Scuola universitaria professionale della Svizzera italiana
Dipartimento ambiente costruzioni e design
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SUPSI

Update on the new IEC standards and their impact on quality of PV modules

Review of the major changes in the last editions of the standards series

IEC 61215 - Terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61730 - Photovoltaic (PV) module safety qualification

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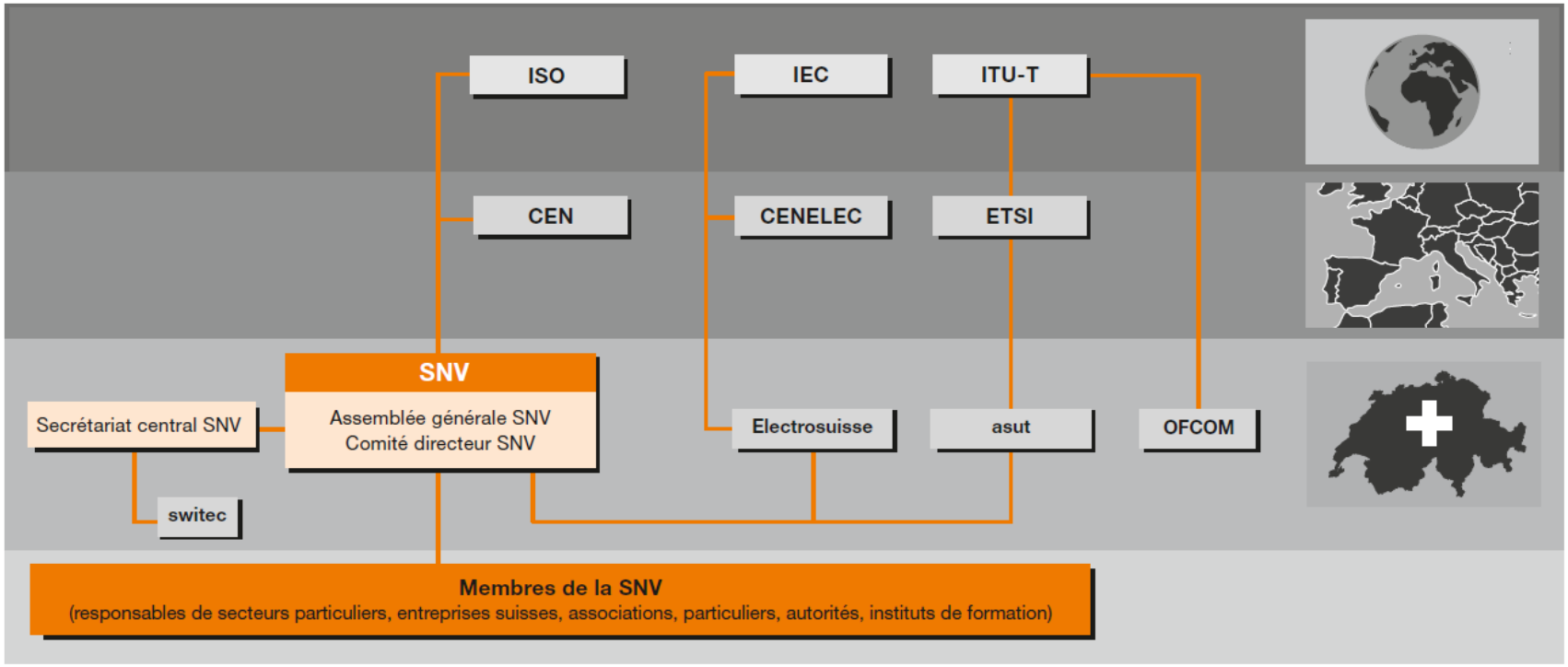
PV products' testing and certification

- The wide spread of technologies for the exploitation of renewable energies, with particular regard to photovoltaic products, has assumed more and more relevance over the last 20 years, also in the field of standardization, certification, product testing and qualification
- The commercial success of photovoltaics (PV) is mainly based on the long-term reliability of the PV modules. Normally PV modules carry a performance warranty of 25 years.

