Standards for quality of PV modules: current status and ongoing activities

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Lifetime and reliability issues in PV
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Joint Research Centre

Outline

- Introduction
- Overview and limits of IEC qualification tests
- Ongoing activities for quality assurance of PV modules and systems
- Conclusions

ESTI goals:

- Assess the performance of new and improved PV devices
- Perform pre-normative research
- Help development of international standards

Activities:

- PV device calibration
- Module lifetime
- Energy rating
- PVGIS – solar resource analysis tool

ESTI is an accredited laboratory under ISO 17025 for calibration of PV devices.

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Introduction

Quality assurance of PV modules is crucial for all the chain of a PV project:

- Module manufacturer: needs to determine the right number of years for the warranty
- Customer: needs to choose the modules that assure highest performance for longest time vs cost
- Investor: needs to evaluate the risk of investment, as can not always rely on warranty
- Insurance company: needs to determine the right rates for insuring PV installations

Introduction

Two main aspects for quality assurance of a PV module:

- Is the PV module designed to assure a long enough durability?
  - Depends on location (climate)
  - Depends on mounting (close roof or in the field)
  - Depends on application (some might plan to replace modules after a number of years)
- Is the PV module consistently manufactured?
  - Variation in material composition could reduce durability
  - Variation in production process could reduce durability

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Overview and limits of actual IEC qualification tests

At present there are three IEC standards for type approval of PV modules:

- **IEC 61215** for crystallline-Si modules
- **IEC 61646** for thin film modules

} In process of being merged in a single standard

- **IEC 62108** for concentrated photovoltaic modules

PV modules safety is certified by application of two standards:

- IEC 61730 (parts 1 and 2)
- UL 1703 (US only)

These qualification and safety tests do an excellent job of identifying design, materials and process flaws that could lead to premature field failures.

Overview and limits of actual IEC qualification tests

Characteristics of type approval tests:

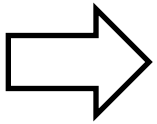
- Use accelerated stress tests to replicate failure modes observed on field
- Are based on a pass / fail criteria
- Are very effective to find design and production defects
- Module passing the IEC qualification tests are much more likely to survive in the field

IEC tests are not designed to:

- Identify and quantify wear-out mechanisms
- Differentiate failure mechanism based on different climate and application
- Estimate module lifetime
- Provide comparative data (does not make distinction between modules that might have longer or shorter lifetime)

Development of accelerated stress tests

- Outdoor performance data are needed to evaluate the durability of a PV module and to identify failure modes
- But we can not wait for years to determine the lifetime of a module



- We need accelerated stress tests to predict the module's lifetime
- Accelerated stress tests must be performed in a reasonable amount of time
- They must duplicate failure modes observed in the field

Development of accelerated stress tests

- Once the failure mode is identified we need to develop accelerated stress tests to duplicate the failures

    1. Identify the stresses that cause the same failure as in field

    2. Quantify the acceleration factor (for how long do I need to apply the stress to duplicate the same degradation observed outdoor in a given amount of time?)

- IEC qualification tests incorporate several accelerated stress tests (eg. thermal cycling, damp heat, humidity freeze, hot spots…) to duplicate failure modes, but not to predict lifetime.

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Ongoing activities for PV module quality standards

- In 2011 the **"International PV module quality assurance task force"** was created by NREL, AIST, JRC and SEMI

TARGETS:

- Provide a rating system to ensure durable design of PV modules for the climate and application of interest.
- Provide guidelines for factory inspections and quality assurance (QA) during manufacturing.
- Provide a comprehensive system for certification of PV systems, verifying appropriate design, installation, and operation.

ORGANIZATION:

- Participation open to all who want to contribute
- Relies on research done by volunteers worldwide
- 12 task groups have been established, each working on a specific topic

Ongoing activities for PV module quality standards

Status of climate and application specific tests

IEC 62892-1 "Testing of PV Modules to Differentiate Performance in Multiple Climates and Applications – Part 1 Requirements for Testing" submitted to IEC as a Committee Draft.

