New International Activities Relating to Standardization in PV Technologies

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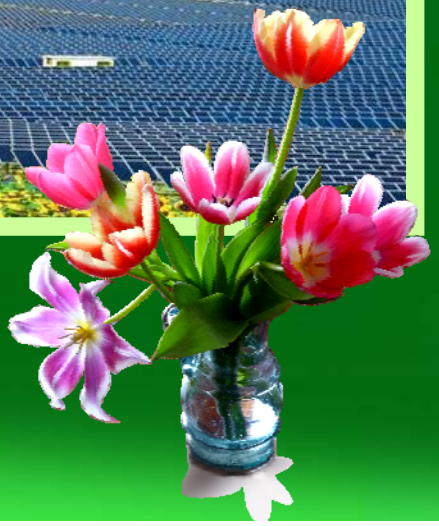
TOKYO TECH AES



New International Activities Relating to Standardization in PV Technologies

1. 30 Years of IEC TC82 & JIS
2. Future Items
3. Fire Proof; Fire Prevention
4. Pre-standardization: Quality Assurance Forum
5. Frequent Question

30 Years of TC82

Technical Committee 82

Solar Photovoltaic Energy Systems

http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID,FSP_LANG_ID:1276,25

- Established 1981. Japan joined 1983.
- WG1: Terminology, WG2: Cell/Module, WG3: System
- WG4: PV Storage
- WG5: Quality/Certification, WG6: BOS, -WG4
- -WG5, WG7: Concentrator
- JWG 1: JCG TC 82/TC 88/TC 21/SC 21A
- 23 P-members, 13 O-members
- 61 Standards Published (2.5 per year)

30 Years of TC82

1981:

- **18 MW/Y**
- **30 MW Total**
- **25 $\$_{2002}$ / W or more**

1,170 fold →

2010:

- **2,400MW/y (~18%/Y_ave)**
- **35,000 MW Total**
- **2 $\$_{2010}$/ W or less (- 8.1 %/Y)**

Working Group 2: PV Cells & Module

- **Basic Measurement Requirements:**
  - **IEC 60904** -1 to -10:
    I-V characteristics: reference cells; equivalent cell temp.; reference modules; spectral mismatch error; solar simulator; linearity measurement
- **Initial emphasis was on modules:**
  - **IEC 61215 Ed. 2** Design qualification and type approval for crystalline modules
  - **IEC 61646** for thin film modules
- **Module Safety qualification standards:**
  - **IEC 61730-1** Requirements for construction
  - **IEC 61730-2** Requirements for testing
- **Others**
  - **IEC 61345** UV test; **IEC 61701** Salt mist corrosion test

Working Group 3: PV System

- **WG 3 Systems has published the following:**
  - **IEC 61724** PV system performance monitoring--Guidelines for measurement, data exchange and analysis
  - **IEC 61727** PV Systems--Characteristic of the utility interface
  - **IEC 61829** Crystalline silicon PV array--On site measurement of I-V characteristics
  - **IEC 62124** PV stand alone systems--Design verification

working Group 6: BOS Components

- **WG 6 on Balance of Systems components is working on:**
  - **IEC 62109-1** Safety of power converters for use in PV power systems--Part 1--General requirements
  - **IEC 62116** Test procedure of islanding prevention measures for utility-interconnected PV inverters

Working Group 7: Concentrated PV

- **WG 7 Concentrator modules:**
  - **IEC 62108** Concentrator Photovoltaic (CPV) Modules and Assemblies - Design Qualification and Type Approval (2007)
  - Tracker standard is under initial draft (publish in 2009?)

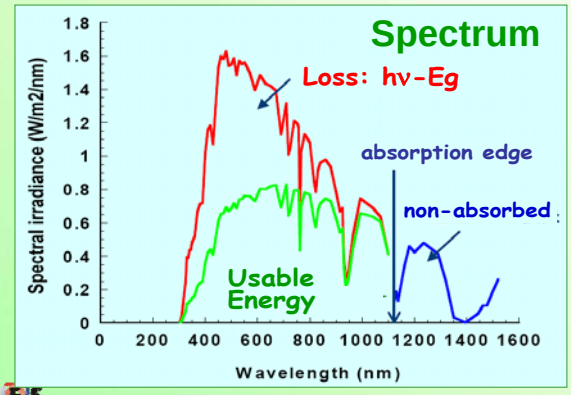
http://www.iec.ch/dyn/www/f?p=103:14:0::::FSP_ORG_ID,FSP_LANG_ID:2754,25

