Product Certification of PV Modules – Quality Requirements and Standards

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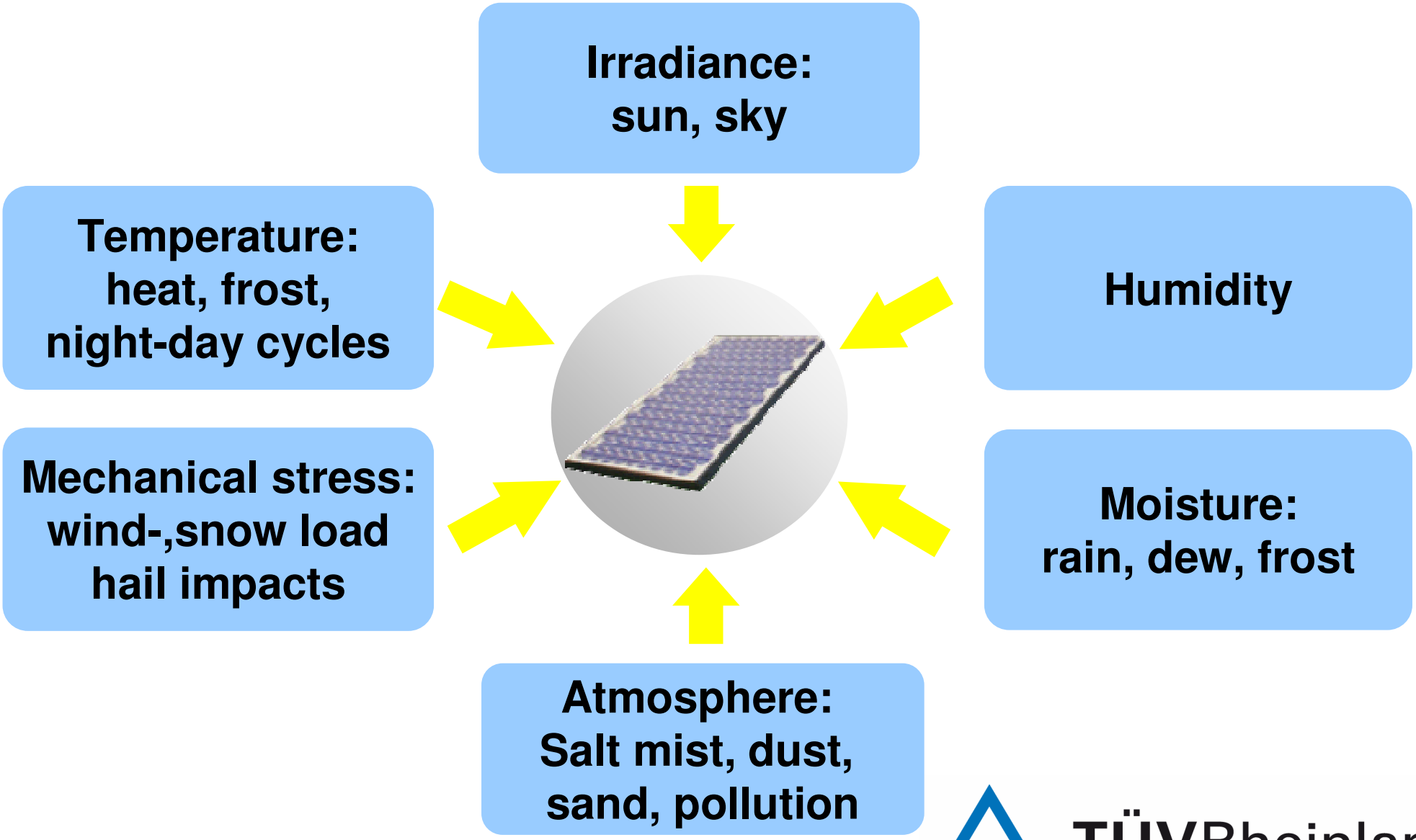
1. Introduction

Quality aspects for PV modules

- **Safe**
- **Durable, suitable for the operating conditions, low degradation**
- **Compliance with the promised characteristics, especially referring to the rated output power**
- **Low tolerance of performance**
- **High energy output**
- **Short energy payback periods**

1. Introduction

Photovoltaic modules have to withstand a number of environmental influences in their long lifetime.



2. Quality requirements and standards

PV modules are complex products that combine materials of different physical and chemical properties:

- Solar cells (wafer based, thin-film)
- Plastic materials (Encapsulation, Junction box, connectors, cables etc.)
- Metal parts (internal interconnection circuit, frame etc.)
- Glass (textured, non-textured, coated)

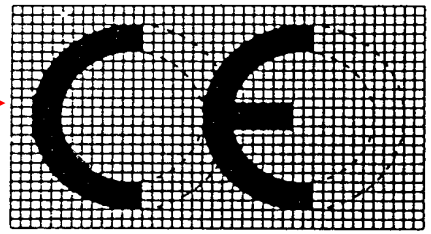
Long-term operation puts high quality requirements to PV modules:

- Resistance of materials to weathering effects
- Compatibility of Materials (Adhesion etc.)
- Suitable construction and design (Compensation of mechanical stress caused by thermal expansion etc.)

2. Quality requirements and standards

Conformance with test standards as measure of quality

IEC 61215 Ed. 2 (2005)	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC 61646 Ed. 1 (1996)	Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC 61730-1 Ed. 1 (2004)	Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction
IEC 61730-2 Ed. 1 (2004)	Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing



2. Quality requirements and standards

Qualification testing in accordance with IEC 61215 / IEC 61646

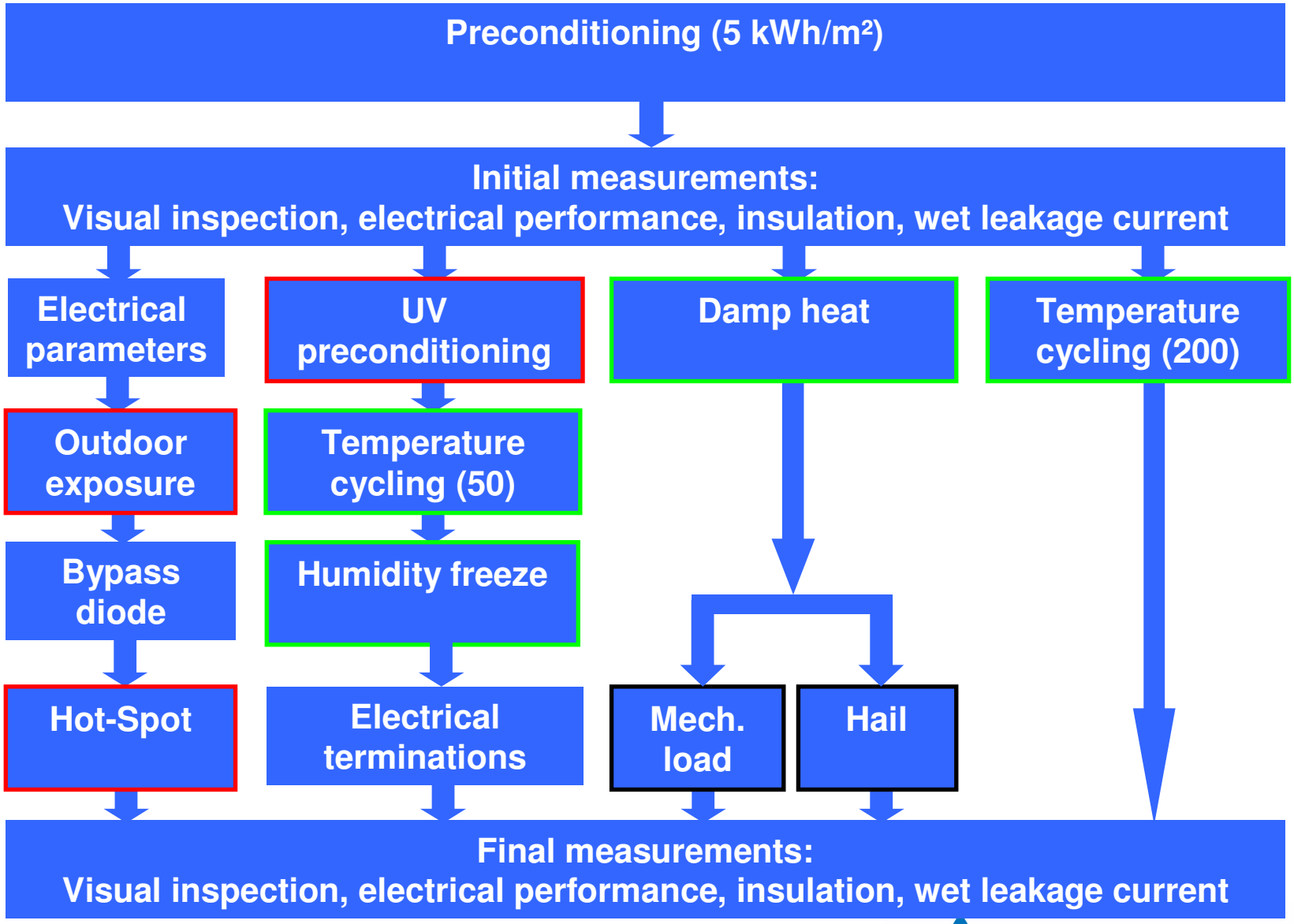
These international standards lay down requirements for the design qualification and type approval of terrestrial photovoltaic modules suitable for long-term operation in general open-air climates.

The object of the defined test sequences is to determine the electrical and thermal characteristics of the module and to show, as far as is possible within reasonable constraints of cost and time, that the module is capable of withstanding prolonged exposure in general open-air climates.

The actual lifetime expectancy of modules so qualified will depend on their design, their environment and the conditions under which they are operated.

2. Quality requirements and standards

Test sequences of IEC 61215 Ed. 2



2. Quality requirements and standards

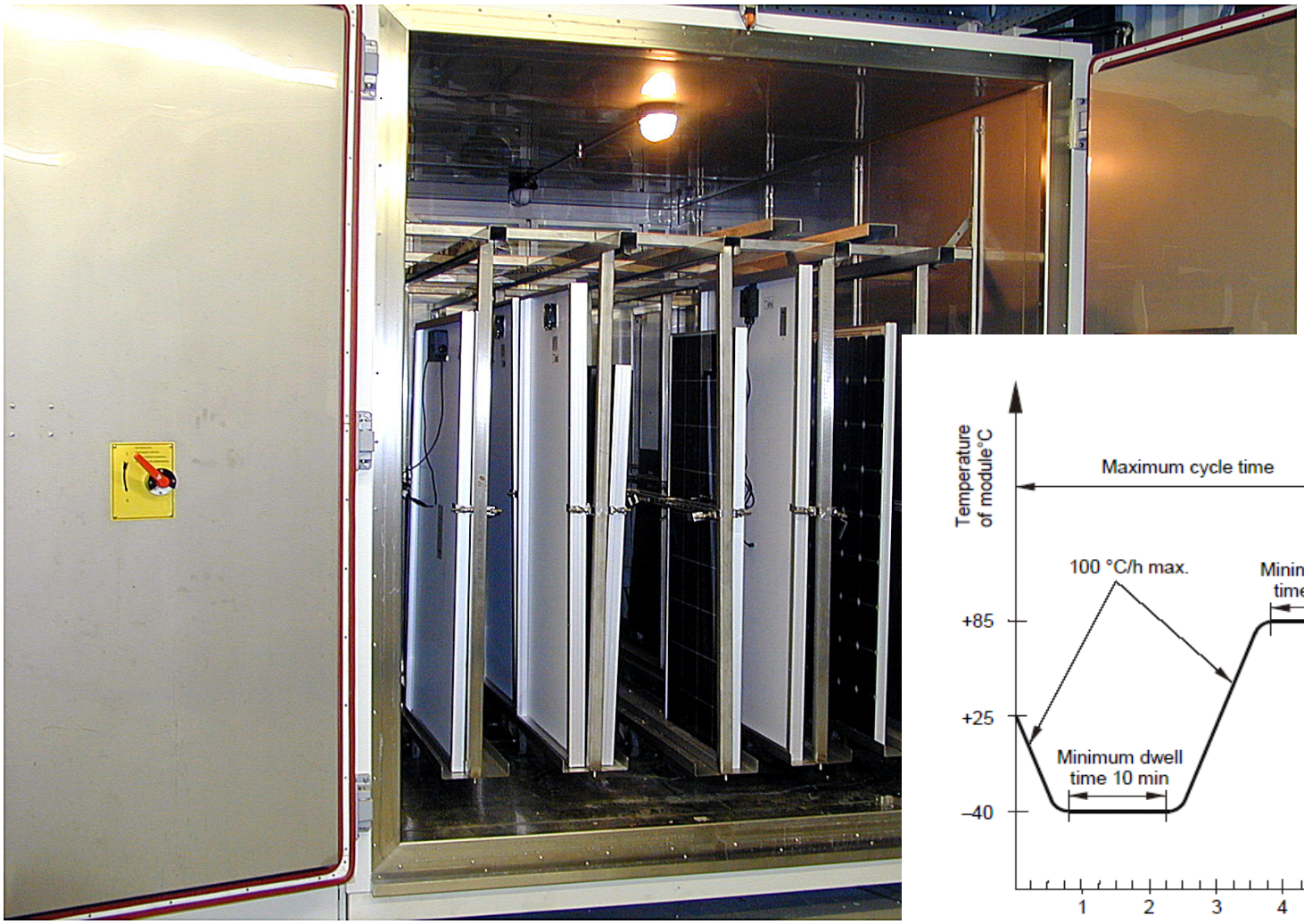
Pass criteria

Depending on each test the following specific pass criteria must be fulfilled:

