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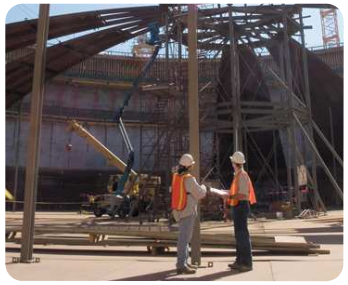




Ensuring System Quality for the California Solar Initiative

加州太阳能行动计划的质量保障体系

Beijing Workshop

December2010

Agenda 日程

- How is solar PV system “Quality” ensured for customer sited systems? 对基于用户侧的光伏系统质量，其系统质量如何得到保障？
- This question is explored in this Case Study of California, the largest solar market in the United States. 加州是世界上最大的太阳能市场，在加州案例的研究里，探讨了这个问题 。
- In California, a mix of international, national, state, and program-specific standards are used to ensure quality. 在加州，有国际的、国内的、州的、项目特定的等多个标准在执行，为了保障质量。

California Solar Initiative 加州太阳能行动计划（CSI）

- California is the largest solar market in the U.S.

  加州是美国最大的太阳能市场。

- $3.3 billion CA ratepayer funded total solar program budget with a 3,000 MW goal.

  加州的电费支付资金资助的太阳能项目，目标：3GW，预算：33亿美元。

  - Projects are all customer sited (e.g. behind the meter)， not wholesale projects. Residential and Commercial. 1 MW maximum size.
    项目全都是基于用户侧的（在表后面），不是趸售项目，住宅的和商业的，最大1MW。

- CSI program totals to date (November 2010):
  全部CSI计划截止到2010.11月

  - Installed: 422 MW at 39,845 sites 已经安装：422MW在39845个地方。
  - Applications: 446 MW at 12,514 sites 申请：446MW在39845个地方。

Quality Components in California 加州的质量构成

- National Standards: 国家标准
  - Underwriters Laboratory (UL) (Modules, Inverters) Underwriters 实验室（UL）（组件，逆变器）
  - National Electric Code (NEC) (System Design) 国家电气标准 （NEC）（系统设计）
  - Institute of Electrical and Electronics Engineers (IEEE) 电气和电子工程师研究所
- California Standards (CEC) (Modules, Inverters) 加州标准 （CEC）（组建，逆变器）
- Inspections: 检查
  - Local Electrical Authority 地方的电力部门
  - Utility 电力
- Ongoing Maintenance: 10-year warranty Required 维护：要求10年的质量保证。
- Incentive paid for production, not installed capacity, on larger systems 较大的发电系统，针对发电，为非安装容量，给予鼓励 。

PV System Quality Components in California

Design
设计

- UL Listed Modules and Inverters Required
  要求：列入UL的组件和逆变器。
- CEC Approved Modules and Inverters Required
  要求是加州能源委批准的组件和逆变器
- System Design stamped by licensed engineer to comply with NEC
  系统设计要求有资质的工程师来完成，符合国家电气规程

Installation
安装

- Installer obtains C-46 license
  安装人员要求获得C－64执照
- NEC 690 compliance – local inspector
  当地的验收人员要遵守NEC 690
- Utility Inspects
  电力系统检查

Operation
运营

- Installer required to offer 10-year Warranty
  安装要求保证质量10年。
- Performance Based Incentive
  实施基于表现的奖励

This process is focused on California – the most mature US Solar PV market. Processes are similar in other states.

本过程主要针对加州－作为美国最成熟的光伏市场。其他州办法相类似。

Key National Standards: National Electric Code
主要国标：国家电器规程

- Uniform National Code focused on safety of electrical wiring. Section 690 deals specifically with photovoltaic systems (grounding, wire size, string sizing, etc). 国家规程均注重电气接线安全。第690节专门针对光伏系统的（接地、线粗细，组串大小等）。
- This is the code that local electrical inspectors ensure that photovoltaic systems meet. 本规程中规定当地的电气检查员要确保光伏系统可满足要求。
- American National Standards Institute (ANSI) standard. 美国国家标准化研究院标准。

Key National Standards: ANSI/IEEE 1547

关键的国标： ANSI/IEEE 1547

- A uniform standard for interconnection of distributed resources with utilities. It provides requirements relevant to the performance, operation, testing, safety, and maintenance of the interconnection. Adopted in 2003. 是分布式发电接入电网的一个统一标准。它提出与性能、运行、测试、安全和接入维护的要求，于2003年施行。
  - Installation of distributed generation on radial primary and secondary distribution systems is the main emphasis of the standard.

