

PV Codes and Standards Gap Issues

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as the Administrator of the Solar America Board for Codes and Standards

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Introduction

Under contract to the National Renewable Energy Laboratory, Sherwood Associates conducted a gap analysis by surveying stakeholders, industry, utilities, state and municipal agencies, and enforcement community to identify their most urgent and important needs for emerging codes and standards.

This report summarizes the gap analysis and includes four parts:

1. **Process** described the process used to conduct the gap analysis.
2. **Summary of Topics Rated the Highest Priority**
3. **Detailed Description of the Highest Priority Topics.** The section includes information on the action required for each proposed gap topic.
4. **Detailed Description of Other Gap Topics.** This section includes a similar list to the previous section for those topics not included in the highest priority.

Process

The gap analysis process solicited input from a broad group of stakeholders involved in PV codes and standards. The gap analysis was conducted in late 2014 and early 2015 and over 50 stakeholders participated in the process.

Prior to soliciting stakeholder input for Gap Analysis, the Solar ABCs Administrator developed a list of potential gap topics suggested by stakeholders over the past several years.

Next, in the July 2014 Newsletter, Solar ABCs requested Gap Analysis input from all stakeholders. This was followed by the annual Solar ABCs Stakeholder meeting on October 23, 2014, during which the Administrator briefed stakeholders on the Gap Analysis process and encouraged Stakeholders to submit potential topics. Stakeholders submitted proposed topics to the Project Administrator as a result of these requests.

The Solar ABCs Administrator compiled a list of about 100 stakeholders for the remainder of the gap analysis process. The list included members of the former Solar ABCs Steering and Advisory Committees, stakeholders who have participate

din recent Solar ABCs meetings and other stakeholders chosen to represent a diversity of stakeholder groups.

To this list, the Administrator sent a draft list of gap topics with action required for each topic. Input was requested and a webinar held on January 7, 2015 and attended by 31 stakeholders. In addition to the webinar, the Administrator received numerous e-mail suggestions and met individually with many stakeholders. The final result of this process was a list of 46 gap topics with action required for each topic.

Next, the Solar ABCs Administrator send the gap list to the Stakeholder list and asked each stakeholder to vote for the 12 items they felt were the most important. Thirty-three stakeholders voted for the highest priority topics.

The priority vote gives a good picture in a general sense of the high priority topics, but is not perfect. Stakeholders are more likely to vote for topics with which they are familiar and did not have an opportunity for discussion on the importance of the proposed topics. This can skew the results based on the expertise of the stakeholders who actually voted.

Summary of Topics Rated the Highest Priority

1. Fire Fighters and solar industry have different views on requirements for module level disconnect.
2. Fire fighters are unsure how to fight fires safely around PV installations.
3. Some insurance companies have PV loss concerns that cause them to recommend against installing solar.
4. Continued involvement of stakeholders in NEC development process.
5. Arc-fault standard needs to be adopted.
6. Draft UL standards have been developed (combiner boxes, etc.) but not adopted.
7. Better address storage technologies in NEC.
8. Need a qualification standard for distributed array electronics.
9. IEEE 1547 does not allow the functions required to PV to operate in high penetration environments.
10. Need stakeholder education on grid connection standard changes and requirements.
11. UL 1703 fire test procedure should be updated to clarify and fix problems.
12. Stakeholders are unaware of current fire test requirements and/or are confused about them.
13. Ground-fault requirements need to be added to inverter standards.
14. Wind upload requirements for flush-mounted solar arrays.
15. Building code requirements related to fire rating requirements are confusing.
16. Need standard for operation and maintenance requirements.
17. No safety standard exists for disconnect devices

Detailed Description of High Priority Topics

National Electrical Code

GAP	ACTION REQUIRED
Need continued involvement of stakeholders in the NEC development process	Stakeholder meetings to develop recommendations and respond to proposals for changes to the NEC
Use of storage is increasing rapidly and codes and standards are not ready to provide for safe installation of new storage technologies	Stakeholders need to develop consensus recommendations on storage issues.

