
By Ryan S. Greenough
Director and Sr. Program Engineer
-Space Alliance Technology Outreach Program-
Florida

TOOL BENEFITS

1. This tool will accelerate solar deployment nationwide.
2. It will reduce the total installed cost of solar energy systems by 75%
3. It will reduce system design, installation and permitting cost since the calculator will suggest proper hardware configuration by calculating wind-loads in real time for any solar system design.

www.centecorp.com

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ATC Applied Technology Council

WINDSPEED BY LOCATION

Home | About This Site | Lat/Long Finder | Related Resources | Sponsors | About ATC | Contact

The purpose of the "Wind Speed Web Site" is to provide users with a site specific wind speed using the GPS coordinate system. On this website, users can retrieve wind speeds from ASCE 7-10, ASCE 7-05 and ASCE 7-93. Wind speeds are also provided for serviceability purposes for 10, 25, 50 and 100-year return periods.

The reason this utility is needed is that the spatial resolution of the wind speed maps that are displayed in ASCE 7 are not sufficient to determine a site specific wind speed. There are no reference city or town locations on the ASCE 7 maps and while county boundaries are shown, the resolution is affected when the maps are expanded large enough to distinguish the boundaries and approximate the city locations.

To find the windspeed for a specific area, select one of the following methods:

1. Click the radio button for decimals and enter latitude and longitude in the spaces in decimal form and select "Get Windspeed" or
2. Click the radio button for address and enter the desired address; Select "Find" to auto-populate the latitude and longitude and select "Get Windspeed" or
3. Find the site on the map, right click the mouse and the latitude and longitude will be displayed in decimals. The coordinates auto-populate in the decimal location. Select "Get Windspeed" or
4. If your site is in the US Virgin Islands, Guam, American Samoa or Hawaii, click the appropriate radio button below and select "Get Windspeed".
5. If you are unsure of the location use the "Lat/Long Finder" tab at the top of the page to enter an address and retrieve a latitude and longitude.

Windspeeds are site-specific for the GPS coordinates provided and are found by interpolation to the nearest 1-mph.

Decimal (Enter Decimal Value)

Latitude: 28.3863994 | Longitude: -80.755056599

Address (Enter Complete Address Below)

1679 Clearlake Road, Cocoa, FL 329 [Find]

US Virgin Islands

Guam

American Samoa

Hawaii

[Get Windspeed]

Visit Our Partners

New App-Calculate Wind Pressures

ATC Support this site through sponsorship

Powered by SunShot U.S. Department of Energy

Search Results

Latitude: 28.3643
Longitude: -80.6086

ASCE 7-10 Wind Speeds
(3-sec peak gust MPH*):

Risk Category I: 137
Risk Category II: 148
Risk Category III-IV: 159
MRI 10 Year:** 83
MRI 25 Year:** 99
MRI 50 Year:** 110
MRI 100 Year:** 121

ASCE 7-05: 127
ASCE 7-93: 98

*MPH(Miles per hour)
**MRI Mean Recurrence Interval (years)

Users should consult with local building officials to determine if there are community-specific wind speed requirements that govern.

