PV Infrastructure 1993+ and new Test Facilities for Education and Research

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ABSTRACT: In 1989, the worldwide first monetary "feed-in tariff" scheme for electricity from photovoltaics (PV) fed into the grid was invented and introduced in Burgdorf (Switzerland). Ten years before, in the late 1970s, (telecommunication) companies like Hasler AG in the Swiss capital of Bern had already con-ducted pioneering PV research. Here, we illustrate how innovative industry research in the region and pioneering governmental policy has interlinked with electrical engineering education at Bern University of Applied Sciences (BFH) in Burgdorf (Switzerland) since the 1990s.
Keywords: Campus, PV research infrastructure, PV tracker, solar carport, EMI, arc detectors

1 INTRODUCTION

In 1993, part of the Engineering Department at Bern University of Applied Sciences (BFH) moved to a new Campus in Burgdorf-Tiergarten, Switzerland. Since then, the Campus has offered a vast PV re-search infrastructure to the BSc and MSc students enrolled in the electrical engineering degrees at BFH, including a high voltage test facility for up to 1 MV and a 100 k DCA test chamber. Several pioneers enabled this development.

[1] As a response to the Chernobyl nuclear disaster (1986), Prof. emer. Dr. Heinrich Häberlin, then leader of the Laboratory of Photovoltaic Systems (PV LAB) at BFH in Burgdorf-Tiergarten, aimed at installing a big photovoltaic (PV) plant on the roof of the Burgdorf-Tiergarten building. This idea for research and education on PV systems at a 60 kWp roof-top PV plant on the Burgdorf-Tiergarten Campus was also inspired by the first "feed-in tariff" for PV in the world invented in 1989 in the city of Burgdorf. The PV plant project sounded convincing to the Ministry of Energy at the State of Bern and Mr. Bärtschi, then Minister of Energy, permitted co-financing of the M55 PV modules (> 500'000 Swiss Francs) . The roof-top PV plant at the Burgdorf-Tiergarten building of BFH has been monitored by the PV LAB at BFH since its construction in 1993.

[2] The new leader of the PV LAB at BFH Burgdorf-Tiergarten since 2010, Prof. Urs Muntwyler, had investigated the use of PV for telecommunication applications since the late 1970s on behalf of Hasler AG in Bern and operated several test sites on the Chasseral mountain (1'600masl), the Piz Corvatsch (2'900masl) and several sites in the Swiss Basin. In 2012, he complemented the roof-top PV plant at the PV LAB at BFH by a 4,8 kWp free-field PV tracker and a 2,7 kWp solar carport. In 2014, a new "smart module" PV test facility with about 6 kWp installation was established . The most re-cent PV research infrastructure is a flexible DC-/AC test facility on a roof slope of a BFH-building at the Burgdorf-Tiergarten Campus in January 2020.

2 AIMS AND APPROACH

The roof-top PV installation mounted in 1993 stimulated first PV inverter tests and laid the founda-tion for a long-term measurement program of ca. 30 PV plants in Switzerland conducted by the PV LAB at BFH. In the context of the feed-in tariff, the energy yield produced by the PV plant (almost) generated the yearly salary for a research assistant past the last 20 years (production figures see www.pvtest.ch). The free-field PV tracker and the solar carport are mainly used for research on snow on PV modules and on charging electric vehicles / PV-EV links, respectively. The smart module PV test facility enables research on partial shadowing of PV modules. As for the new slope-roof 4 x 6 kWp (KNS) test facility, a new and flexible research concept is adapted that draws on the different PV modules and cabling techniques, different PV inverter con-cepts and PV components (see Figures 1-2). Among the research questions to be addressed are:

- Electric magnetic interferences from cabling / inverters and other components
- Influence of different cabling concepts on induced voltages in the DC-part of the PV installa-tion
- Function and use of Arc detectors in different DC parts
- PV inverters with and without arc detectors
- PV inverters with galvanic separation and without galvanic separation
- Wind load measurements under different conditions
- Comparison of four different PV technologies
- Use of different PV inverters topologies
- Cross compatibility of PV connectors
- Rapid shut down device tests
- Yield of east-west installations compared to south expositions and 1-axis tracker
- Salination of east-west installation (big railway lines nearby)
- Influence of different mounting systems
- Thermal behavior of PV surfaces with different installation conditions

3 TECHNICAL CONCEPT OF SLOPE-ROOF INSTALLATION

Four different PV module types were installed (Figure. 1):

- JA Solar: m-Si PV module JA Solar mono JAM60S10-330/PR (HC) Halfcut-Zellen, 330Wp
- JA Solar: p-Si mmodule JA Solar Poly JAP60S01-275/SC, 275 Wp
- Sharp: m-Si module NU-AK310, 310Wp
- LG: high power m-Si LG 345N1C-V5, 345Wp

Figure 1: Illustration of the four different PV technologies installed, the associated two cabling concepts and mechanical structures.

Several types of PV inverters were mounted, being: A Fronius ñPrimoò inverter (offered by Fronius), two ABB inverters (offered by the utility company of the city of Bern) and one Huawei-inverter. Cur-rently, we are planning to extend the facility with some PV inverters in the 6 kWp size with arc de-tectors.

The measurement concept is based on the long-term monitoring network operated by the PV LAB at BFH since the 1990s. Existing sensors are used for some of the measurements, e.g., for global insolation.

4 PRELIMINARY RESULTS

Despite some delay due to state administration, construction of our new slope-roof 4 x 6 kWp – KNS test facility could be completed in January 2020 (Fig. 2a, 2b). The facility is expected to be fully functional in spring 2020.

Figure 2a: Four PV technologies were installed.

Figure 2b: Inverters and test surfaces at KNS test facility.

5 CONCLUSION

First research tests and industrial projects already started; the facility will also be integrated in out-reach events and engineering education after spring 2020. In addition to being used for research, outreach and education, the collaboration between Bern University of Applied Sciences (BFH) in Burgdorf-Tiergarten with the local utility company starting in the 1990s will be continued. Among others, the (surplus) electricity yield produced by the KNS test facility will be sold to the local utility company in Burgdorf.

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7 REFERENCES

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