Grid Connection Standards

GAP	ACTION REQUIRED
IEEE 1547 does not allow the functions required for PV to operate in high penetration environments <ul style="list-style-type: none"> • Voltage and frequency ride-through • More descriptive of voltage regulation • Need to separate requirements for inverters and rotating machines 	<ul style="list-style-type: none"> • IEEE 1547 needs to be revised • Good collaboration underway between industry, utilities, national labs, EPRI
Ground fault requirements need to be added to inverter standards	<ul style="list-style-type: none"> • Group is working to develop recommended language for 62109-2 • Resources would help speed this development.
Arc-fault standard needs to be adopted	<ul style="list-style-type: none"> • UL 1699B in development and ballot by STP • Needs additional work
Several draft UL standards have been developed (combiner boxes, etc.) but have not been adopted as national standards	<ul style="list-style-type: none"> • Resources needed to complete work on these new standards
Need stakeholder education on grid connection standard changes and requirements	<ul style="list-style-type: none"> • Webinars and other educational outreach

Distributed Array Electronics

This is an important and controversial issue in the 2014 and 2017 National Electrical Code Revision cycle.

GAP	ACTION REQUIRED
Fire fighters and the solar industry have different views on requirements for module level disconnect	Convene meetings between fire fighters and the solar industry to develop common ground on this issue
No safety standard exists for disconnect devices	<ul style="list-style-type: none">• UL 1741 STP should develop requirements to list and certify disconnect devices.• UL preparing proposal and should go to STP soon.
Need a qualification standard for distributed array electronics (similar to IEC 61215)	<ul style="list-style-type: none">• Need to test in various environments to make sure they are adequately designed

Wind Loads

GAP	ACTION REQUIRED
Wind tunnel research by Dr. Greg Kopp at the University of Western Ontario, indicates that ASCE 7-10 significantly overestimates wind uplift loads on flush roof-mounted solar arrays, resulting in costlier installations.	Support Greg Kopp's proposal to incorporate his findings in the next edition of ASCE 7, Minimum Design Loads for Buildings and Other Structures. For many flush-mounted arrays ("air-permeable cladding"), design wind uplift loads would be 65% of current code – the greatest reduction allowed based on wind tunnel studies.

Fire Classification Rating

A new fire classification rating tests was adopted into the UL 1703 standard in October 2013. Solar ABCs convened a meeting of stakeholders in September 2014 and they developed the following action items for this test requirement.

GAP	ACTION REQUIRED
The UL 1703 test procedure should be updated to clarify ambiguous requirements and to fix problems.	A Committee, chaired by Chris Flueckiger of UL, is working on recommended changes.
Authorities Having Jurisdiction (AHJs), manufacturers, and installers are unaware of the current code and standard requirements or are confused about them.	Educate Authorities Having Jurisdiction (AHJs), manufacturers, and installers on the new code and test requirements. <ul style="list-style-type: none"> • Training • Hotline or method for AHJs to get answers when they have questions
Building Codes requirements related to fire rating requirements are confusing	Proposals for recommended changes to the International Building Code should be submitted to the ICC Code revision process.

Qualification Standard for large installations

GAP	ACTION REQUIRED
Need standard for operation and maintenance requirements	<ul style="list-style-type: none"> • Sandia has a working group on this topic. They have identified more specific gaps. • IEC-RE has formed a new conformity assessment system and is now writing rules so system certification audits can begin by the end of 2015.

Fire Fighter Safety Concerns

GAP	ACTION REQUIRED
Firefighters are unsure how to fight fires safely around PV installations	<ul style="list-style-type: none"> • Develop model Standard Operating Procedure language that local fire service can adopt. Will require several different models to complement different SOPs. • Educate firefighters on safely fighting fires around PV installations

Insurance Industry Concerns

GAP	ACTION REQUIRED
Some insurance companies have PV loss concerns that cause them to recommend against installing solar.	<ul style="list-style-type: none">• Discussion between insurance industry and solar stakeholders to understand concerns and develop recommendations to mitigate concerns.• Implement recommendations

Detailed Descriptions of Other Gap Topics

National Electrical Code

GAP	ACTION REQUIRED
Utility-scale installations are not well addressed in the NEC and requirements in the NEC and NESC are not harmonized	Good progress has been made on this issue in the current NEC code cycle. Need to continue this work and harmonize requirements in the NEC and NESC.
Large-scale utility systems are designed improperly and do not meet requirements of the NEC	<ul style="list-style-type: none"> • Inspection by AHJs • Education for engineers on applying code and standard requirements
NEC needs to better address the use of Micro-grids	Good progress has been made on this issue in the current NEC code cycle. Need to continue this work.
Do BIPV systems have a higher rate of fires? (Evidence from Germany suggests this might be the case).	Research BPIV systems to determine if this is a real problem that needs to be addressed.