- Degradation of output power by not more than 5%
- Fulfilling the minimum requirements for insulation
- No major visual defects

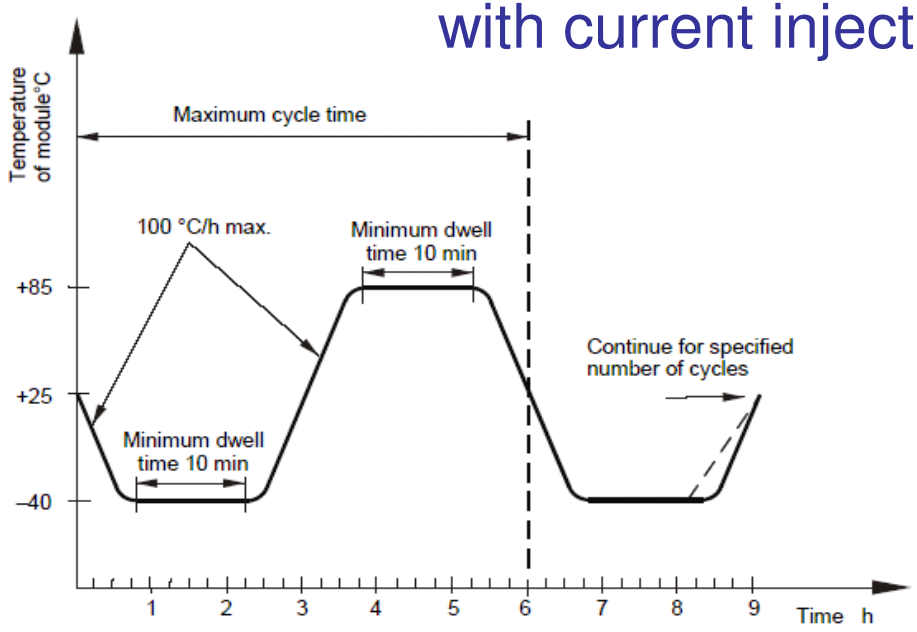
3. IEC qualification testing and failure mechanisms

Environmental stress tests



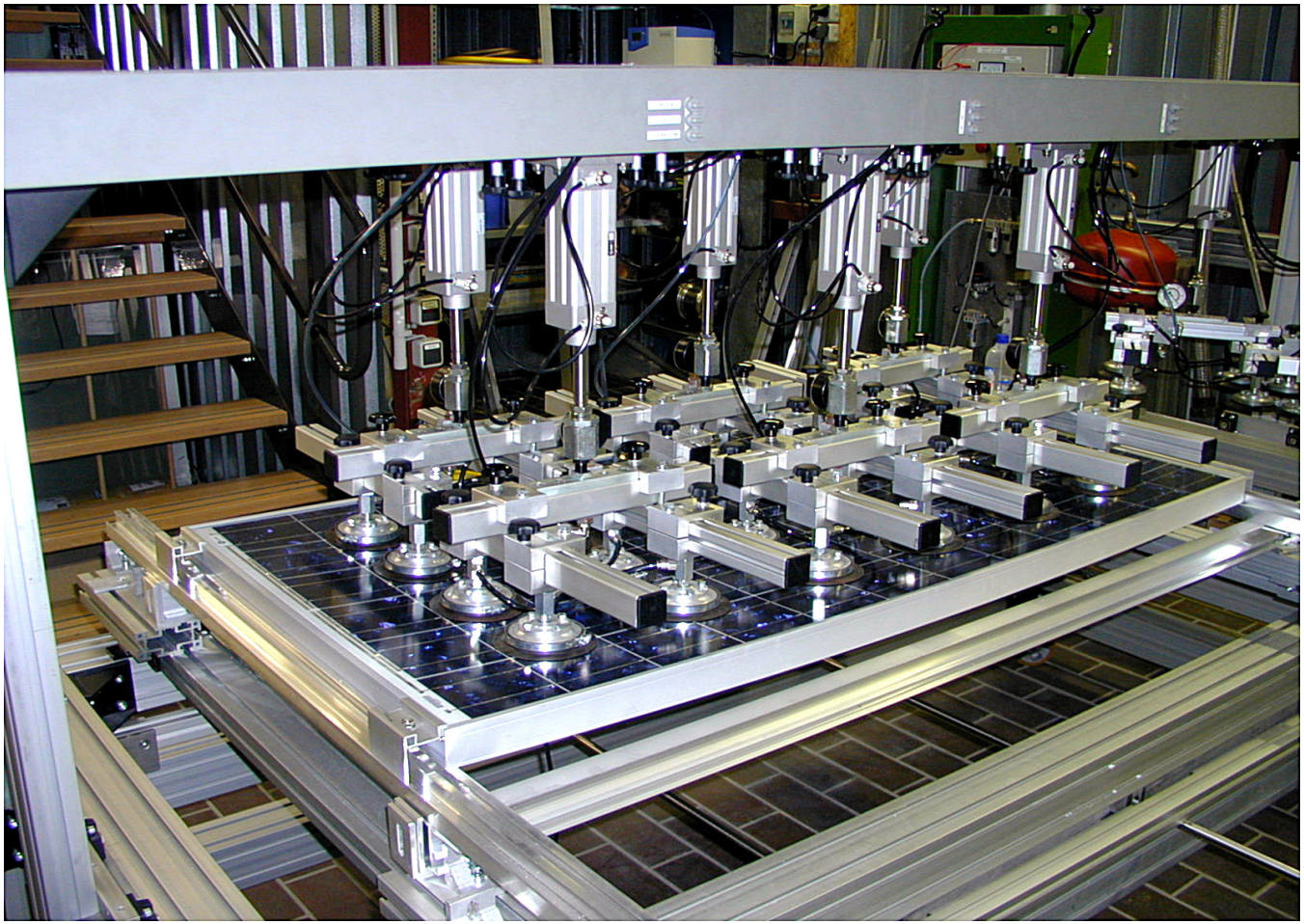
Damp heat:
1000 hours
85°C, 85% RH

Thermal cycling:
200 cycles
-40°C to 85°C
with current injection



3. IEC qualification testing and failure mechanisms

Mechanical stress tests:



Mechanical load test
to determine the ability of the module to withstand wind, snow, static or ice loads.

