SWITZERLAND

PV TECHNOLOGY STATUS AND PROSPECTS

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Fig. 1 – Installing photovoltaic panels in high mountains could reduce the power deficit experienced in winter, according to a recent study by the WSL Institute for Snow and Avalanche Research SLF and EPFL (Annelen Kahl, Jérôme Dujardin, and Michael Lehning, PNAS January 22, 2019 116 (4) 1162-1167) (Photo: © ZHAW Wädenswil).

GENERAL FRAMEWORK AND IMPLEMENTATION

The transformation of the Swiss energy system aimed at with the "Energy Strategy 2050" is a long-term project. The Swiss electorate accepted a revised Federal Energy Act in 2017 in a popular referendum. This new legislation entered into force on 1 January 2018. The aims are to reduce energy consumption, increase energy efficiency and promote the use of renewable energy (www.energystrategy2050.ch). In addition, the revised act prohibits the construction of new nuclear power plants. As an additional element of the "Energy Strategy 2050" the Federal Council (Swiss government) decided to establish new framework conditions for the Swiss electricity market and submitted a revised Electricity Supply Act (Stromversorgungsgesetz) at the end of 2018, for consultation until end of January 2019. The focus lies on security of supply, an efficient and fully open electricity market, as well as new network regulations designed to support the expansion of decentralized, renewable power production. In the context of climate policy and with respect to the reduction of fossil fuel consumption, the next stage of Swiss climate policy is under current discussion in the Parliament (revision of the CO_2-act).

Electricity production from photovoltaics is one of the key pillars in the strategy for the future Swiss electricity supply and should contribute – according to the official scenarios – with roughly half (11,1 TWh) of the net addition in renewable electricity production until 2050 (24,2 TWh). In 2017, the national power production was 61,5 TWh. A monitoring report of the "Energy Strategy 2050" in 2018 – sketching the situation until end of 2017, actually before the coming into force of the new legal measures – shows, that the increase in renewable power production in Switzerland is at the moment on track and the benchmark for 2020 with 4,4 TWh should be within reach (see Figure 4). The contribution from photovoltaics is thereby above the long-term scenarios. This fact will be considered in the revision of the official scenarios for the "Energy Strategy 2050" starting in 2019.
The entry in force of the new Energy Act in 2018 had specific impacts on the development of photovoltaics in Switzerland. The surcharge on electricity consumption from the grid for the support of renewable energy and other measures has increased from 0,015 CHF per kWh to 0,023 CHF. The feed-in-tariff scheme established in 2009 is now time limited and new installations will be considered only until to 2022. Due