- Three climates (temperate, tropical and desert)
- Two applications (rack mount, roof mount)

IEC 60721-2-1 Climate	Rack Mount	Roof mount
Moderate (Temperate)	Leg 1 500 Thermal cycles Leg 2 Increased UV at 60°C, DML, 10 cycles of HF and 500 Hours Damp Heat (85/85)	Leg 1 500 Thermal cycles Leg 2 Increased UV at 80°C, DML, 10 cycles of HF and 500 Hours Damp Heat (85/85)
Warm Damp Equable (Tropical)	Leg 1 500 Thermal cycles Leg 2 Increased UV at 80°C, DML, 10 cycles of HF and 1000 Hours Damp Heat (85/85)	Leg 1 500 Thermal cycles Leg 2 Increased UV at 80°C, DML, 10 cycles of HF and 1000 Hours Damp Heat (85/85)
Extremely Warm dry (Desert)	Leg 1 500 Thermal cycles Leg 2 Increased UV at 80°C, DML, 10 cycles of HF and 1000 Hours Damp Heat (85/40)	Leg 1 500 Thermal cycles Leg 2 Increased UV at 100°C, DML, 10 cycles of HF and 1000 Hours Damp Heat (85/40)

Ongoing activities for PV module quality standards

Status of consistency of manufacturing

PV-specific version of ISO 9001 has been proposed as IEC/TS 62941 "Guideline for increased confidence in PV module design qualification and type approval"

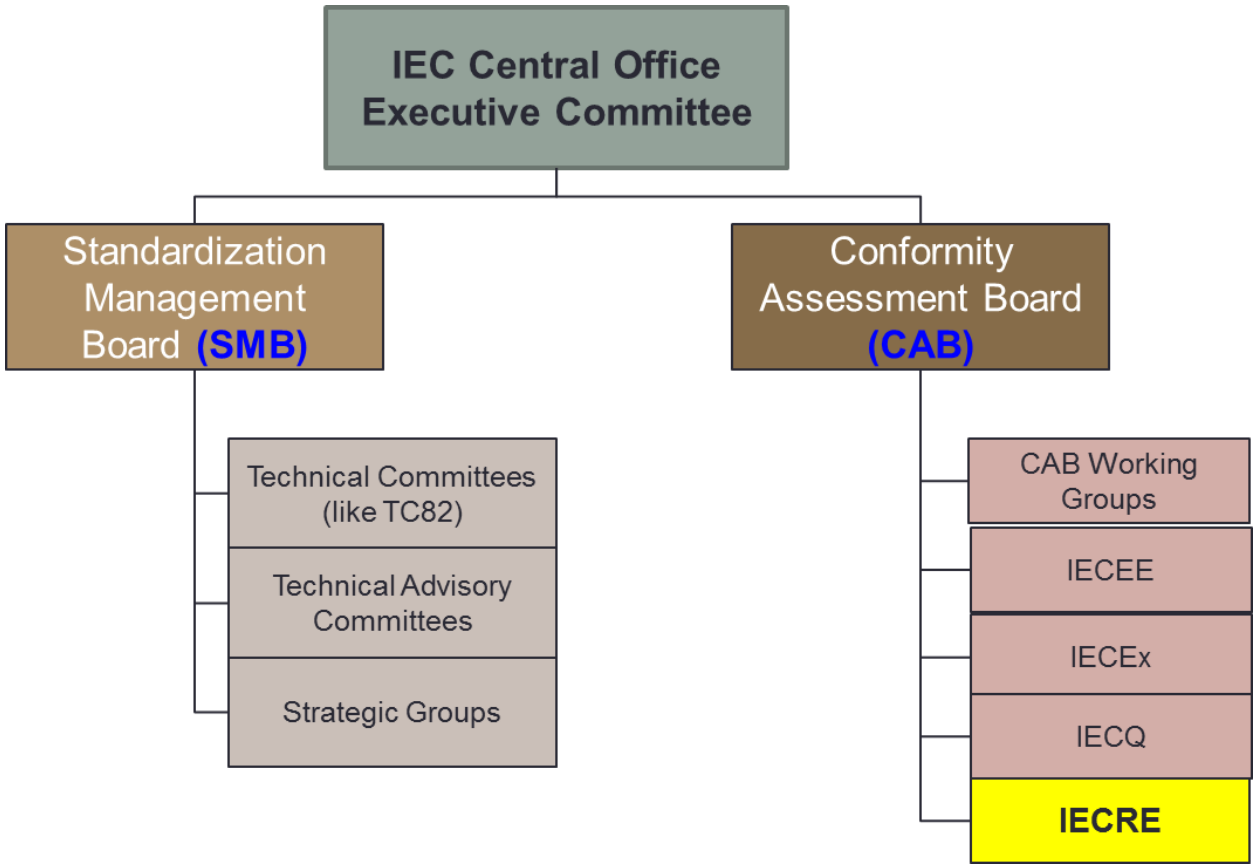
Draft technical specification (DTS) to be published early 2016