Grid Connection Standards

GAP	ACTION REQUIRED
Standards need to be revised to implement new California Rule 21 requirements	<ul style="list-style-type: none"> • UL 1741 STP needs to approve a special appendix for advanced inverter functions. (Group has been working to develop proposal and should be ready to go to ballot soon). • IEEE 1547 needs to be revised to harmonize with these California requirements.
Temporary and transient overvoltage are not well understood for inverters, resulting in grounding transformer requirements that may be unnecessary and restrictions in high penetration areas	<p>Following action identified by industry group working on these issues. Additional resources are required to fully implement this plan.</p> <ul style="list-style-type: none"> • Develop and validate tests for Ground Fault Overvoltage and Load Rejection Overvoltage (some tests underway by Solar City and NREL). • Conduct public tests that can be used for IEEE Standard development (need resources) • Develop generic transient model(s)

	for inverters (need resources) <ul style="list-style-type: none"> • Incorporate tests as optional requirement in UL 1741 • Incorporate requirements/knowledge in IEEE standards (need resources)
Do utilities need to require external disconnect switches?	<ul style="list-style-type: none"> • Need a best practices document and education

Snow Loads

GAP	ACTION REQUIRED
Snow loads around rooftop solar installations are poorly understood	Conduct research to understand snow loads around rooftop solar installations <ul style="list-style-type: none"> • Michael O'Rourke of Rensselaer Polytechnic Institute conducted a recent study in conjunction with FM Global and MBMA.
Snow sliding from solar installations can cause injury.	Conduct research on this issue and develop recommendations for best practices and code changes.
Power production is reduced when covered with snow	Develop method to predict reduced power production from snow cover.

Wind Loads

GAP	ACTION REQUIRED
No guidance to determine load-sharing capability of rack systems for determining appropriate wind averaging area.	Research is needed to develop this guidance and then code change recommendations.
Parking lot structure failures need to be prevented	Recommended structural requirements need to be developed and recommended for code changes.
Wind load issues for utility scale ground mount systems are not addressed well in ASCE-7	Need research on this issue that will lead to a code change proposal.
Many solar manufacturers recommend flush mounted array anchors at six feet on center in moderate wind zones, while conventional overly-simplistic analysis of the supporting roof structure incorrectly suggests a four feet spacing because rafters are treated like separate “piano keys” with no load sharing between rafters.	Recognize and support the use of the “Concentrated Load Sharing Factor” described in the Structural Technical Appendix to the California Solar Permitting Guidebook, Second Edition. Plywood roof sheathing interconnects rafters, causing concentrated loads on one rafter to be shared with adjacent rafters. The effective rafter strength is in the range of 1.25 to 2.00 times the single loaded rafter, and depends on the relative stiffness between sheathing and rafters. This “Concentrated Load Sharing” effect differs from the “repetitive member factor” of 1.15 currently recognized by the code.
Code evaluation reports for wind uplift capacity of solar array manufactured mounts are based on standards for joist hangers designed to carry long duration (ten year) loads, and prohibits the 1.60 short duration wind load capacity increase that the building code normally allows. The result is that allowable capacities based on testing for solar anchors have a factor of safety 1.60 times more conservative than the factor of safety for structural collapse-critical floor joist and girder connections.	Work with the two major structural product evaluation agencies, ICC and IAPMO, to amend ICC AC 13 and IAPMO EC 002 respectively, to allow load duration capacity increases based on testing. Alternatively, work with ASTM International to amend ASTM D7147 (referenced by both AC 13 and EC 002) to properly address connections loaded in short duration wind uplift, or add a new ASTM specifically addressing solar array connections to wood framing that resist wind uplift.

