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Bundesamt für Energie BFE

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# LIFETIME, MECHANICAL AND SAFETY TESTING FOR PV MODULE CERTIFICATION

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Scuola universitaria professionale  
della Svizzera italiana

**SUPSI**

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Für den Inhalt und die Schlussfolgerungen ist ausschliesslich der Autor dieses Berichts verantwortlich.

## 1. Abstract

In the expanding PV market testing and certification capacities constitute a serious bottle-neck. The institute ISAAC of Supsi has a long experience in PV module testing and intended with this project to set-up a laboratory, capable to respond to the growing request by the national and international PV industry. The project includes important investments in testing equipment reinforcing the position of ISAAC in the field of PV module characterization for services as well as for research.

The overall goal of this project was to set-up, in the course of 6-8 months, a new test centre to be accredited according to the ISO 17025 standard for testing laboratories and to dispose of the IEC tests cycles to carry out the PV module qualification. This goal has been reached in due time and within the limits of the budget.

The test centre is fully equipped to carry out the test cycles according to the three presently relevant testing standards for PV modules defined by the IEC norms:

- IEC 61215 – design qualification and type approval of crystalline PV modules
- IEC 61646 - design qualification and type approval of thin film PV modules

In addition this qualification tests will be completed by the security tests as requested from the

- IEC 61730 – safety qualification of PV modules.

The expected productivity of the laboratory is about 32 certifications in the first year and should reach after three years up to 40 certifications. About 15%-20% of the capacity of the test centre is dedicated to research purposes. The laboratory offers new opportunities for the development of the research activities at the ISAAC, increasing the range of topics and enhancing the relationship with the industry as expressed in the long term strategy of the institute.

The test centre has been presented at the 8<sup>th</sup> Nationale Photovoltaiktagung in Winterthur in February, and was present on invitation by OSEC with its own stand at the Hannover Energiemesse in spring 2010 and at the 25<sup>th</sup> European Photovoltaic Solar Energy Conference Exhibition and 5<sup>th</sup> World Conference on Photovoltaic Energy Conversion in Valencia (Spain) in September 2010.

## 2 Aim of the project

In the fast growing PV market the successful industries in this market are looking for new testing laboratories. The Institute of Applied Sustainability to the Built Environment (ISAAC) at the University of Applied Sciences in Lugano is the Swiss competence centre for the PV module characterization and an internationally recognized test laboratory for the electrical measurements. The institute already disposes of in-

door testing facilities and outdoor test stands and has over twenty years of experience in the field of photovoltaic.

The overall goal of this project is to set-up a new test laboratory by integrating the accredited tests for the PV modules with new tests on lifetime, mechanical and security aspects according to the IEC standards for crystalline and thin film PV modules.

## 2. Project description

The project basically consisted in the set-up of a test laboratory from scrap including the planning of the layout and construction of the internal spaces of the laboratory. The building had to accommodate all the instruments for the lifetime and safety testing of PV modules as well as the sun simulators, which is determined by:

- Thermal cycling, damp heat and climatic test chambers
- Mechanical load tester – hail tester – module breakage tester
- UV resistance of the materials
- Steady state sun simulator and flash sun simulator

These lifetime and safety tests enable ISAAC to cover the complete certification according to the three presently relevant certifications standards for PV modules defined by the IEC norms:

- IEC 61215 – design qualification and type approval of crystalline PV modules
- IEC 61646 - design qualification and type approval of thin film PV modules

In addition this qualification tests will be completed by the security tests as requested from the

- IEC 61730 – safety qualification of PV modules.

The expected result of this project was to set-up, in the course of 6-8 month, a new ISO-17025 accredited test centre and to dispose of the IEC tests cycles to carry out the PV module qualification. This goal has been reached in due time and within to the limits of the budget. The expected productivity of the laboratory is about 32 certifications in the first year and should reach after three years 40 certifications. About 15%-20% of the capacity of the test centre is dedicated to research purposes. The laboratory offers new opportunities for the development of the research activities at the ISAAC, increasing the range of topics and enhancing the relationship with the industry as expressed in the long term strategy of the institute.

The new equipment of the laboratory can also be used for research purposes such as:

- Mechanical tests in particular for the BiPV group
- Lifetime of new lamination materials
- New design of modules

- New measurements and testing methods for thin film PV modules.