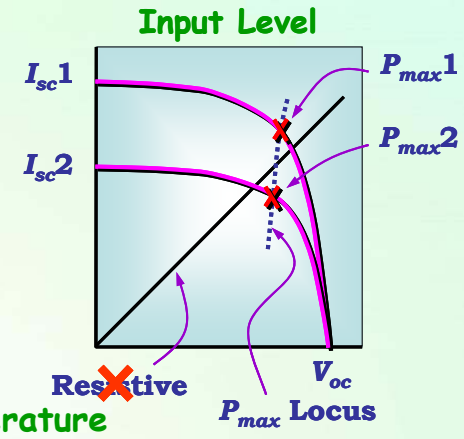
Requirements for Modules

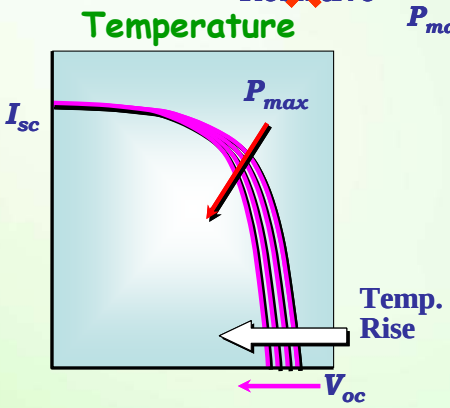
- **Protect active layers from long-term exposure to climatic conditions:** heat cycles, rain fall, humidity, UV, etc.
- Provide front sheet of **maximum transparency**
- **Mechanical Stability:** wind load, snow, hail ...
- Isolate outer surfaces from **high internal voltage**
- **Electrical contacts for cabling**
- Protection against **partial shading** (hot spot)
- Resistance against **fire**

Basic Measurement Requirements on I-V curve & spectrum matching

- **IEC 60891: Inter- & Extrapolation**
  - PV cells → non-linear devices
- **IEC 60904 series -1 to -10**
  - STC: sensitive to
    25°C-cell,
    AM 1.5,
    1000 W/cm^2

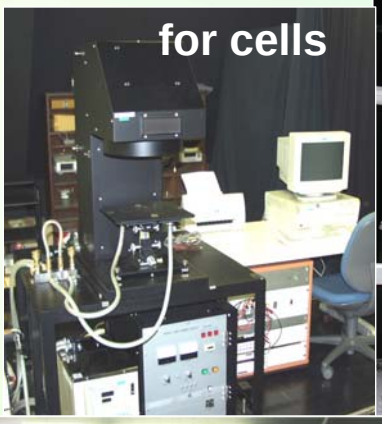


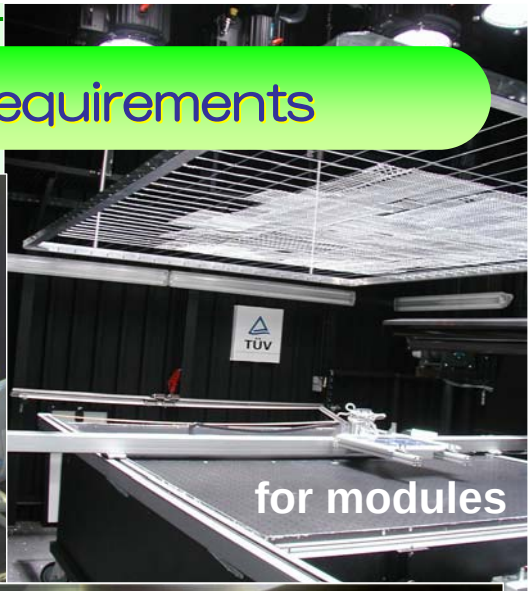




Basic Measurement Requirements

Solar Simulator – Key Equipment





IEC 6125 & 61646

- **Today's IEC 61215 (and 61646) Address:**
  - **Climatic Exposure**
    - **To include 1000 hours of Damp Heat, 200 Temperature Cycles, 10 Humidity Freeze cycles**
  - **Mechanical Stress**
  - **Electrical Insulation**
  - **Partial Shading (Hot Spot Test)**
  - **Performance measurements**

Typical Test Equipments:

- Damp heat chamber (85°C,85%RH)
- Temperature and humidity cycling chamber (-40 to 85°C,85%RH)
- Long pulsed solar simulator
- Hail impact test equipment
- Mechanical load tester
- Light soaking equipment
- Tester for robustness of termination
- Wet leakage current tester
- Twist tester
- Impulse voltage tester
- Fire test equipment
- Bypass diode thermal tester

Hail Impact Test Equipment
(23m/s, 25mmϕ Ice ball)