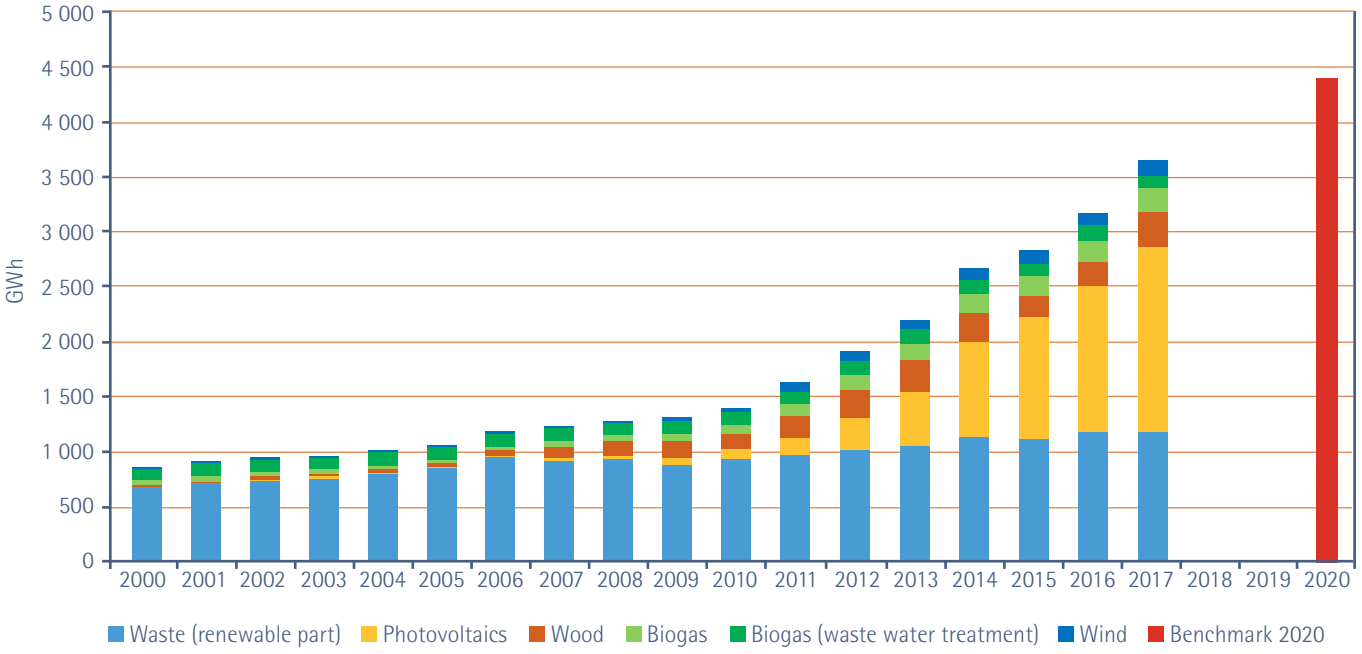

Fig. 2 – Evolution of the power production from renewables in Switzerland without hydropower. The increase in production from photovoltaics has mainly contributed to the fact that Switzerland is currently on track to reach its benchmark for 2020 of 4,4 TWh (Source: SFOE).

to an existing long waiting list, no new photovoltaics installation will enter into the feed-in-tariff scheme. Installations of a certain capacity within the feed-in-tariff scheme will have to sell their production directly in the market from 2020 on and are remunerated with a tariff closer to market requirements. Installations with capacity smaller than 100 kW only receive a onetime investment subsidy of 30 % of the costs of a reference installation. The onetime investment subsidy is available for all systems with capacities from 2 kW to 50 MW. At the end of 2018, the Swiss Federal Office of Energy announced a strong increase of the quotas for onetime investment subsidy for photovoltaic installations. With this measure, a large part (260 MW) of smaller installations (<100 kW) can be supported until end of 2019 with a total subsidy of 100 MCHF. Also, larger installations (150 kW to 50 MW) with pending subsidy requests and a total capacity of 502 MW will receive a guarantee for subsidies within 2019 with a total volume of 150 MCHF. While providing for financial security for partly already built PV systems, these changes in the regulatory framework should also bring an additional boost to the Swiss PV market in the coming years.

This, together with additional new opportunities such as the collective grid connection of various end consumers to increase self-consumption and flexibility, should give a push to the yearly market development of photovoltaics in Switzerland, which has been stagnating around 250 MW in the last years.

NATIONAL PROGRAMME

The Swiss Federal Office of Energy (SFOE) runs a dedicated national photovoltaic RTD programme that involves a broad range of stakeholders. The programme is part of the long-standing coordinative activities by the SFOE to support research and development of energy technologies in Switzerland, where funds deployed in a subsidiary manner aim to fill gaps in Switzerland's research funding landscape Grants are given to private entities, the domain of the Swiss Federal Institutes of Technology (ETH), universities of applied sciences, and universities.

The focus of the photovoltaics programme lies on R&D,D in a system and market oriented approach, from basic research, over applied research, product development, pilot and demonstration projects. On average, the volume of the SFOE PV RTD programme (including pilot and demonstration) is in the order of 10 % of the total public support for photovoltaics research in Switzerland, which is in the order of 36 MCHF per year (including roughly 30 % from European projects). The programme supports research and pilot & demonstration projects in different areas of photovoltaic cell technologies (c-Si, CIGS and others), in the field of photovoltaic modules and building integration of photovoltaics, as well as in the topics of system aspects of photovoltaics such as grid integration, quality assurance of modules and inverters or battery storage technology. Other themes are life

Fig. 3 - High efficiency pilot PV system by Insolight which uses a unique module design: The panel's protective glass embeds a grid of lenses which concentrate the direct sunlight on an underneath array of high-performance space-grade solar cells. An integrated tracking system keeps each cell in focus regardless of the sun's position without active tracking of the modules. Efficiencies of 29 % have been demonstrated (Photo: © Insolight).

cycle analysis, solar forecasting, as well as performance monitoring. International co-operation on all levels, related to activities in the Horizon 2020 programme of the European Union, the European PV Technology and Innovation Platform, the European SOLAR-ERA.NET Network, the IEA PVPS programme and in technology co-operation projects is another key element of the SFOE photovoltaics programme.