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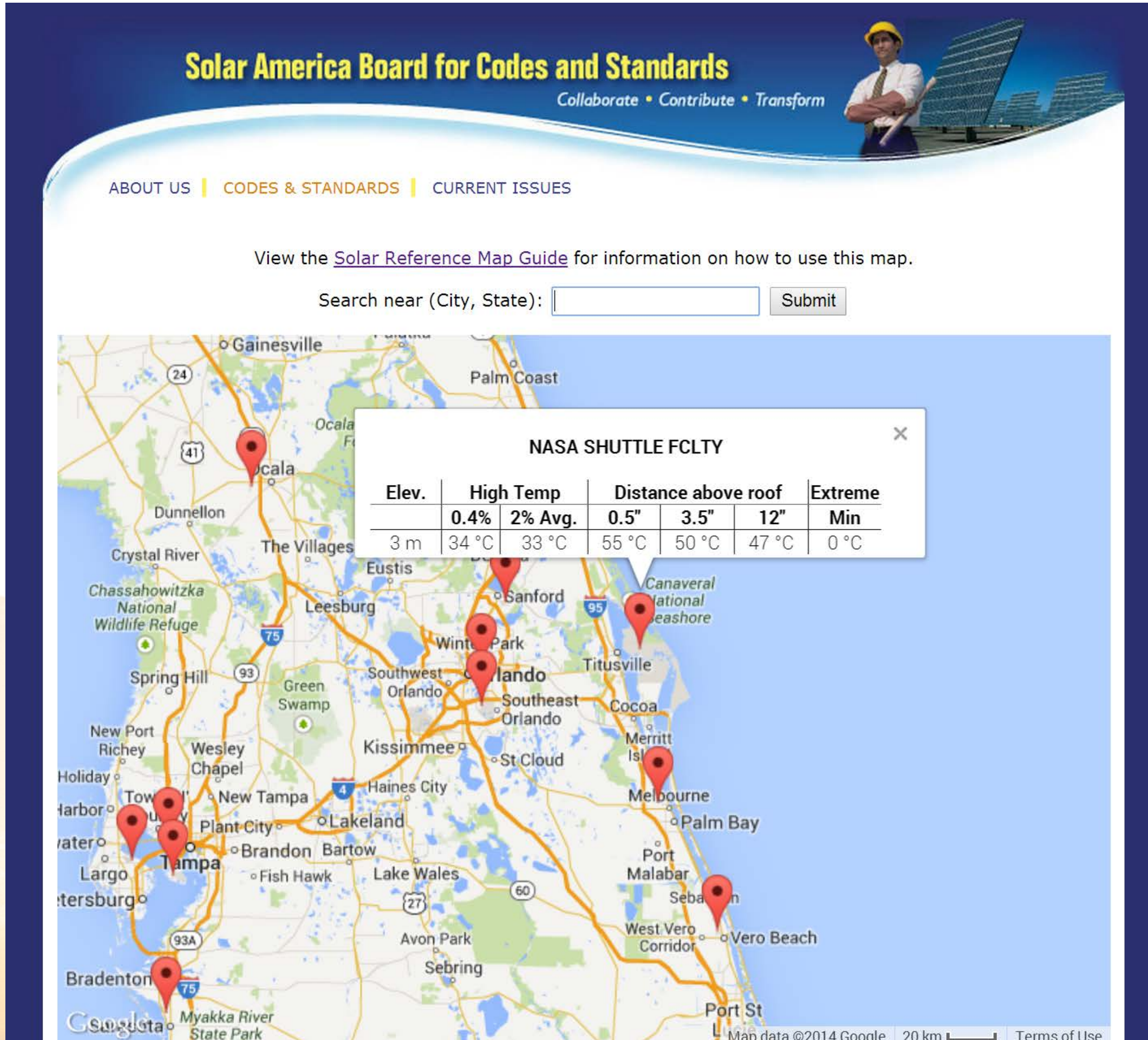
Solar ABCS Temperature Map

Input:

Zip code

Output:

Electrical design parameters



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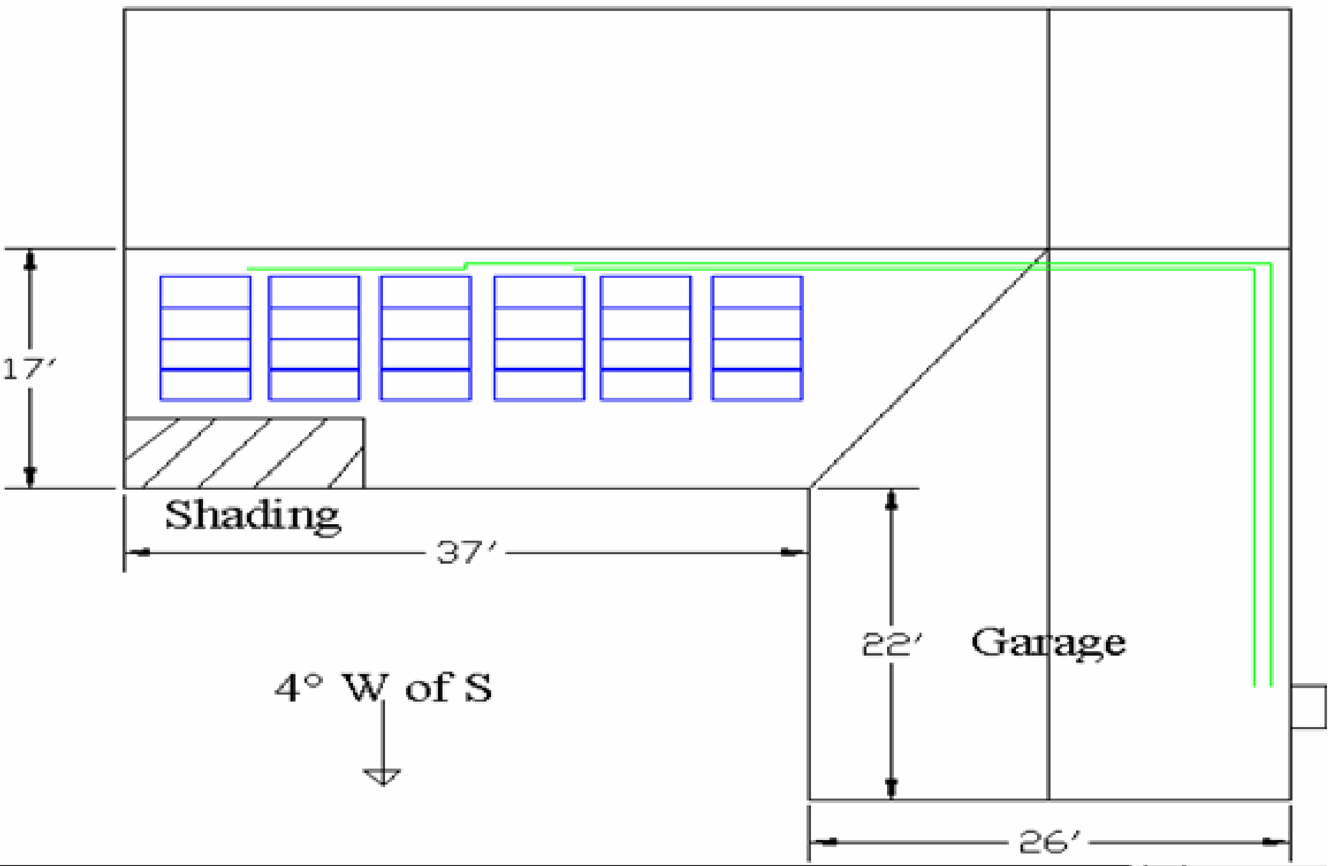
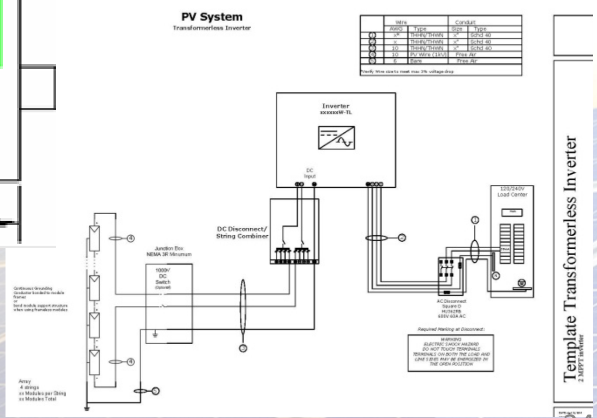
Array Layout Sketch





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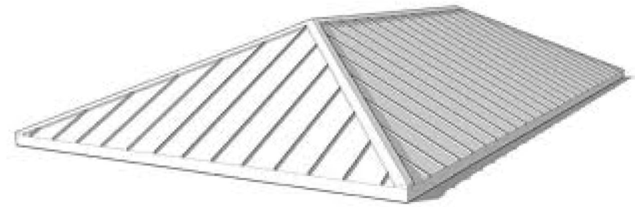
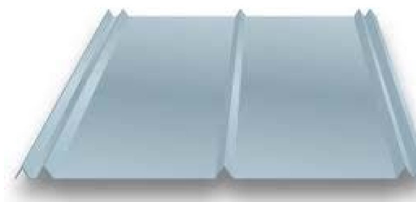
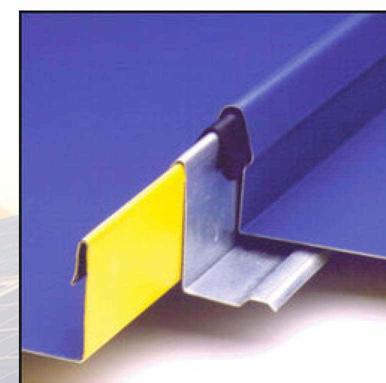
Automated System Design Tool Limitations