A photo of broken ice ball in testing

Hot Spot Test Equipment

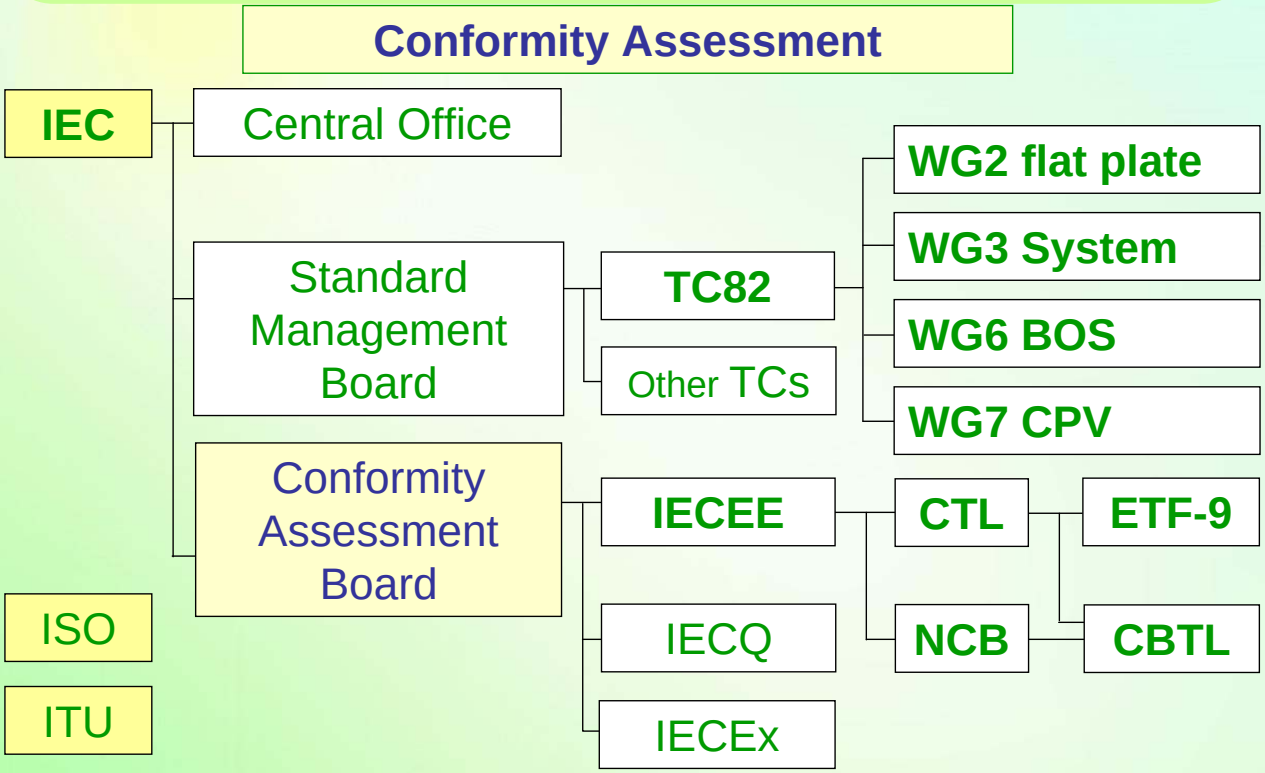
Building Integrated PV modules: BIPV

- **Roof tiles and shingles**
- **Custom made façade modules**
- **Transparency important for building elements**
- **Flexible “Roll-out” modules**
- **but: often custom design and expensive**
- **not commonly standardized yet**

Power Conditioning system

- MIC: AC module integrated conditioners?
- SHS: Battery chargers
- String inverters (distributed)
- Residential inverters (single; clustered)
- Medium size inverters
  - central; - distributed
- Large size inverters