- 3 load cycles to the module front and back surface
- Standard:
  2.4 kN/m² uniform load
- Optional:
  5.4 kN/m² during last front cycle

3. IEC qualification testing and failure mechanisms

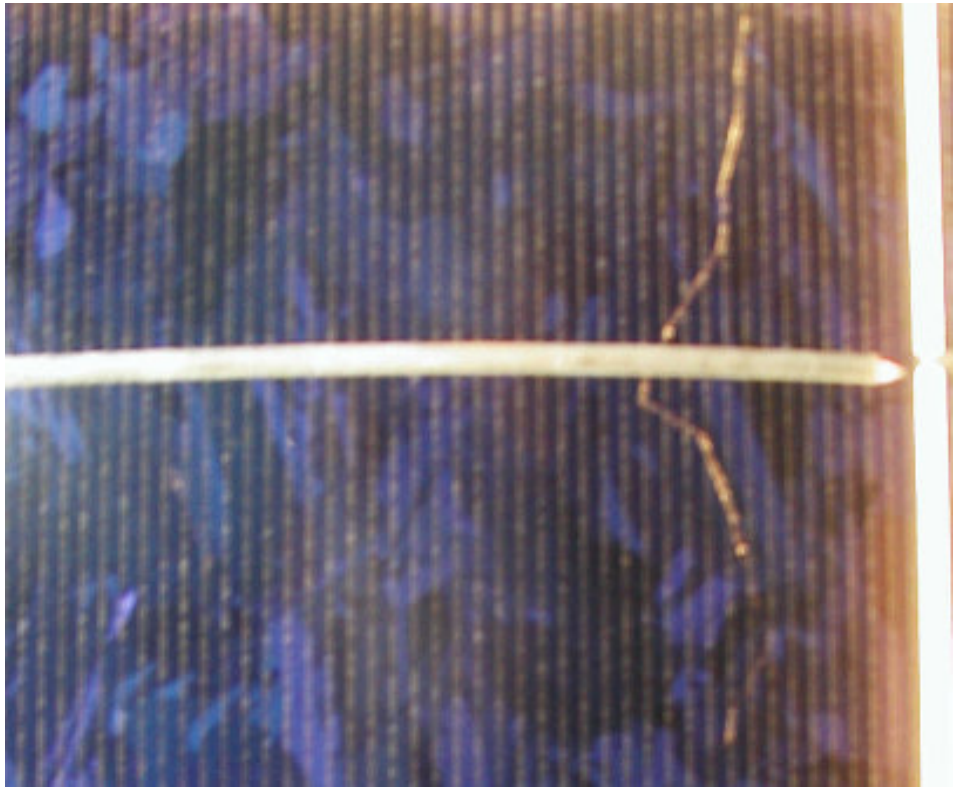
Additional national or regional requirements

- Additional national or regional requirements must be referenced (Example Germany: Wind and snow loads acc. to DIN 1055-4 and DIN 1055-5)
- Test conditions of 5.4 kN/m² uniform load for mechanical load test is recommended.