Roof Types



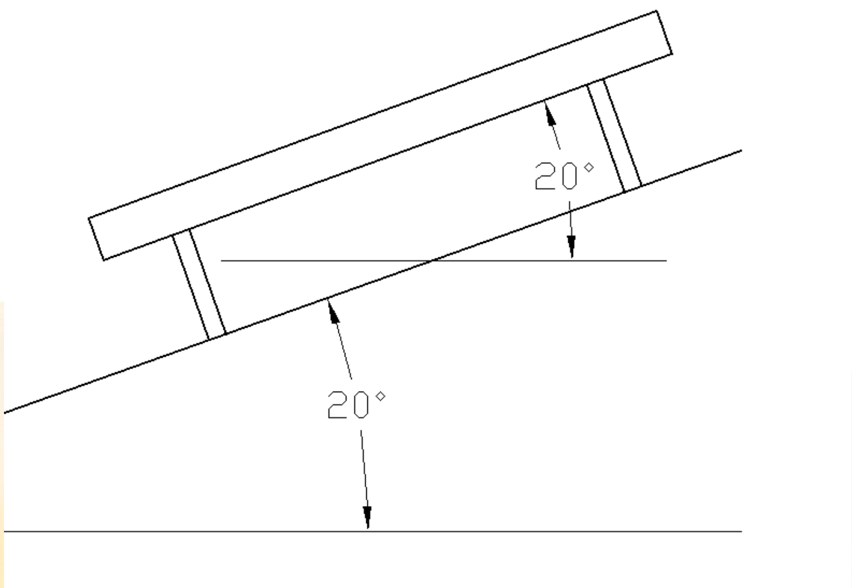
Source: Quick Mount PV



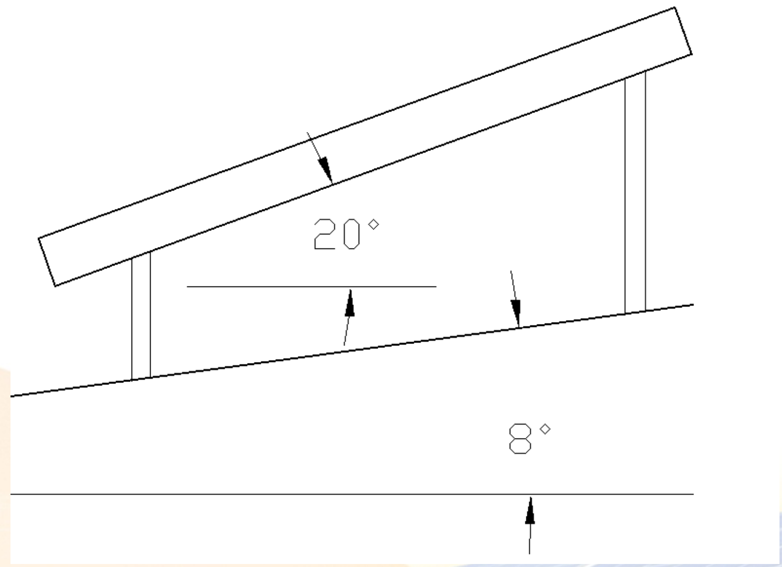


PV Arrays on Rooftops

Two general categories for roof mounted PV arrays



1) Above and parallel to the roof plane



2) At a tilt relative to the roof plane

Design Loads

- UL 1703 describes the structural loading tests for PV modules
- Minimum design load
  30 psf* 1.5 = 45 psf
- The Design Load can be greater if specified by the manufacturer