IECEE PV Certification Scheme



IECEE PV Scheme

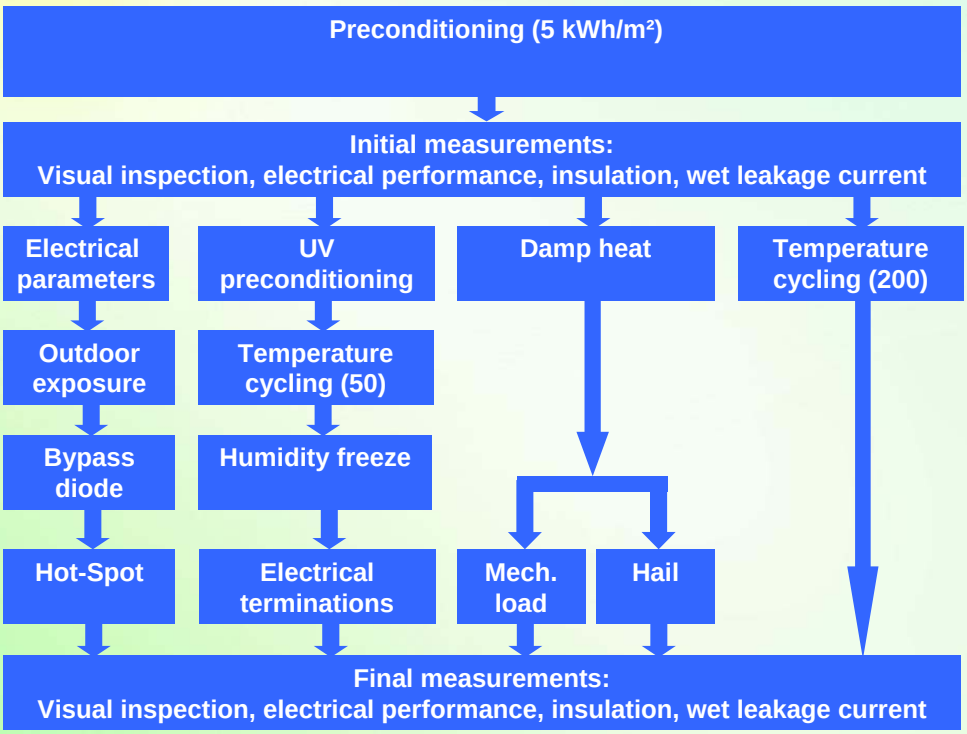
Participation Coutries

Country	Member Body	NCB	CBTL
France	LCIE by delegation from UTE	LCIE	
Germany	Deutsches Komitee der IEC	VDE TÜV Rh	VDE TÜV RH PS GmbH
India	BIS	STOC	ETDC NERDC
Japan	JISC	JET	JET Yokahama
The Netherlands	Netherlands National Committee of the IEC	KEMA	KEMA Quality B.V
Spain	AENOR	AENOR	CIEMAT Fundacion Cener-CIEMAT
USA	US National Committee of the IECEE	UL Inc.	UL Inc. ASU

Data Source: H. Ossenbrink

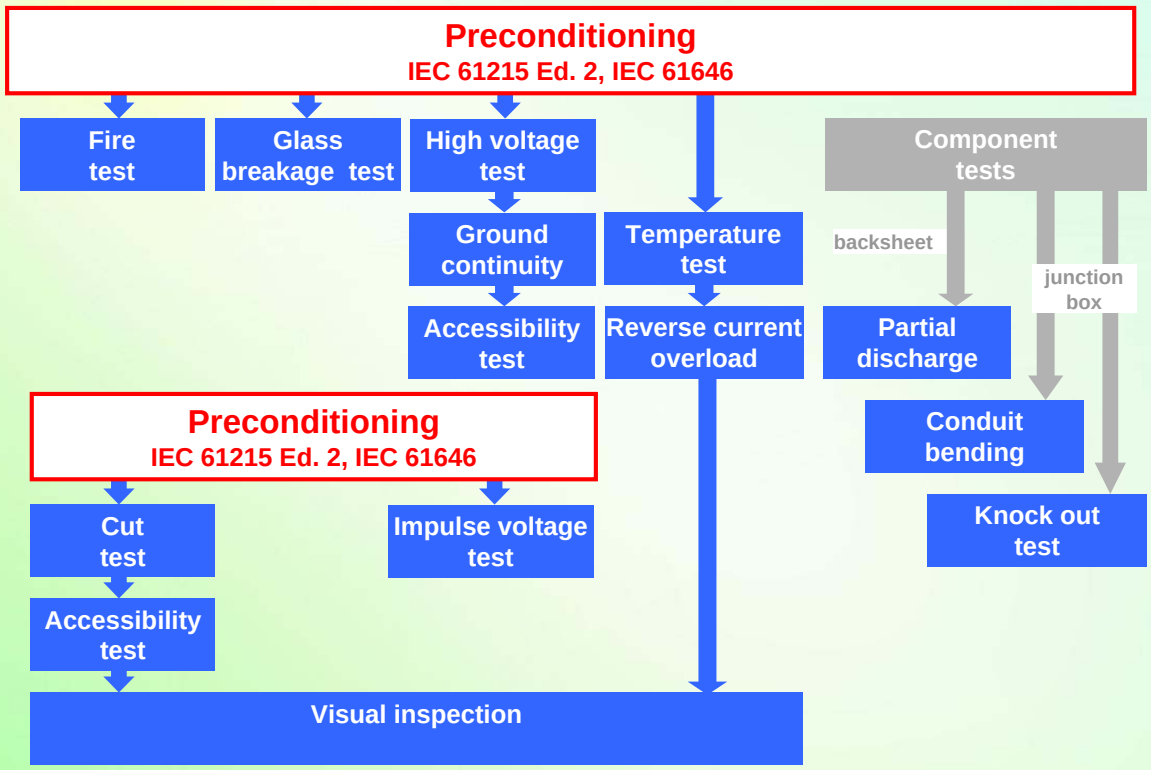
Qualification Testing

in accordance with IEC 61215 Ed. 2 (2005)



TUV Rheinland Group

Safety Qualification Testing



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Japan's Contribution

IEA PVPS : Many joint studies as pre-standard stage!

JP's examples: Islanding detection know-how from Rokko Is. experiments (Task5/OA); proposals on VLS-PV concept (Task8/OA); submission of PV system operational data (Task2); BIPV concept (Task7); translation of IEA results into local language (Task1); ....