### 3. Work carried out and results achieved

In the following paragraphs the equipments for the most significant of the 29 tests will be shown, which can be carried out in the laboratory.

#### 3.1 Building

A major challenge for this project was to find an adequate space. According to the plans and the layout of the laboratory a building with at least 1000 m<sup>2</sup> was needed. This space was not available in the school buildings. The search for an industrial building with the necessary surface was the first step in the realization of this project. The plan for the layout and the work for the internal division of the building was carried out by the ISAAC team, reducing significantly the time from the desk to the building. The empty building was ready on 1<sup>st</sup> of May.



*Outside view*



*Inside view of the laboratory*

**Fig.1:** The industrial building hosting the new PV test laboratory in Lamone

The building is located in a strategic position, with a good accessibility for the clients, about ten minutes from the institute and well served by public transport. The building also includes a large roof, which is supposed to be prepared next year for outdoor measurements. The building corresponds the new energy requirements of the Canton Ticino. The energy efficiency standards for buildings could be reached thanks to the use of residual energy of the climatic chambers.

### 3.2 Workflow

The testing and certification of PV modules needs a very tight management and workflow planning. The testing process concerns from 8 to 11 different modules depending on the required IEC standard of different ongoing test procedures. Fig. 2 shows an example of the IEC 61646 flow.

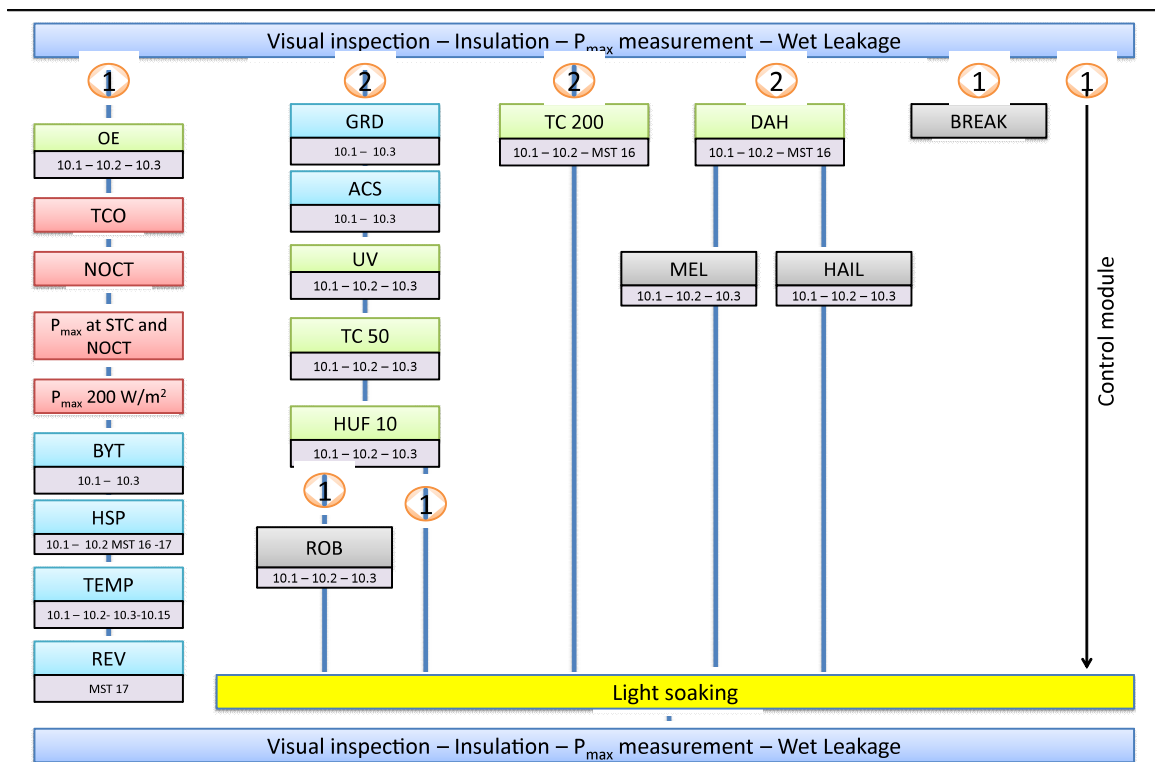
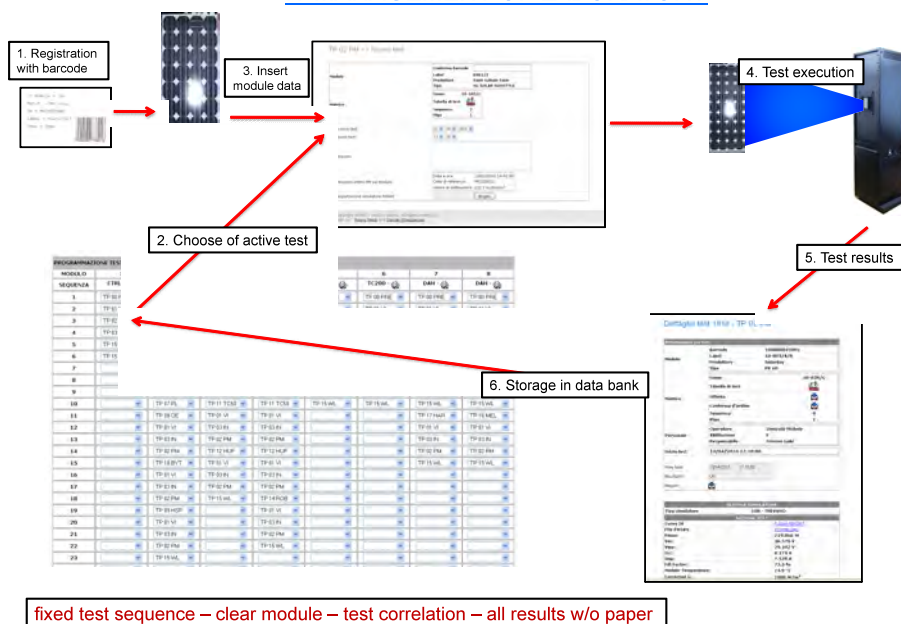