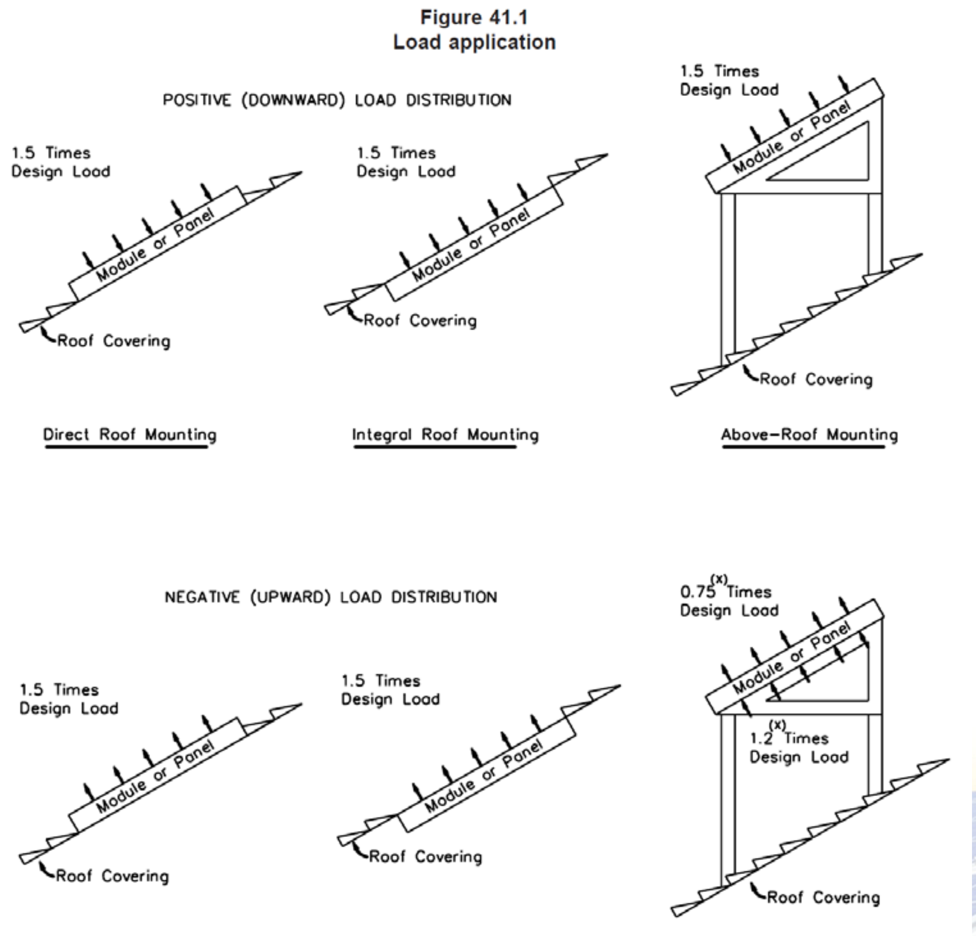


Figure from UL 1703 Test Standard

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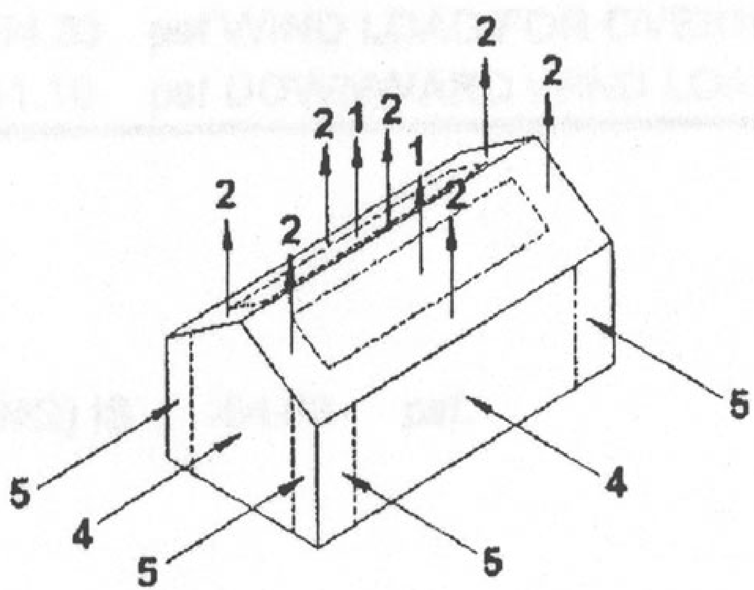
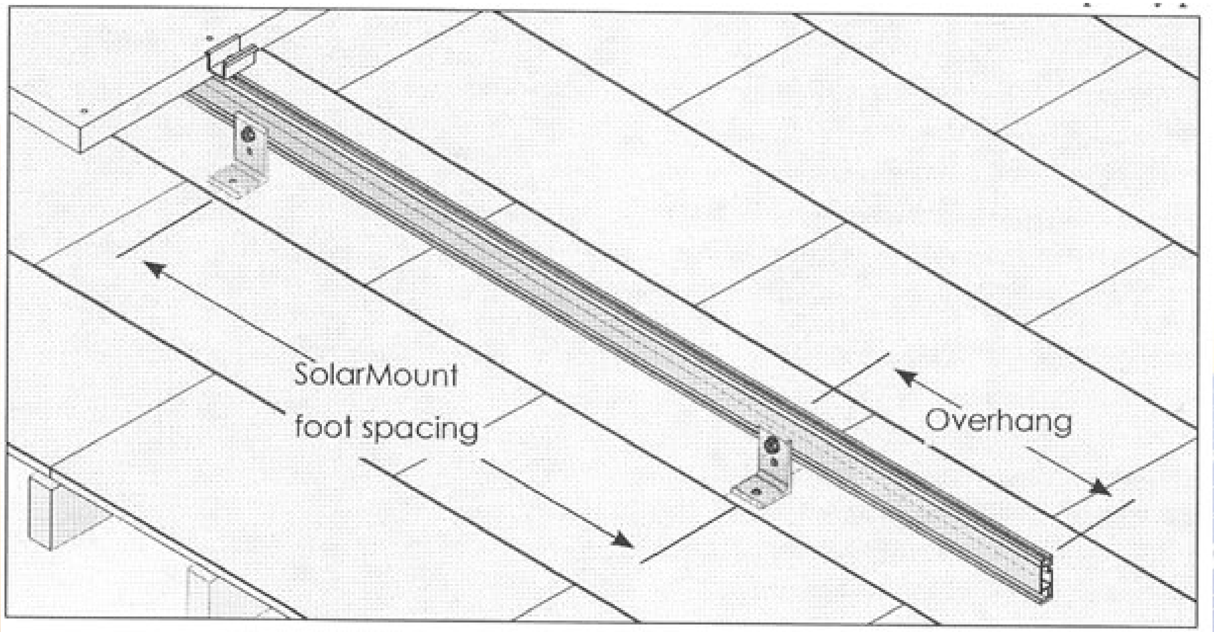
Net Design Wind Pressures

- Roof Component and Cladding design pressures can exceed 100 psf
- Upward (negative) design pressures typically exceed the downward (positive) for components and cladding
- 50 psf meets requirements for 100 mph wind zones
- May be exceeded in 100+ mph wind zones
- Arrays should be installed in the interior zone of the roof to minimize the wind loading