PV-JIS ⇔ IEC TC82

JP's examples: indoor measurement of cell/module by solar simulator; measurements of amorphous silicon cell; interpolation/extrapolation of I-V curve translation; PC efficiency measurement (PL); islanding prevention testing (PL); technical term (WG1 covener); ....

SHS to VLS-PV

- **SHS: Solar Home System**
  - Domestic; tens watt to hundreds watt
- **Mini Grid: Village Electrification**
  - tens kilowatt to hundreds kilowatt **isolated**

- **Residential Rooftop** **distributed, grid-connected**
  - several kilowatt to 20 kilowatt
- **PV Micro Grid: Solar PV Community**
  - Unit Community Size: 1000 houses; 1 km by 1 km; ~10 mega watt

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- **LS-PV: Large Scale PV System** **central**
  - Mega; Super-Mega
- **VLS-PV: Very Large Scale PV System**
  - Giga solar
  - Desert Community Development

CONCLUSIONS

- Over the years, surprising Convergence of module designs.
- We believe global standards played an important role in module design qualification.
- Quality very high, lifetime > 20 years.
- Still, 'useful energy for lifetime' almost unknown
- Real Building Integration did NOT take off yet.
- Revival of Concentrator modules, mainly in sunbelt or dry climate.
- Large capacity module factories may drive new design concepts.

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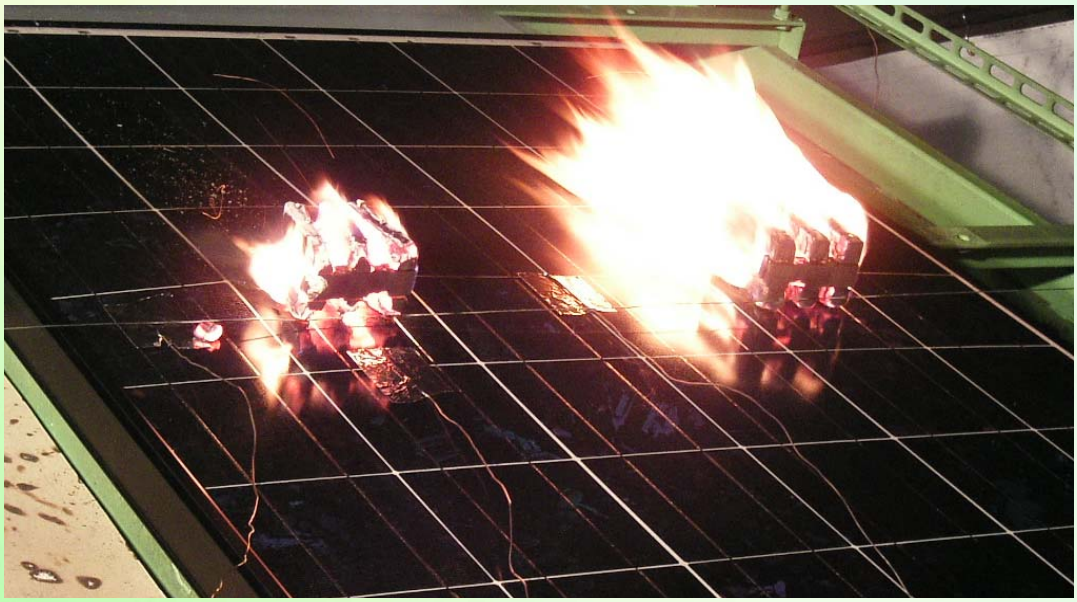
Possibility of Ignition by PV System?

Potential New Topic:
Anti-Fire Prevention for PV Systems

- Firing limit study to know safety factor
- Tracking discharge (electrical treeing) in J-Box or connector
- DC arcing (blocking diode, fuse, switch, wiring, etc.),
- hot spot (module firing, bypass diode
- **Fire Control Issues urgent for fire brigade: how to fight a fire on PV houses.**

Fire Test by 61730-2

Only for fire catch!
How about Ignition by PV system itself?