    本标准重点在于径向的一级和二级分布系统上的分布式发电的安装。
  - It includes specifications for: response to abnormal conditions, power quality, islanding, and test specifications and requirements for design, production, installation evaluation, commissioning, and periodic tests. 包括：异常条件的响应、电能质量、孤岛的特性和测试特性，以及设计、发电、安装评估，调试、周期测试的要求。
  - Applies to systems 10 MVA or less. 应用与10MVA系统及以下。
  - Incorporated into UL 1741 合并入 UL1741.

Key National Standards: UL 1703 and UL 1741
关键的国家标准：UL1703和UL 1741

- UL 1703:
- Concerned with safety and longevity of solar modules

  关注组件的安全和寿命。
- Standard based on IEC 61730 (international standard)

  本标准基于 IEC61730 （国际标准）
- Required by the NEC and the California Energy Commission (CEC)

  NEC和加州能源委（CEC）都要求遵守。

- UL 1741:
- Standard for fire protection and anti-islanding for Inverters

  本标准针对逆变器的防火、防孤岛。
- Incorporates ANSI/IEEE 1547

  包含： ANSI/IEEE 1547

UL Listing Required for Modules and Inverters

组件和逆变器要求经由UL认证

UL Certified Equipment Required

UL认证的
设备
必须的

- California, like most states, has adopted ANSE/IEEE 1547 as its Standard for Interconnecting Distributed Resources with Electric Power Systems

  向很多州一样，加州已采用ANSE/IEEE 1547，作为分布式发电电网接入的标准。

- System must use certified equipment from a list maintained by the California Energy Commission. Equipment must be IEC/UL certified

  系统必须使用经过认证的设备，设备被列入加州能源委的设备名单，设备必须经由IEC / UL认证：

  - Inverter: ANSI/UL 1741 certified 逆变器： ANSI/UL 1741 认证过的
  - Modules: IEC 61730/UL 1703 (Safety focused testing) 组件：IEC61730 / UL 1703 （专注安全测试）

- Underwriters Laboratories writes the testing procedures (for example 1741), but other organizations (Intertek ETL, CSA-Canada, TUV Rhineland) may perform the tests on equipment. UL编写测试操作的规程，例如1741，其他机构（例如：INtertek ETL， 加拿大的CSA，莱茵州的TUV ）可能对设备进行测试。

CEC Testing of Equipment 设备的CEC测试

CEC Certified Equipment Required

CEC认证 设备 要求的

- California Energy Commission tests, certifies and rates modules and inverters allowed for use in the CSI program 加州能源委对组件和逆变器进行测试、认证和评级，允许在CSI项目中使用。
- CEC maintains list of eligible equipment CEC认定合格设备的名单 (www.gosolarcalifornia.org)
- CEC testing is focused on performance CEC测试注重于性能。
- CEC uses the more “realistic” PVUSA Test Conditions (PTC). PTC specifies 20˚C *ambient* temperature vs. STC 25˚C *cell* temperature.
  CEC采用更加理想化的PVUSA测试条件（PTC），PTC规定20 ˚C的环境温度，而STC规定电池温度25 ˚C.

Contractor Licensing 承包商执照颁发

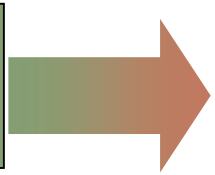
Installer 安装商

Qualifications 资格

- Contractor Licensing - C-46 Solar Contractor License in California 承办商执照签发－C46 加州的太阳能承包商执照。
- Exam covers planning and estimating, solar installation, service and maintenance and safety. 考核覆盖：规划和评估、太阳能设备安装、运行维护和安全。
- Exam questions cover codes, equipment names, calculations. 考核问题包括：规程、设备名称、计算。
- Issued by Contractors State Licensing Board. 由州承包商执照理事会签发。

National Electric Code Compliance 符合国家电器规程

NEC 690 compliance – local inspector



NEC 690 –
当地的核查员

- Local authority (city, town, or county electrical inspector) inspects both the design and the installed solar system to ensure it complies with National Electric Code (NEC) section 690. This covers issues such as grounding, breaker, and wire sizing. 地方当局（市、镇、县的电气核查员）检查太阳能系统的设计和安装，以确保其遵守国家电器规程（NEC）第690节，覆盖诸如接地、断路器、和线缆大小等问题。