- Experts from all over the world, gathering in special technical committees and working groups, apply their best knowledge and experience to the definition of the standard tests methods and acceptance criteria that, if fulfilled, can guarantee safety, reliability and durability to the new products, following and accompanying their technological progress
- Scientific research and international technical standardisation must proceed in tandem and the second must not be a limit to the first.

Chart of standardization - overview



SUPSI PV-Lab – Accreditation according to ISO / IEC 170125

- The testing laboratories perform the tests according to the standard methods: in the slang of test laboratories, it is used to say "*test a product against a standard* ", as a sort of "challenge" that a new product must win before to be placed into the market.
- The reliability and the accuracy of the results are granted by the ACCREDITATION of the testing laboratory:

- Performance and reliability tests can also be performed in a pre-compliance mode, in different phases of research, design and engineering of new products.

PV - DESIGN qualification – History and milestones

- 1975-1981: first test methods for PV modules, based on space applications
- 1993: IEC 61215 - Ed. 1 only for crystalline silicon - summary of all consolidated test methods for performance and **durability**
- 1996: IEC 61646 -Ed. 1 (for Thin Film – amorphous-Silicon) – as IEC 61215 with the addition of methods for **stabilization** (light soaking and annealing)
- 2005: IEC 61215 Ed. 2, addition of by-pass diode test and current flowing through the modules during Thermal Cycling
- 2008: IEC 61646 Ed. 2, test methods of ed. 1 extended to CdTe (Cadmium Telluride) and CIGS (Copper Indium Gallium (di) Selenide)
- 2008-2016: collection of data from the field
- **2016: IEC 61215 –X -X: requirements for crystalline Si and various new technologies grouped in a new structure of the standard – Some major changes and new test methods**

PV - SAFETY qualification – History and milestones

- 2004: IEC 61730 Ed. 1 (c-Si & TF), first standard for electrical safety and mechanical integrity, to be applied in combination with IEC 61215
- 2004-2016: difficulties in the full application of the standard
- **2016: IEC 61730-1 and -2 full revision with alignment to the main electrical safety “horizontal” standards**