Fire Brand Test according to fire class B

JETPVm Certification

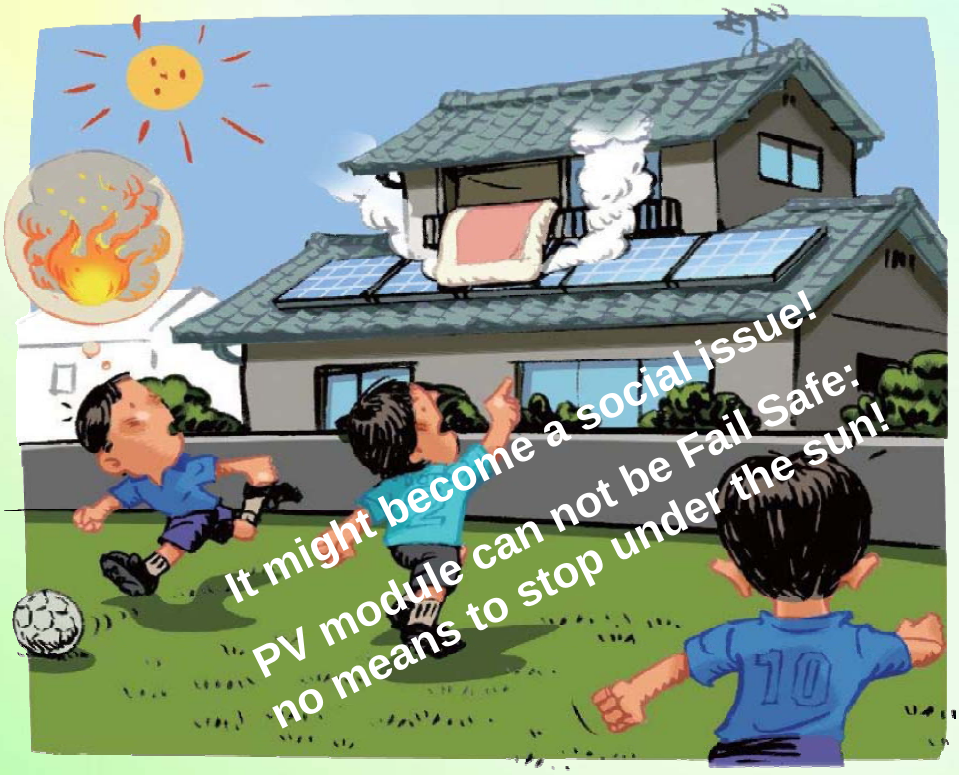
Fire Brigade Measures against burning PV System

Iwaki City, Fukushima Pref. (PV-net)

Outside OK!

Burned J-Box inside

Risks to cause Fire!



エコ住宅トラブル（1）太陽光発電パネルで布団発火，日経BP社ケンプラッツ，2010/07/27.
http://kenplatz.nikkeibp.co.jp/article/building/news/20100723/542443/

Fire Brigade Measures against burning PV System

Protecting the protectors, Photon International , May 2005.

Fire Brigade Measures against burning PV System

John Berdner, SolarEdge, Israel: Solar systems safety standards – from the view of an inverter manufacturer, 1st Pohton PV Safety Conf, San Francisco, 215 Feb. 2011.

Fire Brigade Measures against burning PV System

PV Fire-Related Case Studies

Matt Paiss, Fire Captain
San Jose Fire Department
San Jose, CA

- PV Related
- Non-PV Related

Photon's 1st PV Safety Conference
15 Feb 2011 SF, CA

Global Energy Innovator Forum 2011 Heundai Grand Hotel 16-17 NOV 2011

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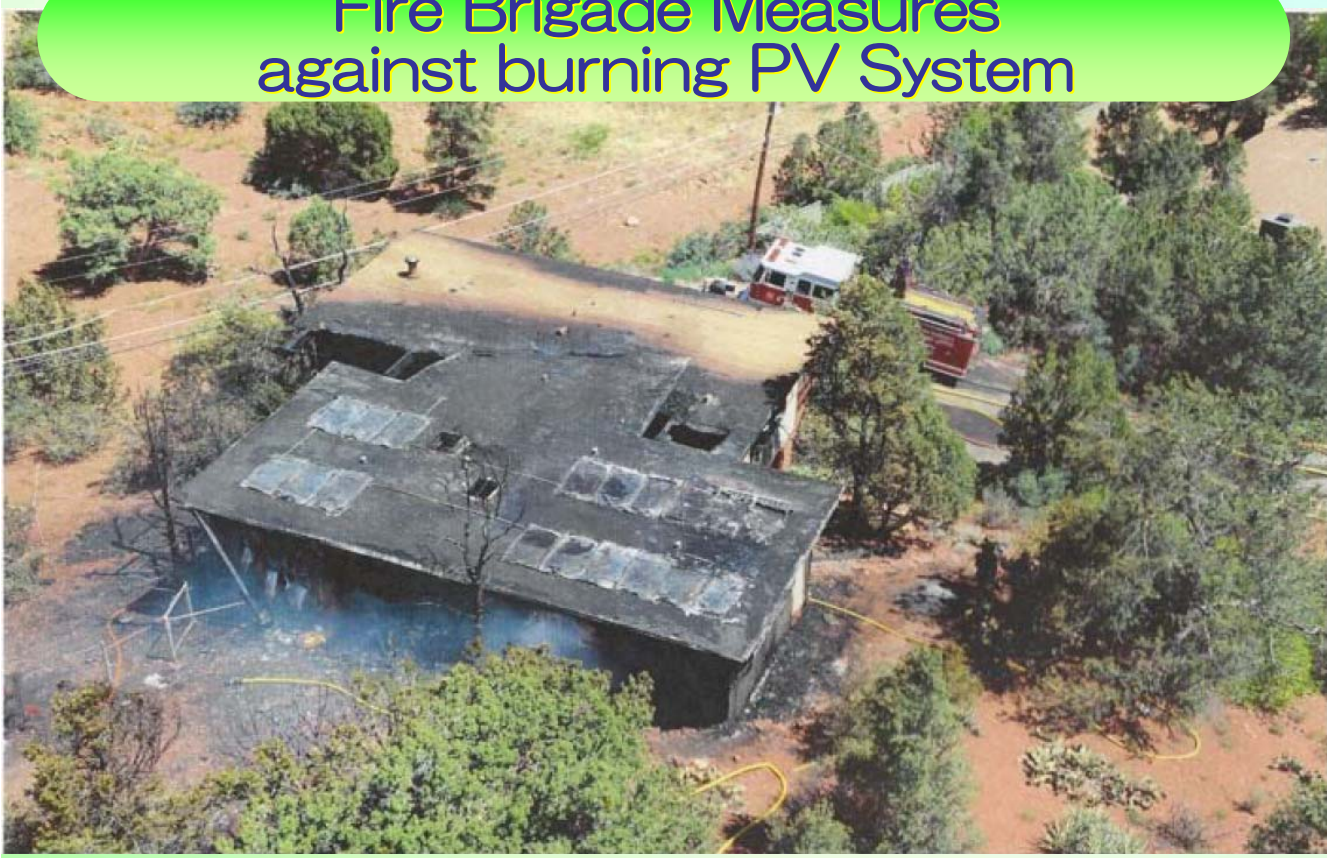
Fire Brigade Measures against burning PV System