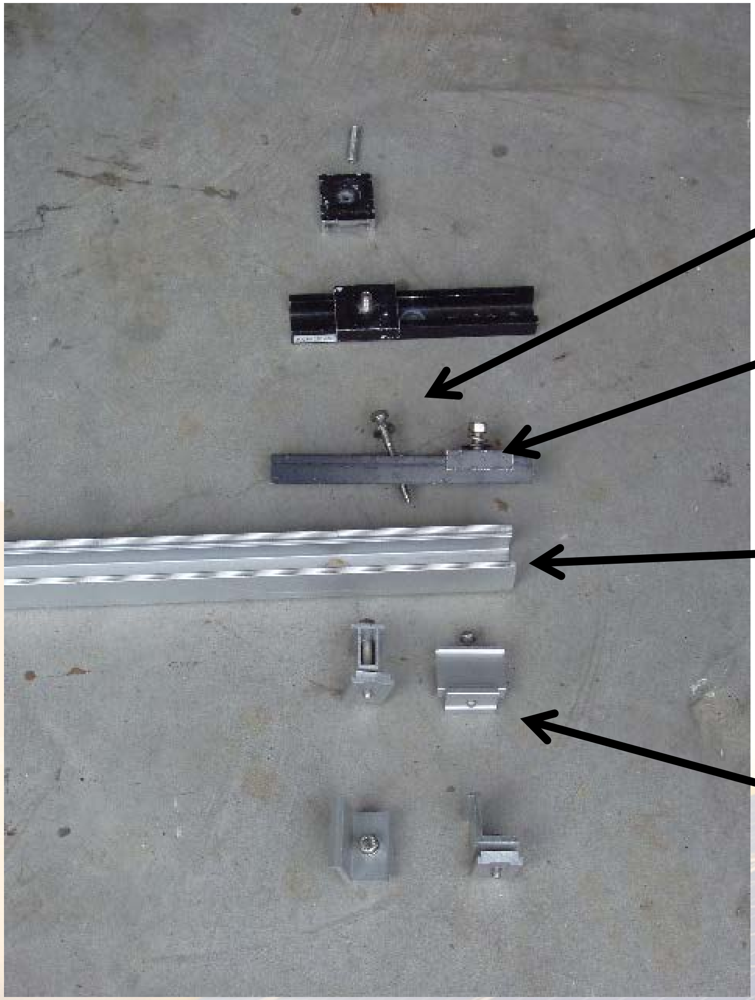


Mounting Hardware

- Array mounting rails and attachments transfer loads from the modules to the structure
- Loads can be concentrated and may exceed the design strength of structural members if installed incorrectly



Module Attachment Hardware



Roof Attachment with lag screw

Attachment for rack

Rack for the Array

Hardware to attach the modules to the rack

Building Integrated PV Limitations

Photo courtesy of USSC

Rooftop PV Array Installation Process

Pilot Hole for Truss

- A pilot hole should be drilled to prevent splitting the wood.
- The drill bit used should be 50-75% of the shaft diameter of the lag screw.
- For softer wood use a smaller pilot hole; for harder wood use a larger one.

Attachment to Trusses

- High-quality, roof-compatible caulk should be applied before attaching the mounts to roof

Attaching the Array Rack

- Additional piece provides a point of attachment for the aluminum rack
- Aluminum rack is then placed over the bolts protruding from the mounting hardware.

Rack and J-Box

- Making sure module J-box doesn't hit the rack

Securing Rack in Place

- Once the rack distance has been determined, the rack can be fastened to the roof attachments.

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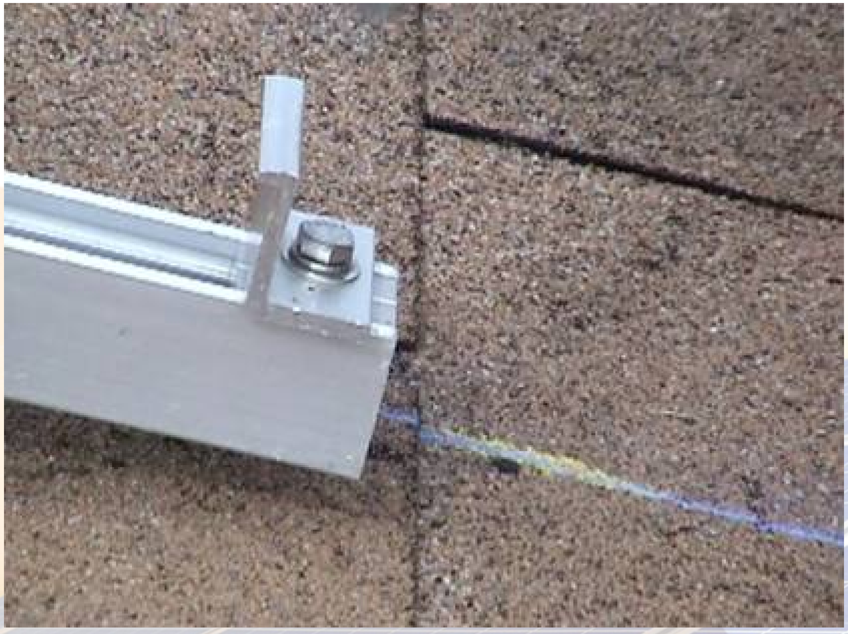
Module Fasteners

- Special assemblies are then used to attach the modules to the rack.

◆ These assemblies slide in the groove at the top and bottom of the rack and clamp the aluminum frame of the module in place.



Attaching the Modules

- The aluminum frame of the modules then slips under the clamps and are secured with a bolt and socket wrench.

Wiring Modules Together

- Once the array is installed, the modules can then be wired in series using the quick connects provided with each module.

Questions?