3. IEC qualification testing and failure mechanisms

Degradation indicator: Visual defects

Insufficient stability of frame

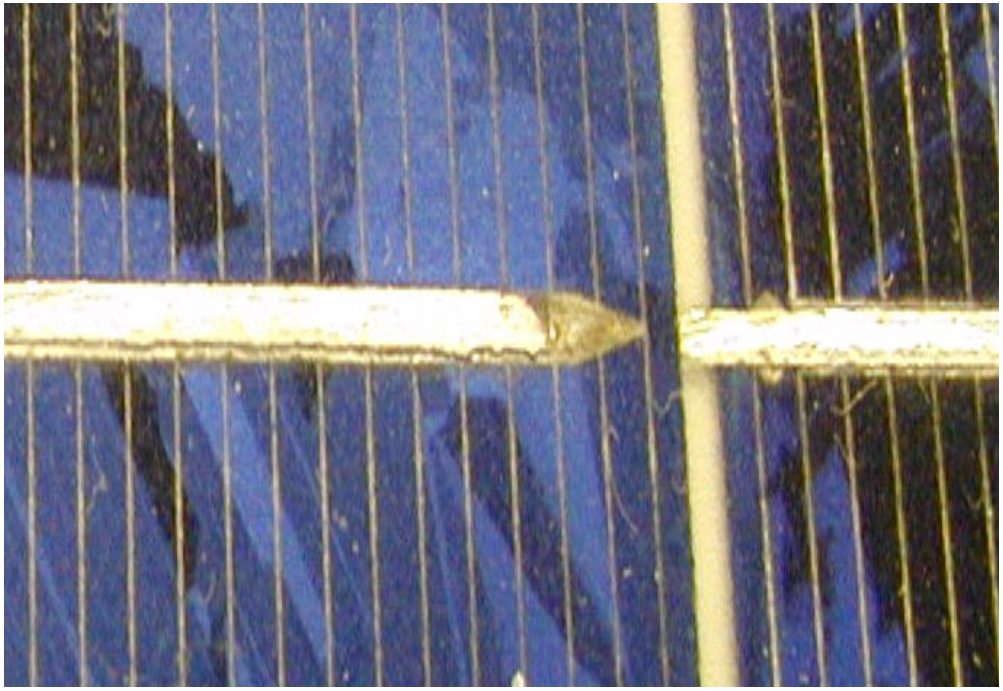


Cracking of solar cells

3. IEC qualification testing and failure mechanisms

Degradation indicator: Visual defects

Insufficient lamination quality



Corrosion of cell interconnects or soldering joints

3. IEC qualification testing and failure mechanisms

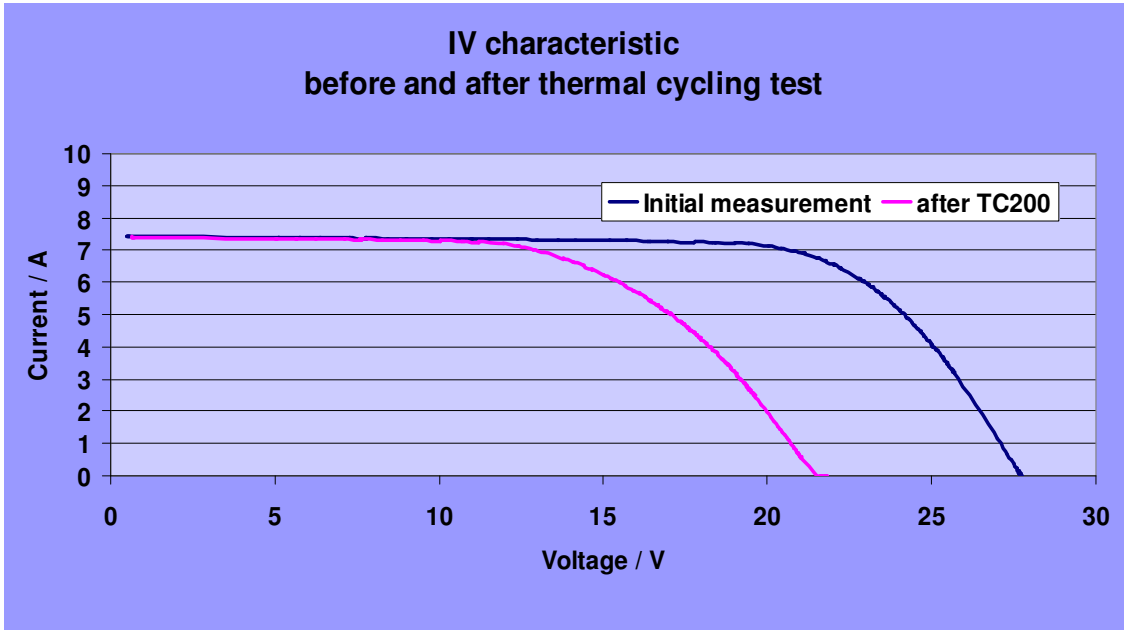
Degradation indicator: Insulation resistance

Max. systems voltage of the module type is applied between internal current carrying parts and the wetted outer surface (conductive wetting agent)

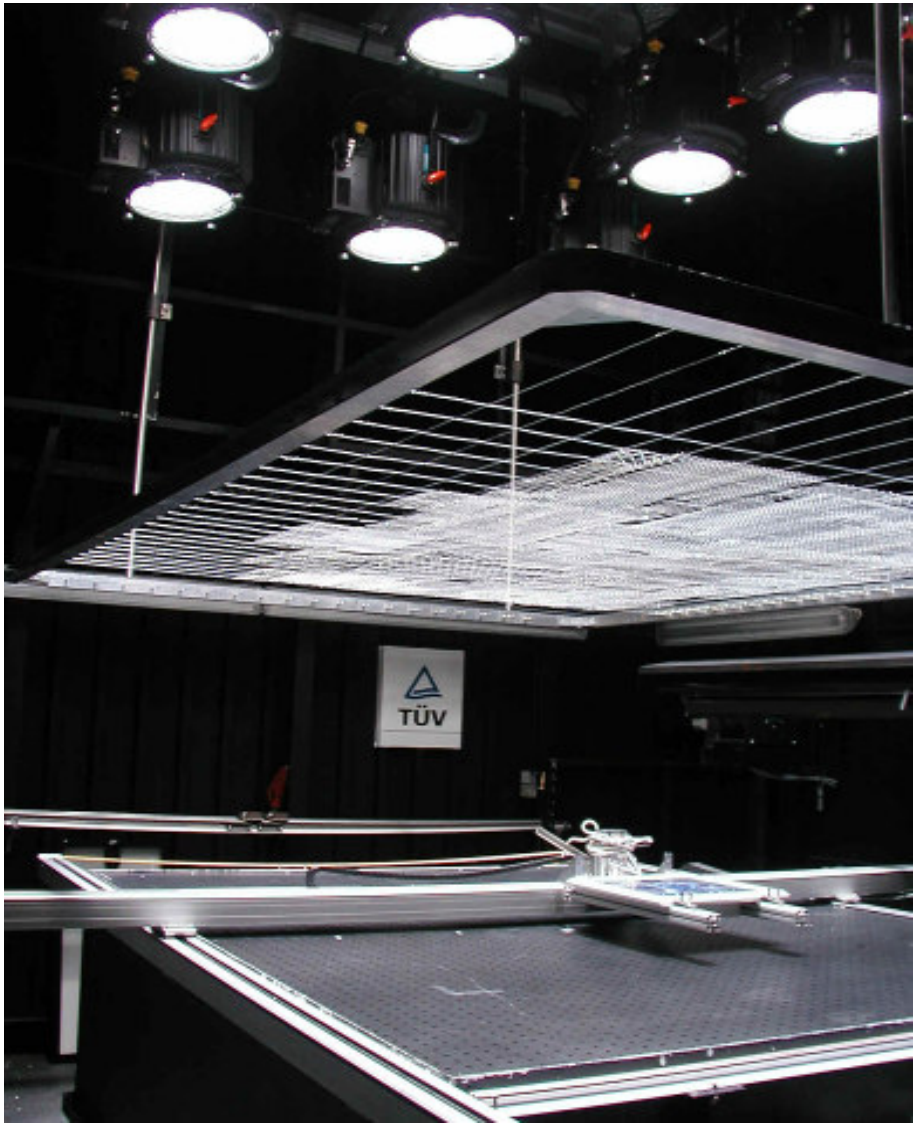
Test requirement under wet conditions:
Insulation resistance x Module area > 40 MOhm