Corrosion

GAP	ACTION REQUIRED
Many methods are available to identify potential risk from corrosion	Need guidance on how to use and interpret the many different corrosion risk methods
Corrosion is frequently observed in combiner boxes	Need to understand cause and if this requires changes to standards or codes

Fire Classification Rating

A new fire classification rating tests was adopted into the UL 1703 standard in October 2013. Solar ABCs convened a meeting of stakeholders in September 2014 and they developed the following action items for this test requirement.

GAP	ACTION REQUIRED
Industry Solutions (to reduce the number of tests required by testing and certifying generic systems) should be made useable to industry.	<ul style="list-style-type: none"> • Funding is needed for additional Industry Solution tests to increase the number of generic solutions available. • A stakeholder group needs to develop and provide advice on these tests. • UL needs to recommend what options are available to put the results from previously conducted tests to use.
The new fire rating test should be adopted into UL 2703.	A joint UL 1703/2703 task group is needed to align the standards and prepare a transition schedule.
Building Codes requirements related to fire rating requirements are confusing	Proposals for recommended changes to the International Building Code should be submitted to the ICC Code revision process.
Do not know if test results from different labs are consistent	Conduct round robin testing
Roofing requirements in the test are difficult to consistently meet and add variability to the test	Develop a second burner test that can be incorporated into the standard. UL conducted initial tests, but further research is required to make this test ready for adoption into the standard.

Expedited Permit Process

Solar ABCs developed an expedited permit process for small PV systems and published a report and fill-in forms. This process is widely used as the basis for expedited permit processes around the country. Hundreds of people download the Solar ABCs report and forms each month.

GAP	ACTION REQUIRED
The Solar ABCs process becomes out-of-date as codes change.	<p>Update the Solar ABCs process to reflect code changes and experience using the process. Include consensus structural requirements for small systems:</p> <ul style="list-style-type: none"> • Use the California Solar Permitting Guidebook as model • SEAOC has a task group working on this issue • John Wolfe of Mar Structural Design was the lead consultant for drafting the structural guidelines for California – need to extend data developed for CA Guideline to high wind and high snow load areas • Sandia Labs has done testing to gather empirical data
The Solar ABCs process should be expanded to larger systems.	<p>Discuss with stakeholders and document if an expedited process is applicable to larger systems. If yes, then develop the process.</p>

Qualification Standard for large installations

GAP	ACTION REQUIRED
Need qualification standard for large installations to give assurance to financial investors and insurance companies	<ul style="list-style-type: none"> • ASTM is developing a standard • IEC-RE has formed a new conformity assessment system and is now writing rules so system certification audits can begin by the end of 2015.

Fire Fighter Safety Concerns

GAP	ACTION REQUIRED
<p>California Building Code Section 3111 was added in the latest code cycle to require 3 feet clearance to most roof ridges, hips and gable ends, in order to provide safe access for firefighters to punch hot-gas ventilation holes in roofs. This removes a large fraction of residential roof area from being covered with solar arrays.</p>	<ul style="list-style-type: none"> Allow the clearance to be reduced to 18 inches at the discretion of the local fire chief (as formerly allowed by jurisdictions such as the City of Berkeley). Amend the code exception language to describe in more detail the circumstances where this access path is not needed because “alternative ventilation methods” are provided or where “vertical ventilation techniques will not be employed”.

FM Global Concerns

GAP	ACTION REQUIRED
<p>FM Global and UL fire rating requirements are different, causing confusion, increasing compliance costs and making installation difficult on some buildings</p>	<p>Need to harmonize FM Global and UL fire rating standards.</p>
<p>Controversy over FM prevention loss requirements for installing non-penetrating PV systems only on fully adhered membranes.</p>	<p>Research needed to determine if concerns are valid.</p>

Nationally Recognized Testing Laboratory Issues

<p>Electrical equipment is improperly listed/labeled to the wrong UL standard. Electrical equipment is listed/labeled, but not consistent with current UL Standards.</p>	<p>AHJs need an avenue to hold the NRTL accountable for their oversight at the federal level.</p>
<p>No standardization of listing/labeling of the common components used in large utility-scale systems</p>	

Sustainability Standards

GAP	ACTION REQUIRED
Concern about what happens to chemicals in PV modules at the end of PV module life.	Develop a standard for recycling and disposal of PV modules at the end of their life.