Accreditation for the PV inverter test bench of the PV Laboratory
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Task: 5.2 Inverters and Balance of Systems

Summary
The Photovoltaic Laboratory (PV Lab) at BFH is involved in the measurement of PV inverters since nearly 30 years. In the first years after 1988, stationary PV installations were used. On the new laboratory building in Burgdorf, a flexible 60 kWp PV plant allowed a wide range of measurements. However, this is not very practical. For this purpose, four linear, high-speed PV array simulators with high stability (12 kW, 20kW, 25kW & 100kW) have been developed. In 2015, a new multistring-simulator with 3 x 11,5 kW was built. These projects were partly supported by the Swiss Federal Office of Energy SFOE.

In 2014 we started a project for the accreditation of the PV inverter test bench. Based on the quality management system QM-Pilot, which is standard at BFH, we could establish the processes. In September 2017 we got the accreditation for PV inverters. It gives the industry and the researchers qualified test processes for their measurements. The project efforts were mainly supported by the Swiss Federal Office of Energy SFOE. Further support was given by the Swiss Competence Center of Energy Research for future grids (SCCER-Furies) and the Berner Fachhochschule Technik und Informatik BFH-TI.

Keywords: PV inverter tests, accreditation, PV-inverter, testing, PV-simulator, EMC

The accredited measurements
The accreditation closes the effort of the researcher of the PV LAB in Burgdorf of the BFH-TI in the measurement of PV inverter. This started 30 years ago and finalized in a very unique test surrounding we use for student courses and projects. The new PV array simulators for 100 kW and 3x11,5 kW are mainly used for research and projects with industry. The goal of the project was to get the accreditation to give the industry more confidence into our measurements. Additionally, more and more certificates are needed to distribute the products worldwide. We can award such certificates now.

The accredited measurements are:

- EN 50530 (IEC 50530)
  - Overall efficiency of grid connected photovoltaic inverters
- EN 61000-3-2 (IEC 61000-3-2)
  - Electromagnetic compatibility (EMC): Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase)
- EN 61000-3-12 (IEC 61000-3-12)
  - Electromagnetic compatibility (EMC): Part 3-12: Limits - Limits for harmonic current produced by equipment connected to public low-voltage systems with input currents > 16 A and >= 75A per phase
- CISPR 11 (EN 55011)
  - Radio interference caused by electromagnetic waves
  - Industrial scientific and medical equipment – Radio-frequency disturbance Characteristics – Limits and methods of measurement
QM – Pilot quality system

There were already accredited measurements processes established at Bern University of Applied Sciences. One of them is the “exhaust treatment” measurement of the “exhaust treatment facility” in Nidau/Biel. Like the PV LAB it is part of the institute “Energy + mobility”. After the start of the project we could use the QM-Pilot quality management system which was introduced at BFH. It allows the administration of all the different processes and their descriptions.

Structure of the QM-Pilot quality management system for the PV inverter test laboratory

New test rooms for the equipment

To have efficient and comfortable test surroundings, we moved the inverter test bench area to the first floor.

The accredited PV inverter test LAB with the “golden sample” PV inverter (Photo: PV LAB).
The main inverter test benches of 100kW and 3x11.5kW are in the same room. Some of the other inverter test benches are outside the closed area. This allows us to work in parallel and to offer researchers and students a simple access to the test equipment which is not accredited.

The accredited measurements in detail:

**PV inverter test standard  EN50530**

The development of the PV inverter test standard was supported by the PV LAB. It allows a characterization of the performance and efficiency of PV inverters. PV inverters developed well in the last 30 years. They reach high efficiencies, are precise and answer quick on changes in the insolation. The test configuration:

![Diagram of the PV inverter test configuration](image)

**Configuration of the PV inverter test (EN 50530)**

“Golden sample” – the reference PV inverter for the test bench (Photo: PV LAB).
PV inverter test procedure for dynamic measurement