Utility Inspection 电力部门检查

- Utility inspects system to see if it meets specifications, uses certified equipment, is sized properly, has required disconnects and interconnects with the grid properly. 电力系统检查，是为了查看是否满足性格参数、使用经过认证的设备、大小是否合适；要求能够恰当地断开和接入电网。
- This inspection occurs **before** system is energized. 这种检查在系统发电运行前进行。

Performance Based Incentives 基于性能表现的奖励

System 系统
Energized 提供电力

Performance Based Incentive
基于表现的性能的奖励

- The system owner only receives incentives/subsidy after the approval to energize the system. PV系统的所有者仅仅在获批系统可以运行发电后，才能获得奖励和补贴。
- For larger systems (< 30 kW), third party Performance Monitoring and Reporting is required.
  对于较大的系统，必须提供第三方的性能检测和汇报。
  - Incentive payments made based on reported performance.
    奖金支付的依据是所被汇报性能表现。
  - This provides incentive to the
    给PV系统的业主给于奖励，以保证系统能正确运行。

Installer Warranties 安装人的质保

Installer required to offer
10-year Warranty
要求安装商提供10年的
售后质量保证

- The installed is required to offer a 10-year warranty on the system to customers 对于已经安装、交付顾客的PV系统，要提供10年的售后质量保证。
- Most modules carry a 25-year warranty 多数的组件提供25年质量保证。
- Inverters have now started offering 10-year warranties 逆变器开始实施10年质量保证。
- Installer warranty covers the whole system 安装商的售后质保覆盖全部的系统。

Conclusion 总结

- No overall “Quality” standard for PV installation 没有全面的PV安装的“质量”标准
- National standards mostly focused on safety (NEC, UL) 大多数国标注重安全问题 （NEC,UL）
- California specific standards focus more on quality: 加州的个别标准更注重质量问题：
  - Installer certification, warranty requirements 安装人员证，售后的质保要求
  - Performance Based Subsidy 基予性能表现的奖励制度
  - Performance tests of equipment 设备的性能测试

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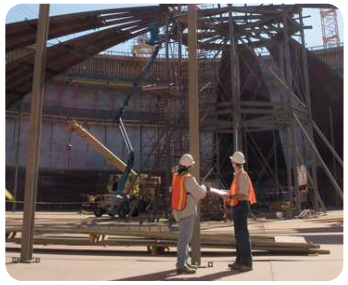



Backup and Reference Material

备份和参考资料

Reference Material: National Standards 参考资料：国家标准

1) The US Department of Energy – has limited authority to make standards, but has promoted streamlined interconnection processes. They released a "best practices" document in early 2007 that gives guidance to state and utility policymakers on interconnection. 美国能源部制定标准的权力是有限的，但在当时曾促进简化了电网的接入程序；早在2007年，能源部发布了一个叫"最佳实践"的文件，该文件对州和电力系统的政策制定人员在电网接入方面提供指导。

http://www1.eere.energy.gov/solar/pdfs/doe_interconnection_best_practices.pdf

2) The Federal Energy Regulatory Commission (FERC) sets national standards for interconnection, mostly in the wholesale, bulk power market. FERC Order 2006 outlines detailed requirements for small generator interconnection. That rule can be found at the following link, be aware that it is lengthy and tedious reading. 联邦能源监管委员会（FERC）制定电网接入的国家标准，主要针对趸售电的、大型的发电项目，FERC2006法令轮廓性地提出小型发电电网接入的详尽要求。这个法规可在下述的链结中找到，请留意，它文字冗长而且读起来令人乏味的。

http://www.ferc.gov/eventcalendar/Files/20050512110357-order2006.pdf

3) The web page for the IEEE 1547 standard can be found here: http://grouper.ieee.org/groups/scc21/dr_shared/ The actual standard is available for a fee, although CAS/IEE should be able to obtain a copy directly from IEEE as a related organization.