«Old» IEC 61215

UV preconditioning

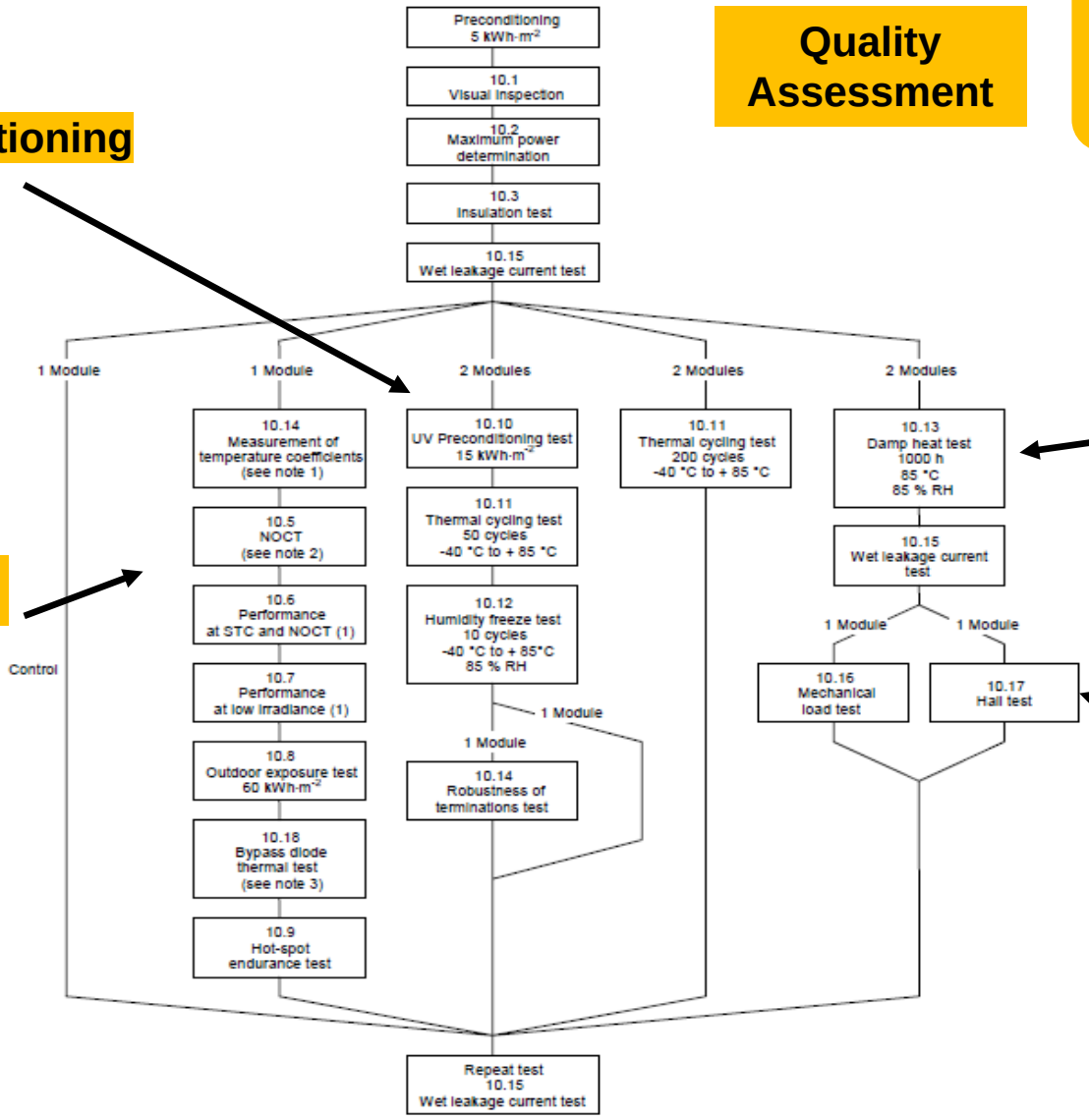
Performances

Quality Assessment

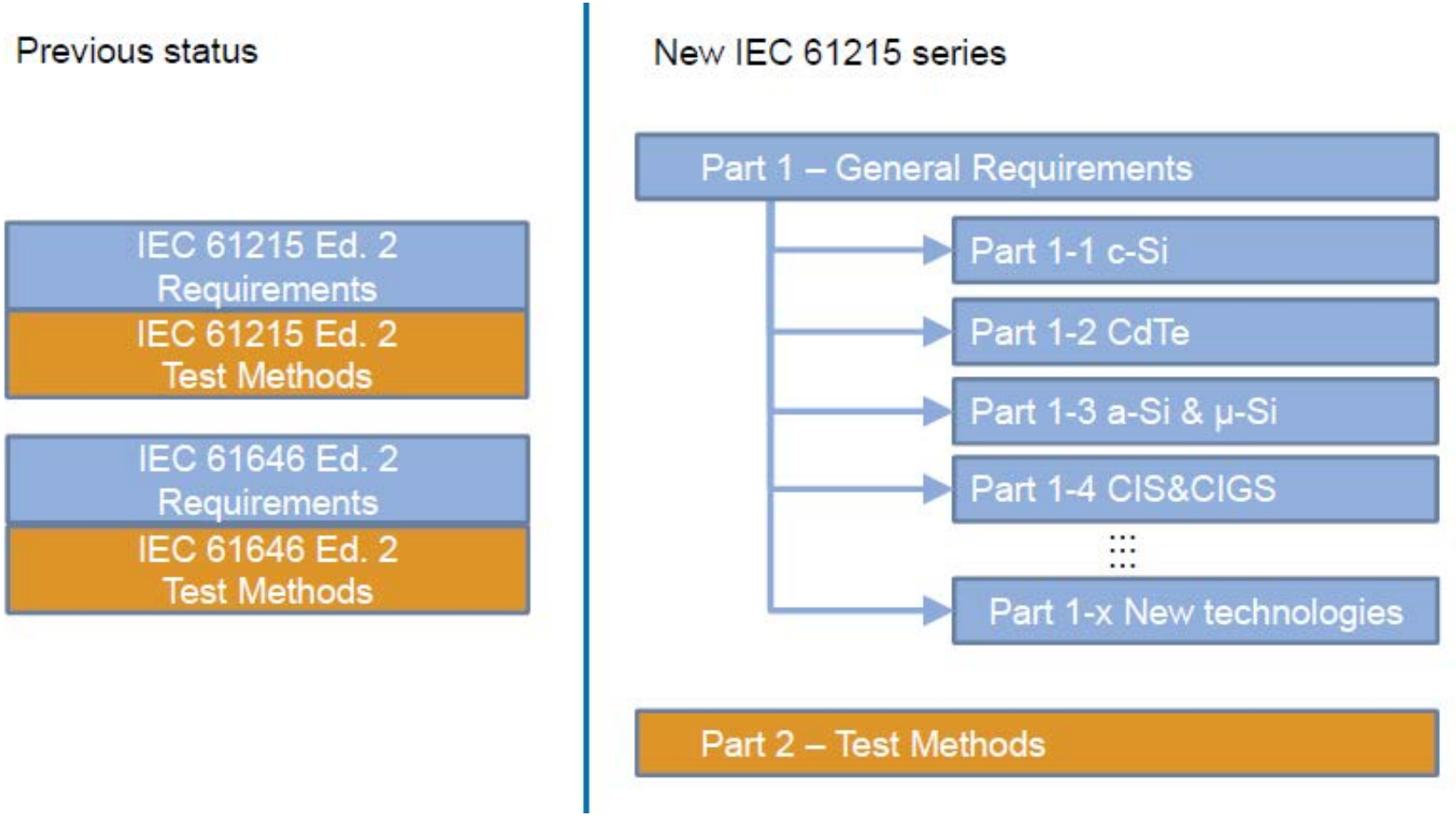
More than 90 tests 3-4 months

Accelerated thermal ageing

Mechanical load – hail test



Structure of the standard



Major changes – Thermal characterisation

NMOT: similar to former NOCT except that it is measured with module under maximum power rather than in open-circuit.

Under maximum power conditions electric energy is withdrawn from the module, therefore less thermal energy dissipates throughout the module than under open-circuit conditions NMOT < NOCT

NMOT is determined at T_{amb} = 20 ° C, irradiance G = 800 W/m², wind speed v = 1 m/s

- Tilt angle: 37° (± 5°)
- Measurement over at least 10 valid days
- Can be performed simultaneously with Outdoor exposure test (MQT 08)
- New value information for data sheets – P@NMOT

Bypass diodes test

Failures in by-pass diodes can be a source of fire hazards

MQT 18.1 – Bypass diode thermal test

New test procedure:

1) Determination of characteristic

- VD (diode forward voltage) vs. TJ (junction temperature)
- Module heated to T_{J1-4} = 30/50/70/90°C, pulsed I_{sc} (1ms) applied, V_{D1-4} measured
- Plot: V_D vs. T_J characteristic

2) Test performance: determination of T_J at T_{amb}=75°C

- Module heated to 75°C ± 5°C, current I_{sc}(STC) applied for 1 hour
- After 1 hour: V_D of each diode measured
- T_J obtained from extrapolation of V_D vs. T_J characteristic

