Longterm measurement of PV installations – toward 40 years lifetime!

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Task: 6.1 Solar Resource and Forecasting

Summary

The measurement of 37 PV installations in 3 different climate zones in Switzerland since more than 25 years, give answers to the long term behavior of PV installations. The PV installations differ in the size from 1 kWp to 2,1 MWp. The installations consist with PV module of more than 10 technologies. In the past the behavior of PV inverters was an important topic too. A side effect of the PV installations measurement was a comprehensive set of labor test equipment which can be used by the PV industry too. Another focus is the life time of PV installations. We want to know if a lifetime of 40 years and more could be reached. This is important as in countries as Switzerland the "soft costs": planning/ safety aspects/ governmental specifications etc. are a growing part in the total cost of a PV installation. With a longer lifetime their influence in the price of PV is lower. With a lifetime of 40 years and more PV is in line with the planning period for buildings in Switzerland.

Keywords: Photovoltaic (PV) measurement network, long-term performance, technology, costs of PV electricity

Long term measurement of PV installations in different climates in Switzerland

The long-term performance and stability of photovoltaic (PV) installations have been hot topics since the late 1970s, when the first pilot- and demonstration installations for telecommunication purposes were built in Switzerland. In this context, an extended PV measurement network in Switzerland was developed by Bern University of Applied Sciences (BUAS) in Burgdorf (Switzerland). Most of the sites in the measurement network are located in Burgdorf, where the feed-in-tariff system for PV was invented in 1989. Subsequently, numerous PV-installations were built around 1990 and many new products (PV-inverters, PV-module technologies, etc.) entered the market.

In the Swiss mainland climate zone there are two big stadium the Stade de Suisse (2005) in Berne with 1,35 MWp, the Tissot Arena (2015) in Biel with 2,1 MWp and a 37 kWp PV plant in Ittigen near Berne with CIS modules.

PV installations on Jungfraujoch (left), Burgdorf (middle) and Mont Soleil (right) all over 25 years and still running.
The network will also be complemented with new technology, mounted at, e.g., Jungfraujoch (3'434 m asl) in the Swiss Alps. Four of the installations are in the alpine climate zone, the biggest and oldest stand-alone PV installation from 1991/1992 with over 500 kWp is in the climate zone of the Jura in the north-western part of Switzerland above 1’290 masl.

The technical design of the long term measurement campaign

The traditional measurement system is now more than 20 years old. It’s based on a Campell data logger. To improve the quality of the measurement system a study was carried out to evaluate a new measurement system. The traditional measurement system is shown here: The results showed that the traditional systems can be improved and used for further decades.

Measurement system for the long term measurement system

Study on the degradation of PV installations in three climate zones

The PV Lab runs several PV systems with mc-Si PV modules from Siemens/Arco Solar M75/M55. Three of them were used to compare the degradation over 25 years and more. The first installation is on the Jungfraujoch in (3'434 m asl). This installation is vertical integrated in the façade of the high alpine research institute. She gets roughly 1’500kWh/kWp. The installation was done in 1991/1992. Therefore the PV modules produced compared to an installation in mid Europe the energy of more than 36 years.

![Graph showing degradation over time](image)

Minor degradation on Jungfraujoch <0,11% over more than 20 years (1994-2016)
The second installation is the probably biggest and oldest stand-alone PV installation in Europe from built from 1991/1992 with over 500 kWp in the climate zone of the Jura, in the northwestern part of Switzerland above 1'290 masl. The third installation is a 60 kWp installation on the laboratory building in Burgdorf in the basin region of Switzerland. From the used PV module M55 we have a big number of modules which were never installed and stored in the dark. Some of them there tested in ISPRA 25 years ago. This is a reference for the analysis.

Degradation on Mont Soleil: 0.57%/year

The results shows that the degradation of the PV modules in all three installation are far below the expected 0.8%/year. The degradation had coincidences with the ambient temperature and humidity. The systems voltage could also influence the life time. This lead to the conclusion, that the life time of a PV plant can be much longer than 25 years.

Costs calculations with 25 or 40 years lifetime

In Switzerland the cost calculation of a PV plant is more and more affected by high “soft costs” as “planning/ safety standards/ regulations/ labor costs etc.”. The economy of scale of the component of a PV installation does not affect them. Therefore we need a longer life time to lower the overall costs of the PV electricity. With a life time of 40 years we have the chance to reach the threshold of below 4cents€/kWh.

Scientific Innovation and Relevance

The long term measurement program of the PV Lab (BUAS) is an important research field for all questions regarding the long term stability of PV installations. With the new efforts we can improve the measurement of the PV installations and can support researchers, PV-installers, governments and insurance companies.

Conclusion

With the new efforts financed by the Swiss Federal Office of Energy (SFOE) and the SCCER (Swiss Competence Centers for Energy Research) we can introduce new measurement systems and techniques for a better understanding of the long term behavior of PV-installations. The results of a first study with PV plants from alpine sites, Swiss basin and on the Jura range with the same
c-Si PV module demonstrate that the PV modules will last over their 25 year lifetime. The lifetime is affected by temperature and humidity. Obviously the climate in mid Europe is especially favorable for a long life of PV installations. This will allow PV investors to expand the expected life time over 25 years. The result will be a better competitiveness of PV electricity.