3. IEC qualification testing and failure mechanisms

Degradation indicator: Maximum output power



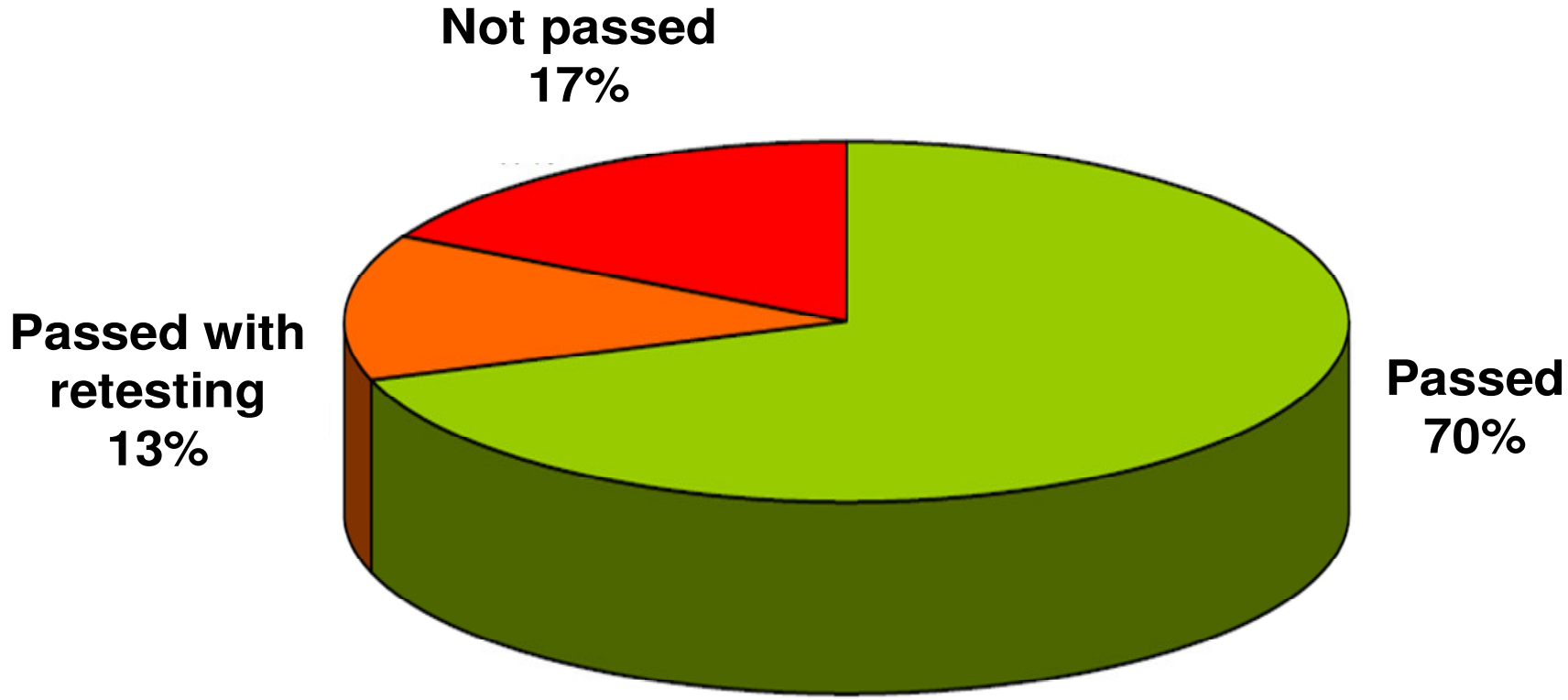
Deterioration of output power due to break in the interconnection circuit or corroded solder joints



View of TUV steady-state solar simulator

3. IEC qualification testing and failure mechanisms

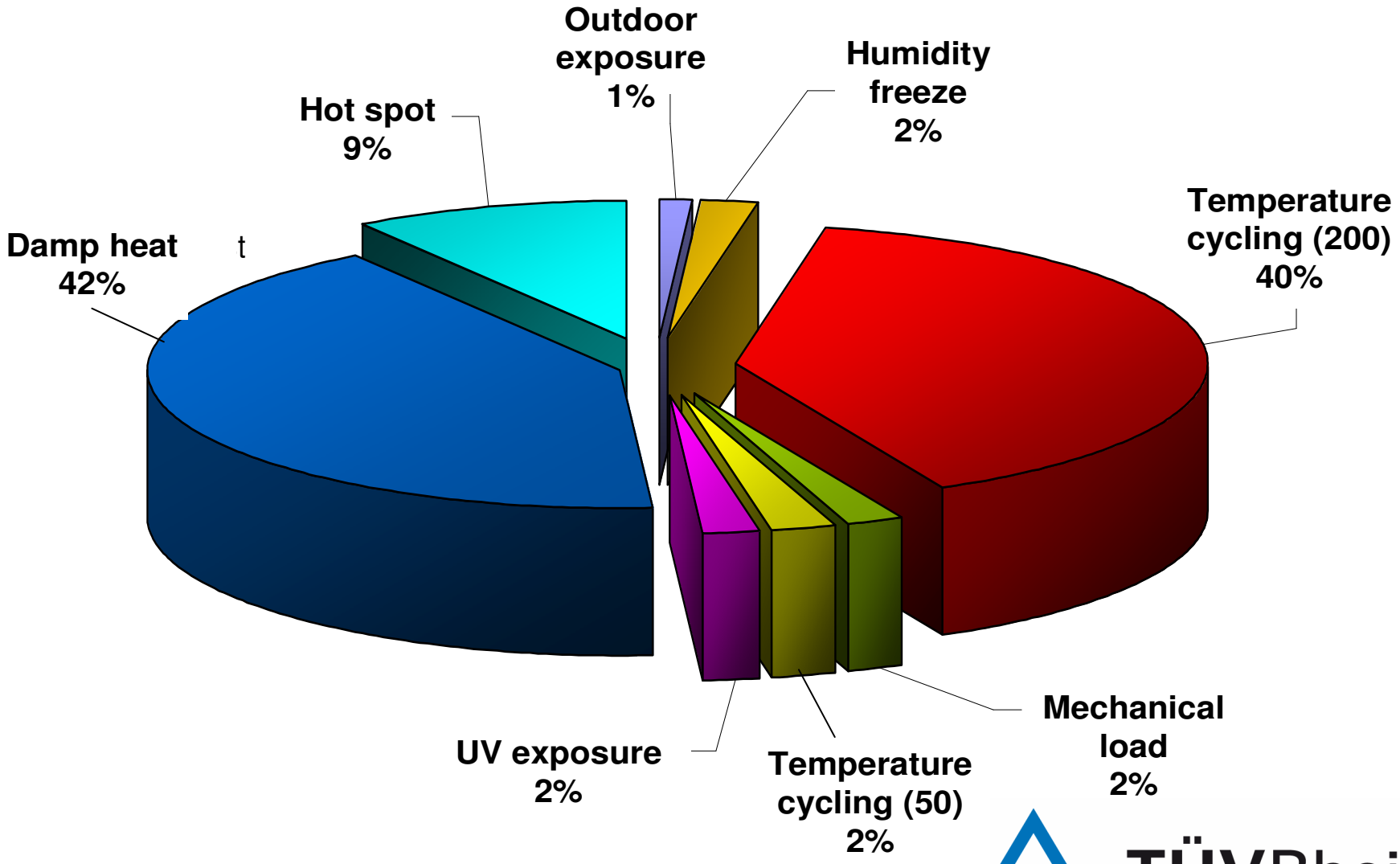
Qualification testing in accordance with IEC 61215 Ed. 1/Ed. 2
Summary of qualification test results at TÜV Rheinland since 1998



Experience in the market has led to the availability of high quality modules. However, due to the large number of new manufacturers and new materials/components overall failure rates at TÜV and other labs have increased in the recent years.