Fig. 2: Example of the IEC 61646 / 61730-2 flow

### 3.3 Database

In parallel to the equipment purchase and installation an intranet web portal was developed with a database to manage the ISO 17025 quality system and to stock all tests results. All tests results are acquired by PC and saved in the database. The single test reports and the final report are generated automatically by the web portal.

## IT MANAGEMENT OF LABORATORY



**Fig.3:** IT management for the module testing sequence and results

Where necessary the data acquisition system and the relative software to acquire the data automatically were created in-house. The database is also used for the PV module registration and all instrument and equipment quality control.

### 3.4 Lifetime

The major investment in the laboratory regards the lifetime and durability tests, carried out in three different climatic chambers, all designed to accommodate the latest PV modules with the dimension of 3.2 m x 3.3 m:

Thermal cycling (TC) chamber; humidity freeze (HUF) cycling chamber; damp heat (DH) chamber



**Fig. 4:** 2 of the 3 climatic chambers

The two cycling climatic chambers are equipped with a condenser in order to recover the residual energy from the 100 kW compressors systems of each chamber. This allows heating the laboratory during the winter time. Recovering the residual heat was also a condition to comply with the new standards of the energy law in Ticino introduced on the 1st of January 2009 and is in line with the general concern of the Institute of energy efficient buildings.

It was the first time the German leader company for climatic chambers had to resolve the problem of energy recovery. Being an innovative company they gladly accepted the challenge and we succeeded together to face this problem in a very satisfactory way.

To simulate the UV exposure and aging of the PV modules a thermal chamber with UV lights was installed. The chamber can work at temperatures from 40°C to 90°C and the UV light is generated by UV lamps with a spectrum similar to the sun light.



**Fig. 5:** UV thermal chamber

### **3.4 Mechanical tests**

The mechanical tests for PV module certification constitute a new area for the PV sector of the institute.



**Fig. 5:** Mechanical load

The mechanical tests include mechanical load test applied by pistons to the PV module (pressure and traction) to simulate the mechanical pressure from snow and wind (Fig. 5). The maximum pressure is 5400 pa.