Status of system verification

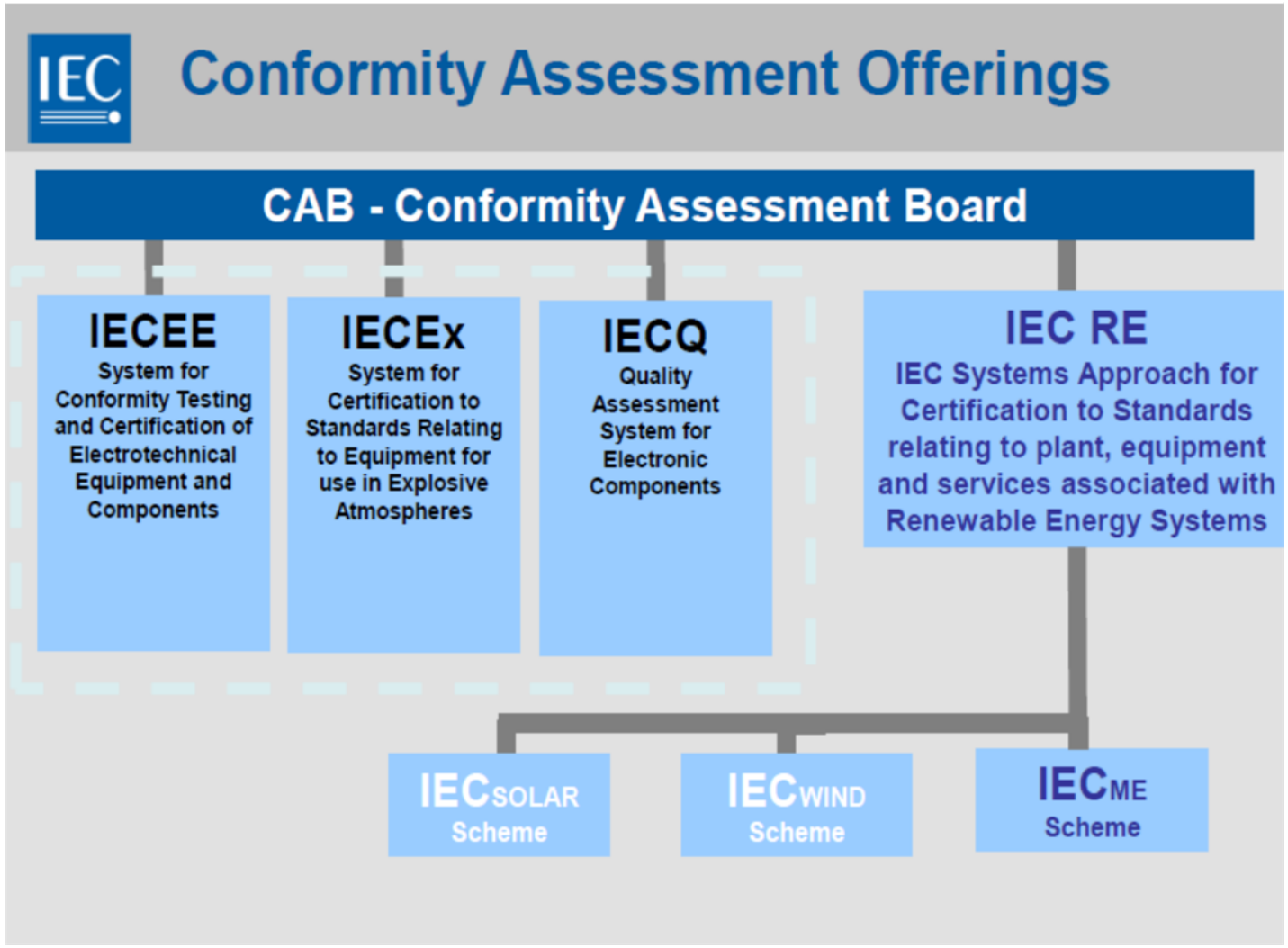
Need to cover systems design, installation and operation

- IECRE formed as means for implementation of the system verification
- National committees are being formed (currently 18 member counties)
- Rules are being written