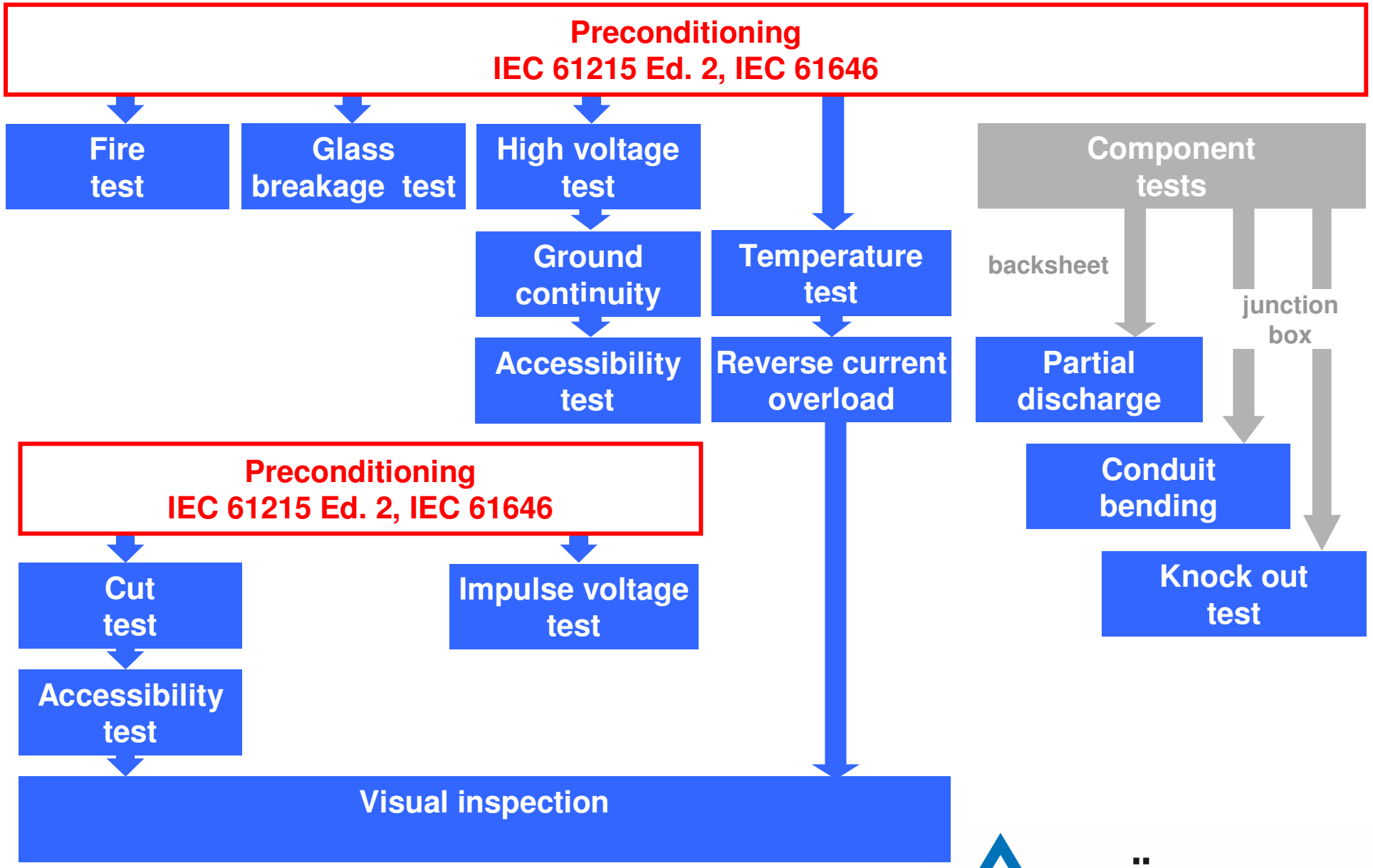
3. IEC qualification testing and failure mechanisms

Qualification testing in accordance with IEC 61215 Ed. 1/Ed. 2
Failure analyses of qualification tests at TÜV Rheinland since 1998



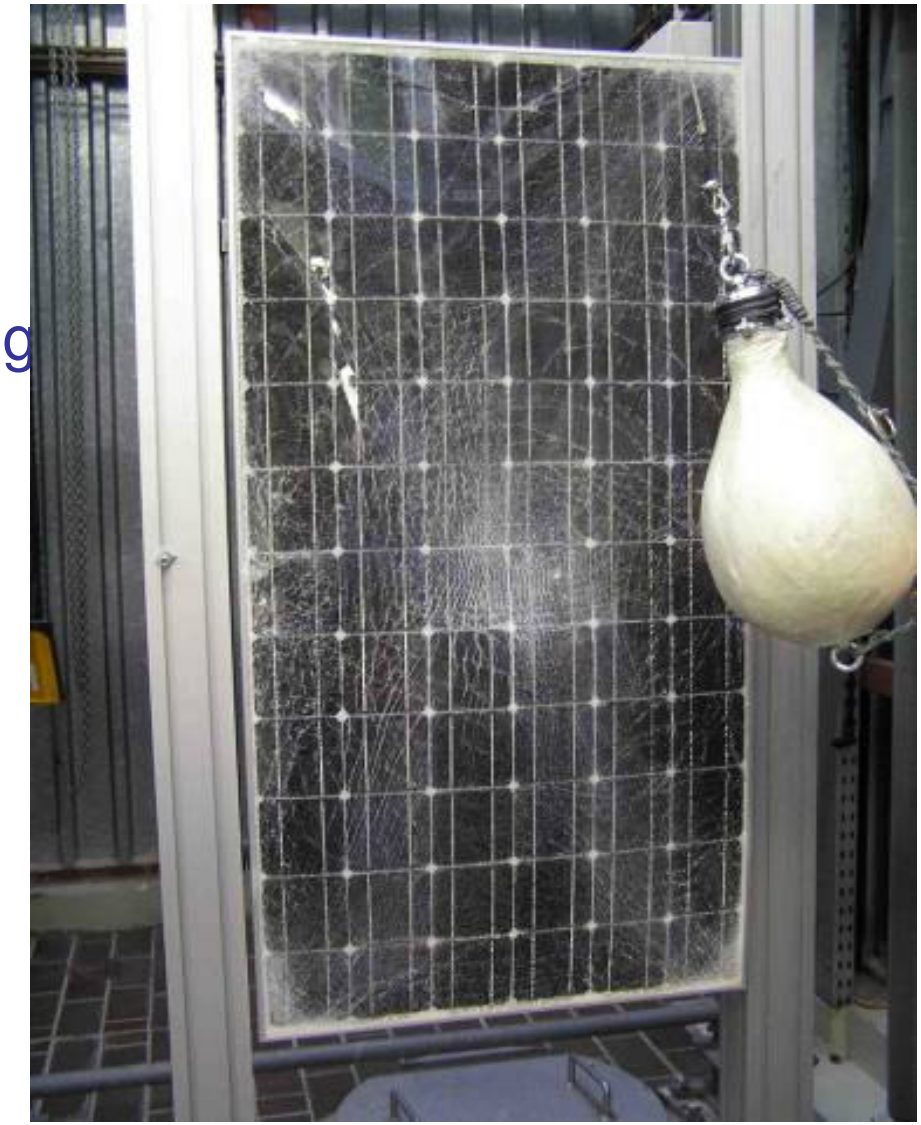
3. IEC qualification testing and failure mechanisms