EN 61000-3-2 (IEC 61000-3-2) - Electromagnetic compatibility (EMC): Part 3-2: Limits - Limits for harmonic current emissions (equipment input current <= 16 A per phase)

Stromharmonische [A] bei $P_{AC} = 2470$ W

Fig. 3: Comparison on the harmonic currents with the Norm (EN 61000-3-2)

- EN 61000-3-12 (IEC 61000-3-12)
  - Electromagnetic compatibility (EMC): Part 3-12: Limits - Limits for harmonic current produced by equipment connected to public low-voltage systems with input currents > 16 A and >= 75A per phase
HF-interference voltage within the limits

**CISPR 11 (EN 55011)**

This standard deals with the radio interferences:
- Radio interference caused by electromagnetic waves
- Industrial scientific and medical equipment – Radio-frequency disturbance

Characteristics – Limits and methods of measurement

![Diagram of measurement setup](image)

Basic measurement setup for the CISPR 11 Ed.6.0 2015-06 test
Measurement setup for small devices

CISPR measurement on a customer example:

CISPR measurement of a customer unit – the Power-Blox PBX-200 in the PV inverter test lab (Photo: PV LAB)

The Powerblox is a special unit for isolated microgrids from the Swiss Company Power-Blox AG in 5200 Brugg/CH. It contains batteries, a PV solar regulator for the battery charge, a small PV
inverter for 230 V/ 50Hz (or 60Hz) and allows to connect several Powerblox units in a swarm to form a bigger microgrid. In this scenario, all these connectors have to be measured according the CISPR standard. The following charts show these results:

Maximum values of the Powerblox 200 at the PV connectors – pass the test!

Maximum values of the Powerblox 200 at the main connectors – pass the test!
Maximum values of the Powerblox 200 at the island network connectors – pass the test!

The customer gets a full report of test results with all the technical measuring conditions. This can be needed for the export of his product in foreign countries. It’s possible to get the test reports in several languages as German, French, Italian and English.
User of the accredited PV inverter test bench
Since the accreditation, the request for measurements and measurement support went up. There are companies from industry and business which want to check and improve their devices. The service goes often over the real measurements. Our specialists have a broad experience in power electronics and can support the industry. This could also be done by projects supported from Innosuisse, which supports the efforts of the PV LAB if the company is based in Switzerland.

We often get systems for the test, which are not at all or not fully operable. This creates delays and extra costs for the customer. Proper manuals are also an important topic. Often, the software access for the system accreditation is not fully operable. Especially the PV battery storage systems shows such problems.

Measurement of PV battery storage systems
PV storage systems are a hot topic in the PV market. There are hundreds of systems in the market in mid Europe. However, the test standard for these systems has yet to be established similar to the PV inverters 30 years ago. The PV LAB supports the test standard from HTW Berlin according to the “Effizienzleitfaden”. This complex measurement gives a clear picture about the static and dynamic behavior of such systems. The measurement is much more complicated as a PV inverter. However, the process is similar. The PV LAB established an automatic test bench for PV battery systems within the “accredited PV test laboratory”.

PV LAB measures PV storage systems (Photo: Muntwyler)
The PV-LAB testbench for the automatic measurement according the «Effizienzleitfaden» is controlled and regulated through the self-developed software “PV BATTTEST™”. It allows a 24-hour/day and seven days a week working procedure. This needed to speed up the measurement process. It takes about one week to test a system.
Display of the self-developed software “PV BATTTEST”, it allows us a fully automated test of PV battery systems in the PV LAB of the BFH-TI in Burgdorf.

Conclusion

The PV Lab at BFH Switzerland got his certification by the Swiss Association for Quality and Management Systems (SQS) in September 2017. The effort is supported by the Swiss Federal Office of Energy (SFOE) and the SCCER (Swiss Competence Centers for Energy Research) initiative. The test bench offers the researchers and the industry tests according to the relevant standards in a proven and checked manner.

The researchers from the PV LAB BFH in Burgdorf

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2 Energieeffizienzleitfaden, HTW Berlin, Version 1.0; August 03/2017
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