Fire Brigade Measures against burning PV System

Sedona, Az. Structure Fire with Injury June 2008

Fire Brigade Measures against burning PV System

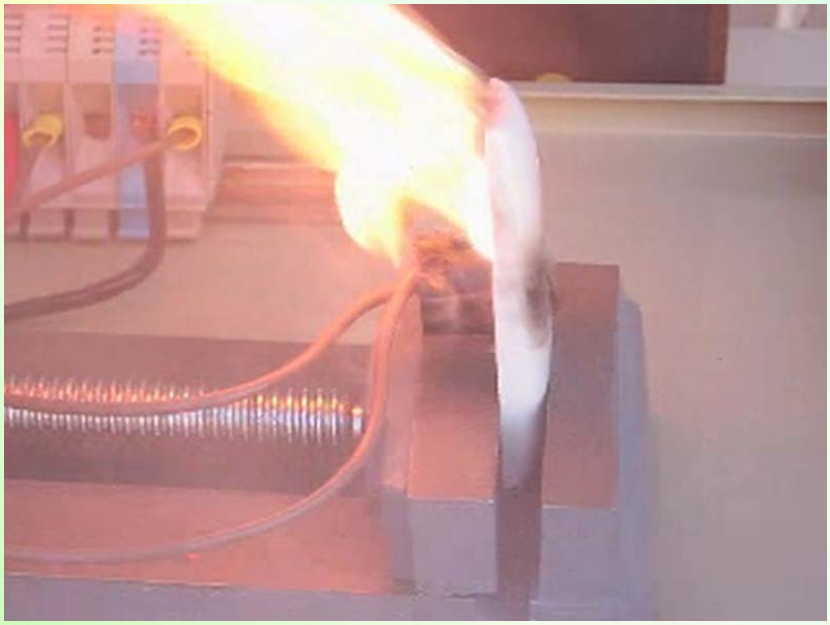


Matt Paiss: 1st Photon PV Safety Conf. 15 Feb 2011

Property of DC ARC

DC Arcing:
http://www.rise.org.au/standards/RISE_DC_arcing2007_lowspeed.wmv
http://www.rise.org.au/standards/RISE_DC_arcing2007_highspeed.wmv
本サイトは現在アクセス不能； その他関連映像を含めてダウンロード済み

Property of DC ARC



DC Arcing - Fuseswitch:
http://www.rise.org.au/standards/fuseswitch_burning_issues_II_0001.wmv

Arc Fault Detector

Arc Detector
www.youtube.com/watch?v=fCLpH96pYpI

Future Standard Work?

- Cells or wafers?
- module related materials?
- Organic cell technology?
- Third Generation?
  - measurement; JP-US; JP-EU, ...
- Solar PV Community or Solar PV City
  - harmonization with smart network*!*
- VLS-PV: Very Large Scale PV System
  - Global Deployment Scenario

New Wave*!*

International PV Module Quality Assurance

- Proceedings from past events are listed below.
  International PV Module QA Forum Meeting, September 8, 2011
  International PV Module QA Forum, San Francisco, July 15–16, 2011

- International PV Module QA Forum Meeting

  September 8, 2011, Hamburg, Germany

  During the meeting, the results from the July forum were reviewed, and the current status summarized.