Safety qualification testing in accordance with IEC 61730-2 Ed. 1



3. IEC qualification testing and failure mechanisms

Safety qualification testing in accordance with IEC 61730-2 Ed. 1



Glass breakage test

to provide confidence that cutting or piercing injuries can be minimized if the module is broken.

Impactor: 46.5 kg
Drop height: 30 cm, 45 cm 122 cm

- Module breakage is permitted
- Test requirements are defined for the size and total weight of glass pieces
- No opening larger than 76 mm in diameter

4. Factory surveillance and Certification

Qualification testing in accredited PV test lab:

Laboratory test with test samples of a type family (Performance: IEC 61215/61646, Safety: IEC 61730)

Factory inspection:

Documentation of materials, manufacturing equipment and processing parameters

Certification and test mark:

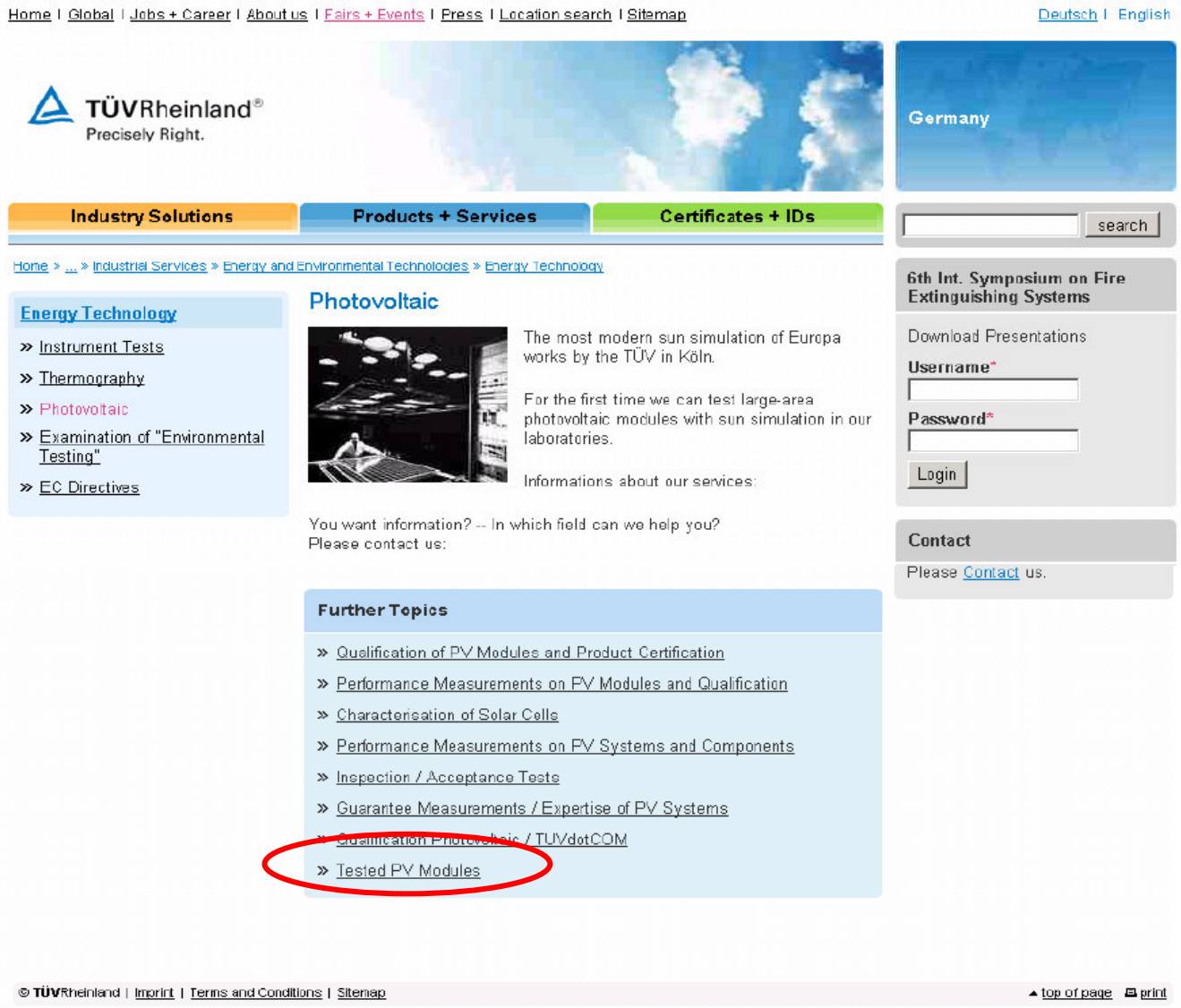
Test certificates are issued by a certification body based on the laboratory test report and factory surveillance reports. A special test mark may be given.

Factory surveillance:

Compliance of actual module designs with the design of tested modules
⇨ consistent product quality

4. Factory surveillance and Certification

Check for authenticity of test certificates
www.tuv-pv-cert.de



5. Summary

Photovoltaic modules have to withstand a number of environmental influences in their long lifetime.

An important quality indicator for PV module is the compliance with international test standards.

The test requirements are high and product that have been tested by accredited test institutes are high quality products.

Factory surveillance as part of certification is an important measure for guaranteeing a constant product quality.

Critical check for authenticity and origin of test certificates is important.

Besides product quality the safe and reliable operation of a PV system also strongly depends on the quality of the installation.