RESEARCH, DEVELOPMENT AND DEMONSTRATION

There are many Swiss research laboratories dealing with all kinds of different aspects of photovoltaics (see Figure 4 for an overview). In the field of solar cells, the focus lies on high-efficiency crystalline silicon solar cells (heterojunction technology, PERC, passivating contacts) and on various thin-film solar cell technologies, in particular CIGS cells. Perovskite solar cells and especially the topic of tandem cells (c-Si with perovskite or III/V, CIGS with perovskite) gain increasingly attention. The development of new module architectures, especially for building integration applications, is another large field of research with a lot of ongoing activities. This includes new approaches and solutions for coloured, light-weight and flexible modules, as well as customized modules with various shapes applying different types of techniques. Grid integration of photovoltaics, photovoltaics in combination with heat pumps and different storage technologies (batteries and thermal storage), photovoltaics and electro-mobility (bidirectional charging) are further themes with ongoing and increased activities.

Fig. 4 – Swiss photovoltaics technology landscape. Circles denote research institutions, squares industrial activities (Source: SFOE).

Fig. 5 - dhp has realized the world's first solar folding roof across a sewage infrastructure, a consistent double use of already sealed land for solar power generation in urban infrastructures and with 100% self-consumption. Following a pilot plant with the HORIZON solar folding roof, the system was extended to a capacity of 643 kW in 2018 (Photo: © dhp technology).

R&D Highlight 2018: Fully Textured Monolithic Perovskite/Silicon Tandem Solar Cells

The optics in different layers of a monolithic two-terminal perovskite/silicon tandem solar cell is of key importance to achieve high efficiency. In 2018, the photovoltaics laboratory at CSEM and EPFL Neuchâtel presented a top cell (perovskite) deposition process that enables the conformal growth of multiple compounds with controlled optoelectronic properties directly on the micrometer sized pyramids of textured monocrystalline silicon. With this technique, a perovskite/silicon tandem solar cell with 25,2 % power conversion efficiency could be demonstrated (Florent Sahli et al., Nature Materials, 17, 820-826 (2018)).

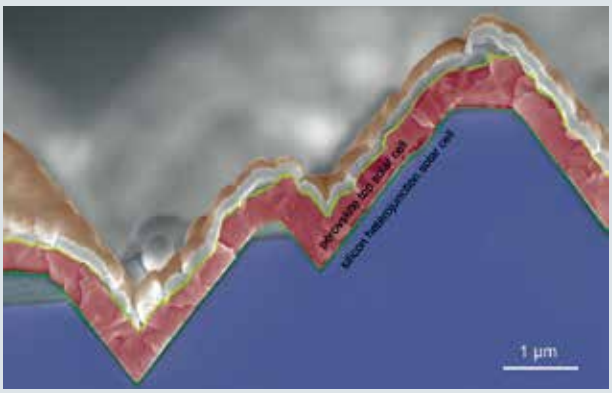

Fig. 6 - Monolithic perovskite/silicon tandem solar cell (Photo: © CSEM/EPLF-IMT).

Several universities of applied sciences are investigating the system performance of photovoltaics, some of them for many decades, such as the Berner Fachhochschule (BFH) and the University of Applied Sciences of Southern Switzerland (SUPSI) with the long-term monitoring of photovoltaic installations. In 2018, a new group with experts from SUPSI, BFH and other institutions has been formed which collectively contributes to the ongoing activities in IEA PVPS Task 13 on Performance and Reliability of Photovoltaic Systems.

NEWS FROM INDUSTRY

Swiss industrial players are grouped along the entire photovoltaics value chain, starting from materials, production equipment and small-scale manufacturing of solar cells and modules, over diverse components and products all the way to system planning and implementation, including recycling (see Figure 4 for an overview). A broad range of competitive technologies, products and services are offered to the growing photovoltaic market, both domestically and abroad.

Meyer Burger, one of the largest equipment suppliers for complete module manufacturing lines and advanced module technologies, communicated a successful return to profitability at net earnings level for the first half of 2018. The main focus today is on photovoltaic cell coating and module connection technologies. Also in 2018, the solar system business from Meyer Burger, taken over from the company 3S in 2010, was sold and transferred to 3S Solar Plus AG (https://3s-solarplus.ch/), a newly created company, that focuses on the Swiss market with its MegaSlate product.

Apart from larger players, an increasing number of new industrial players can be observed during the last years, some with very revolutionary approaches. The EPFL start-up company Insolight (https://insolight.ch/) (see Figure 3) with its concentrating technology using plastic magnifying lenses in order to boost the efficiency of a standard solar panel towards 30 % is one example. Another one is the company dhp-technology (http://www.dhp-technology.ch/) (see Figure 5) with its photovoltaic folding roof technology for the double use of industrial areas such as waste-water treatment plants.