3) Test performance: higher current

- Applied current increased to 1.25 * I_{SC} for 1 h at 75°C ± 5°C

Stabilization

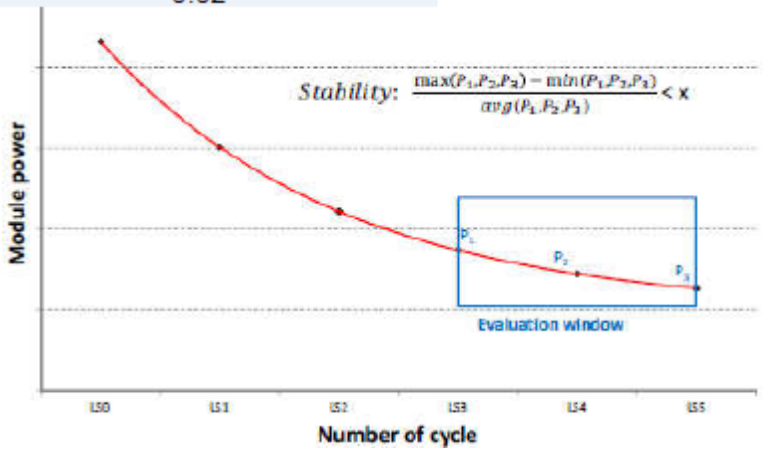
MQT 19 – Stabilization

- New requirement for c-Si (former *preconditioning*); corresponds to former *light-soaking* for t film
- Applied irradiance:

Cell	Min. irradiance initial stabilization	Min. irradiance final stabilization	Requirement for x (specified in IEC 61215-1-NN)
c-Si	2 * 5 kWh/m²	-	0.01
CdTe	2 * 20 kWh/m²	2 * 20 kWh/m²	0.02
a-Si	2 * 43 kWh/m²	2 * 43 kWh/m²	0.02
CIGS	2 * 10 kWh/m²	2 * 10 kWh/m²	0.02

- Calculation of stability:

$$(P_{max} - P_{min}) / P_{average} < x$$



Safety standard

Previous status

IEC 61730-1 Ed. 1
Requirements for construction

IEC 61730-2 Ed. 1
Requirements for testing

New IEC 61730

IEC 61730-1 Ed. 2
Requirements for construction

IEC 61730-2 Ed. 2
Requirements for testing

Labeling

Requirements for design and construction

Marking and documentation:

- name / registered trade name / trade mark of manufacturer
- module type designation
- serial number
- date and place of manufacture (alternatively: serial number assuring according traceability)
- polarity of terminals or leads
- maximum system voltage
- class of protection against electrical shock
- open-circuit voltage **with manufacturing tolerances**
- short-circuit current **with manufacturing tolerances**
- maximum output power with manufacturing tolerances
- maximum overcurrent protection rating
- all electrical data to be shown relative to STC
- international symbols to be used

Requirements for construction

Electrical components:

- Junction boxes ➔ IEC 62790
- Cables ➔ EN 50618 (IEC 62930 under development)
- Connector ➔ IEC 62852
- Electrical insulation layers (backsheet, frontsheet):
  - classification to Material group (CTI)
  - fulfilment of requirements for insulation in thin layers
  - appropriate TI, RTE, (RTI) values

Materials:

- Polymeric materials ➔ appropriate TI, RTE, (RTI) values
  - flammability class minimum V-1 according to IEC 60695-11-10 (not applicable to insulation in thin layers → covered only by MST 24)
  - Ball pressure test according to IEC 60695-10-2 at 75°C (not applicable to insulation in thin layers)
  - **Ignitability test (MST 24)** in final application (laminated or PV module)
  - Peel test for proof of **cemented joints** (MST 35)
  - **Materials creep test (MST 37)**

MST 23 – FIRE TEST

Yet there are no harmonized international standards so far
- Reference to national and regional codes