Another important test is the hail test (shown in Fig. 6). We are equipped with a 25 mm according to IEC and a 35 mm gun for tests needed by the Swiss building insurances.



**Fig. 6:** Hail test

The last important mechanical test set up is the PV module breakage test shown in Fig. 6.



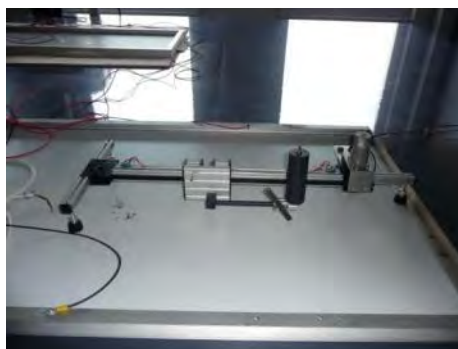
**Fig. 6:** Module breakage test

The other smaller mechanical tests for IEC testing as cutting test, robustness of terminals, conduit bending test and box knock out test were also installed.

### 3.5 Electrical safety

The following electrical safety tests are installed in the laboratory:

- Reverse current test
- Ground continuity test
- Insulation test up to 6000 V
- Wet leakage test
- Accessibility test (see fig. 7)



**Fig. 7:** Accessibility test with artificial finger and cutting test

### 3.6 Electrical measurement and sun simulators

On the roof of building B in Trevano we added to our existing test stands a NOCT stand to measure four modules simultaneously and a stand for the outdoor exposure of the modules. In addition we perform the preconditioning of the PV modules and measure the hot spot endurance test on the roof. All tests and the data acquisition on the roof are integrated the intranet web portal and the relative database.



**Fig. 8:** NOCT Stand

In the new laboratory in Lamone a dark room with the PASAN IIIa flasher (class AAA) was also set up and the 'old' thermal chamber for TCO measurements, which were used in the dark room in Trevano. In Trevano the flasher is a PASAN IIIb (class AAA) in combination with a new thermal chamber for TCO measurements. This chamber has a temperature range from 5°C to 100°C and is very useful even for research purposes.

In Lamone a steady state sun simulator class CCB for the light soaking of thin film PV modules and the hot spot endurance test was also installed. During the light soaking the modules are monitored by the MPPT developed by ISAAC (MPPT3000).



**Fig. 9:** steady state sun simulator class CCB

### **3.7 Accreditation Process**

The accreditation for product testing bodies is defined by the ISO Standard 17025 and conducted by the Swiss Accreditation Service (SAS) with the technical support of an expert. The technical expert comes from the JRC ISPRA (IT), where the test pro-

cedures were developed in the past. The pre-audit took place in August 2009 after the installation of the climatic chambers and the final audit on the 16th and 17th of November 2009. The required correction measures were implemented immediately after the audit in November besides the construction of a new parapet complying with the construction and safety norms on the roof in Trevano.

The accreditation was received on the 3<sup>rd</sup> of March 2010 with the registration number STS 531.

## **4. Conclusion**

The set-up of the new testing laboratory was certainly a great challenge to the institute and the financial support of SFOE is kindly acknowledged. Thanks to the support of the School direction and the head of the department the important decision to create this new infrastructure providing the PV industry with testing services and amplifying our research activities in the PV sector was taken a year ago. All testing facilities, the whole management system, with a totally paperless management of all test reports, and the definition of all test procedures and quality manuals were successfully implemented due to a great team work, supported by the quality delegate of the School. The contacts with the industry were taken during the whole year and with the end of the implementation period the efforts in marketing were intensified, in view of the accreditation in March.

## **References:**

IEC 61215 (2005): Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61646 (2008): Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval

IEC 61730-2 (2004): Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing

## **Public relation and publications:**

### Conferences and fairs:

- PV Tech Conference - Fair - Milan (Italy) – 25. – 27.11.2009
- 8. Nationale PV Tagung – Winterthur 04.-05.02.2010
- Hannover Messe: SWISS Pavillion Energiecluster OSEC 19.-23.04.2010

### Publication – articles:

- PHOTON Newsletter 28.04.2010
- Energieforschung - März 2010
- Newsletter 105 – Energiecluster
- Photon 5/2009 (edition DE – IT – International) - New Testing Laboratories