IEC Organization and IECRE



European Commission



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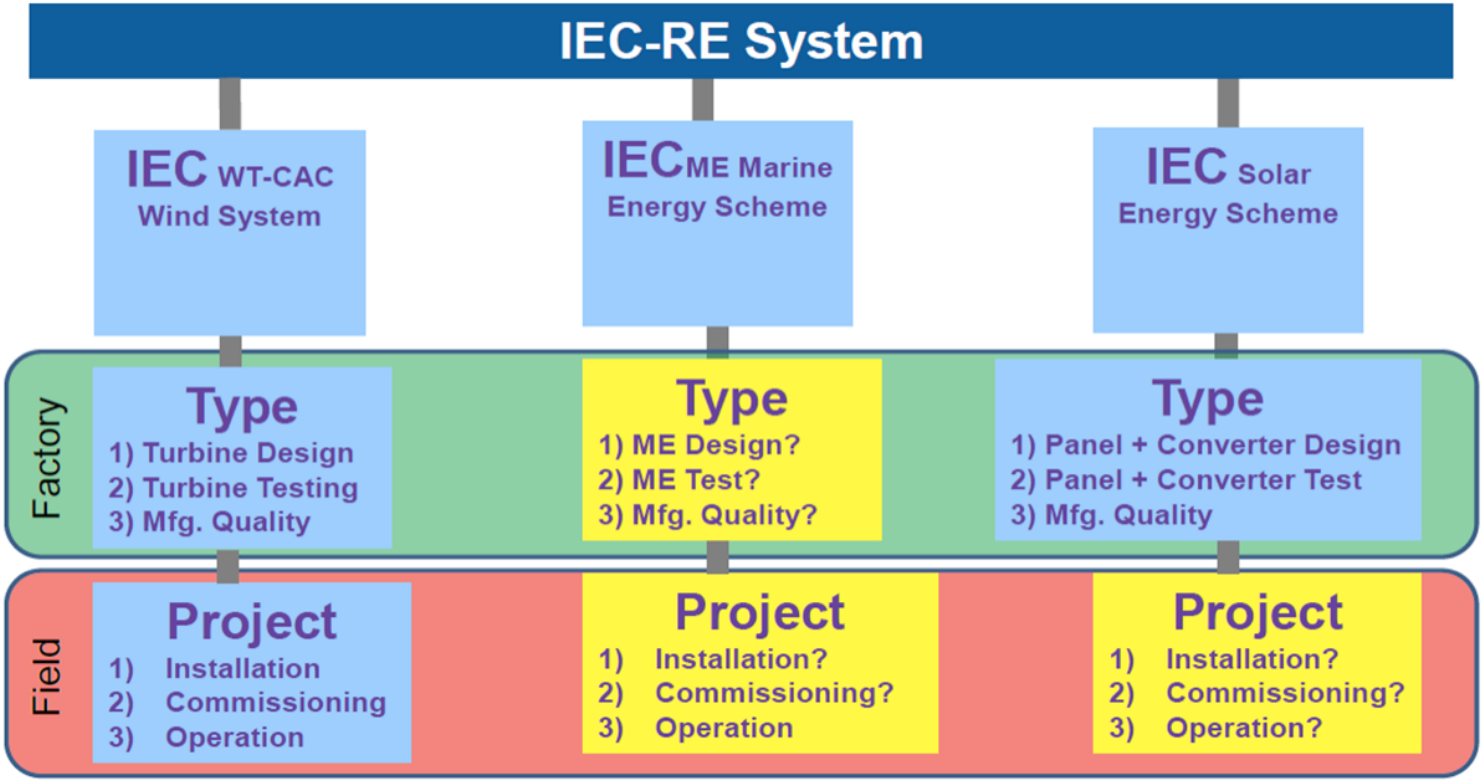
IEC WTCAC

RE System Common Elements



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Conclusions

- Prediction of PV module lifetime and differentiation of qualification tests based on climate and application are important for PV market development
- IEC tests at present have limitations as they are not meant for lifetime prediction and do not differentiate (pass/fail criteria only)
- Several activities in this field are ongoing under the International PV Module QA Task Force and the IEC TC82 WG2 and supporting activities of IECRE

Call for Volunteers

- The International PV Module QA Task Force is open to all who wish to participate to the joint effort

  http://www.nrel.gov/ce/ipvmqa_task_force/

- IEC TC82 is open to participation, interested people should contact their national committee as a first point of contact to register their interest.

  www.iec.ch

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