IEEE1547标准的网页在： http://grouper.ieee.org/groups/scc21/dr_shared/ 这个标准需要支付费用才能得到，虽然中科院电工所作为一个相关的单位，应该可直接从IEEE获得标准的副本。

Reference Material: Solar ABC 参考资料：太阳能初步

Solar America Board for Codes and Standards, www.solarabcs.org 美国太阳能规程和标准理事会，www.solarabcs.org

Comparison of the Four Leading Small Generator Interconnection Procedures, reviews and compares four sets of interconnection procedures that regulators often consider when developing state and local procedures.
http://www.solarabcs.org/interconnection/ABCS-07_studyreport.pdf

四个先进的小型发电机接入程序的比较；评论和比较四套接入程序，他们是政策制定人在开发州的、地方的电网接入程序时，常常想到的。

Utility External Disconnect Switch: Practical, Legal and Technical Reasons to Eliminate the Requirement, documents the safe operation of PV systems without a utility external disconnect switch (UEDS) in several large jurisdictions, and explains the rationale for eliminating UEDS, including redundant functionality, a failure to provide expected protections and the unnecessary costs added to a PV system. Report details.
http://www.solarabcs.org/utilitydisconnect/ABCS-05_studyreport.pdf

电网外部切断开关（UEDS）。排除UEDS要求的实用、合法、技术上的理由；记录部分大的辖区内没有电网外部切断开关（UEDS）情况下的PV发电系统的安全运行，解释说明排除UEDS的根本原因，包括：冗余功能，期望保护功能的失效，附加在光伏系统上的非必要成本。报告详见： http://www.solarabcs.org/utilitydisconnect/ABCS-05_studyreport.pdf

Reference Material: IREC Model Rules

参考资料：IREC模型规则

Another useful document is from the Interstate Renewable Energy Committee (IREC). They have written a "model" ordinances/legislation/rules for Interconnection agreements involving small (simple and short) and large systems (much more detailed). 另外一个有用的文档是来源于 各州间可再生能源委员会（**IREC**）。针对电网接入的协议，涉及小型的（简单的、短的）和大型的系统（有更详细的），他们编写了一个条例 / 法规 / 规则。

www.irecusa.org/connect/modelrules.pdf

IREC has also produced a guide on interconnection of small, distributed renewable systems.各州间可再生能源委员会（**IREC**）还推出一小型的、分布式可再生能源系统电网接入的指南。

http://www.irecusa.org/fileadmin/user_upload/ConnectDocs/IC_Guide.pdf

PV System Quality Process in California

加州PV系统质量保障的过程

UL Certified Equipment Required

UL 认证的设备必须的

- Inverters comply with UL 1741 tests for fire protection and anti-islanding (see next slide). 逆变器防火和防孤岛要遵照**UL741**测试（见下一幻灯片）。
  - UL 1741 is an equipment standard, implements the IEEE 1547 standard. An inverter that is UL 1741 listed will be compliant with IEEE 1547 **UL1741**是一个设备标准，贯彻**IEEE1547**标准。被**UL1741**收录的逆变器将符合**IEEE1547**标准.
- Compliant inverters incorporate fail-safe designs that prevent the inverter from operating unless its protective functions are operating properly. 符合条件的逆变器要包含防止安全失效的设计，来阻止逆变器运行，除非其防范功能能合适地运行。

PV System Quality Process in California

加州PV系统质量保障的过程

Installer 安装商

Qualifications 资格

- Trade Group Code of Ethics – CASEIA excerpts 交易道德守则—摘自**CASEIA**
- safety, health and welfare of the public is paramount 公众的安全、健康、福利是至高无上的
- shall install in compliance with applicable codes and standards 安装要遵守适用的规程和标准
- shall offer and honor warrantees 提供和兑现质量保障
- training and safe working conditions for employees 为雇员提供培训以及安全工作的条件

PV System Quality Process in California 加州PV系统质量保障的过程

Anti-Islanding
防孤岛

UL Certified Equipment Required

UL 认证的设备必须的

- Protection for grid maintenance personnel – no distributed generation online when grid is down 电网维修人员－当电网被断电时，确保没有分布电源在线运行。
- Grid-tied inverters monitor the utility line voltage and frequency continuously. 联网的逆变器持续地监视电网系统电压和频率。
- When abnormal voltage or frequency conditions occur on the utility system, they shut themselves off quickly (or “cease to energize,” the phrase that appears in technical interconnection standards). 当电网出现异常的电压和频率时，他们自身很快从电网切断 （或者“终止供电”，这一术语出现在电网接入技术标准中）。