  Agenda and presentation PDF
  Ensuring Quality of PV Modules PDF
  Summary of the San Francisco Forum PDF
  Task Groups PDF

http://www.nrel.gov/ce/ipvmqa_forum/about.cfm

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

U.S. DEPARTMENT OF ENERGY

Ensuring Quality of PV Modules

26th PVSEC

Hamburg, Germany

Sarah Kurtz[1], John Wohlgemuth[1], Tony Sample[2], Masaaki Yamamichi[3], James Amano[4], Peter Hacke[1], Michael Kempe[1], Michio Kondo[3], Takuya Doi[3], and Kenji Otani[3]

[1]NREL
[2]EC-JRC
[3]AIST
[4]SEMI

Sept. 8, 2011

Motivation: the question on the street "How do I predict lifetime of PV modules?"

- Reliability engineer: How do I test to determine the number of years for the warranty?
- PV customer: How do I choose the PV module that will last longer?
- PV investor: How do I know that I'm making a safe investment of $1 billion (if the modules fail after 10 yr, the warranty will be worthless because the company will be gone)?
- Insurance company: How do I determine rates for insuring PV installations?

Two parts of Quality Assurance

1. Is the *design* durable for the intended application?
   - Depends on location (hot & humid; hot & dry, temperate, etc.)
   - Depends on mounting (close-roof mount runs hotter; partially shaded modules undergo different types of stress)
   - Depends on application (a customer may plan to resurface the roof 10 years from now and only cares about the modules lasting that long)
2. Are the modules *consistently manufactured*?
   - Could variations in the material composition or manufacturing processes result in premature failure of some fraction of the modules?

Current Status

1. Is the design durable for the intended application?
   - IEC qualification tests (61215, 61646, 62108) give pass-fail indication, but do not address the variability of the stresses
   - The relationship between passing the test and the expected service life is not well documented (maybe 10 years in some locations; less in others?)
   - Each test lab is suggesting a testing protocol
2. Are the modules consistently manufactured?
   - The certification to IEC 61215 may or may not indicate that there is an ongoing QA program

No way to look at a module and quickly assess its quality/durability

AIST's
PV Module Reliability Evaluation consortium(64 members)

太陽電池モジュール信頼性評価連携研究体 @ AIST Kyushu Center

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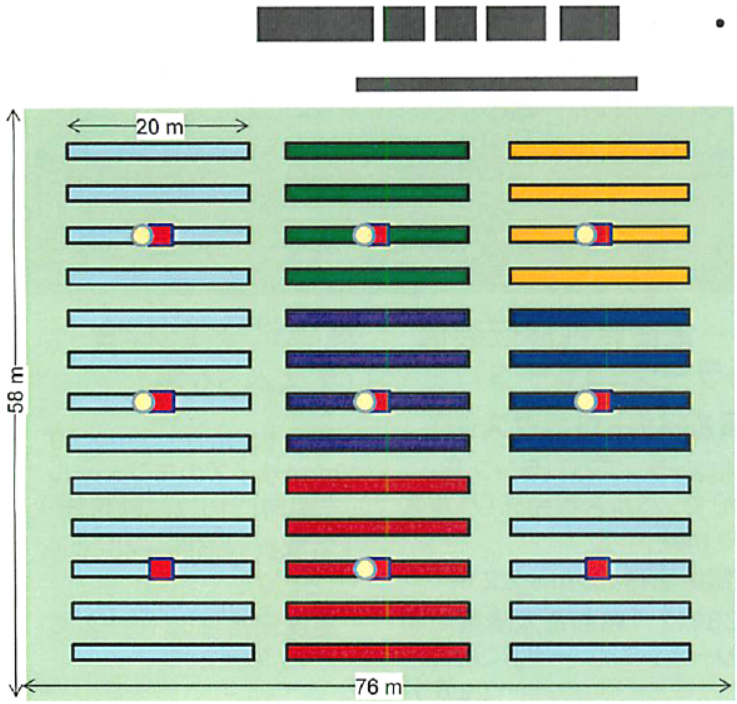
太陽電池モジュール屋外試験装置のレイアウト
平成23年3月現在の配置



- 被試験PVモジュール：5種 ×5 kW
  - –単結晶シリコン
  - –多結晶シリコン
  - –薄膜シリコン（シングル）
  - –薄膜シリコン（タンデム）
  - –CIGS
- PVインバータ
  - –10 kW×9台
  - –マルチストリング（8入力）
- PV計測
  - –ストリングIVトレーサ　7台
  - –10分毎に各ストリングのIV計測
  - –日射量、気温

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Frequent Question: One Common Standards or Regional ?

- **Global Markets:**
  - Wafers, Cells, Modules, BOS, Systems
- **Technical Differences Do Exist:**
  - Inverters
  - Grid interface
  - Safety
  - EMC, Recycling/ Disposal, Env. Friendly Material
  - Project Management / Design Quality
- **But, PV installation be harmonized with its surroundings/culture.** Some parts provided by Regional Business/Industries: **i.e., Nature of distributed system.**
- **Balance: one common standard / regionality**