SWITZERLAND

PV TECHNOLOGY STATUS AND PROSPECTS

STEFAN NOWAK, NET NOWAK ENERGY & TECHNOLOGY LTD.
AND STEFAN OBERHOLZER, SWISS FEDERAL OFFICE OF ENERGY (SFOE)

Fig. 1 - PV façade with micromorphous silicon (left, 10,8 kW)) and multicrystalline silicon PV modules (right, 11,3 kW) (system development and photo: Jansen).

GENERAL FRAMEWORK AND IMPLEMENTATION

Recent national energy scenarios and studies have confirmed an important contribution expected from photovoltaics in the medium and long term. According to the present scenarios, in absolute terms, some 10 – 12 TWh could come from photovoltaics by 2050, representing some 20 % of the present national electricity consumption. The size of the potential contribution from photovoltaics is less debated than the speed at which this may occur: The Swiss solar industry claims such contributions to be achievable much sooner than 2050.

In 2012, on the levels of Swiss policy and administration, work continued extensively regarding the preparation of the various measures in conjunction with Switzerland's phase-out of nuclear energy decided the year before in the framework of the new energy strategy 2050. These measures will have impacts on all levels from research to implementation and use as well as regarding legislative and normative issues. Before coming into force, there will likely be a public vote on the new energy strategy, expected for 2015.

The development of the photovoltaic sector in Switzerland builds on a strong research and technology base, an increasing industrial activity and, more recently, an acceleration of the market deployment efforts. A comprehensive research programme covers R&D in solar cells, modules and system aspects. The Swiss energy research strategy is defined by an energy RTD master plan updated every four years. The master plan developed by the Federal Commission for Energy Research (CORE) in cooperation with the Swiss Federal Office of Energy (SFOE) is based on strategic policy goals (energy & environment, science & education, industry & society) (www.energy-research.ch).

Market deployment continues to grow at moderate but increasing levels, thanks to the feed-in-tariff scheme now available for a few years and additional efforts of regional governments as well as utilities. Within the feed-in-tariff scheme, the size of the Swiss photovoltaic market is limited by the cap on the amount of support attributed to photovoltaic projects and many projects are presently on a waiting list. To support the deployment of renewable electricity through the feed-in tariff model, a levy up to 0,009 CHF per kWh consumed electricity is being perceived, yielding a total annual amount up to 480 MCHF. This amount is divided into maximum contributions for different renewable energy technologies (hydropower up to 10 MW, biomass, photovoltaics, wind and geothermal energy) depending on their specific generation costs. In respect of PV, these maximum contributions started with 5 % of the available financial envelope and increase over time, as the photovoltaic generation costs come down, up to a maximum of 30 %. Thus photovoltaics and the entire support scheme are subject to a cap. This cap is presently under discussion in the Swiss parliament, particularly related to the new energy strategy for 2050. Besides the regular reductions of the feed-in tariffs applied, increases of the total PV capacity allowed under the feed-in-tariff scheme may come into force by 2014.

Concerning market implementation, the photovoltaic sector in Switzerland further developed in the year 2012 whereas the industrial activities suffered from the capacity and competition issues affecting the global PV industry. Nevertheless, activities in the Swiss PV supply industry remain high with an increasing emphasis on technology development and innovation. R&D activities in the public sector confirm this increasing trend. On the technology front, the

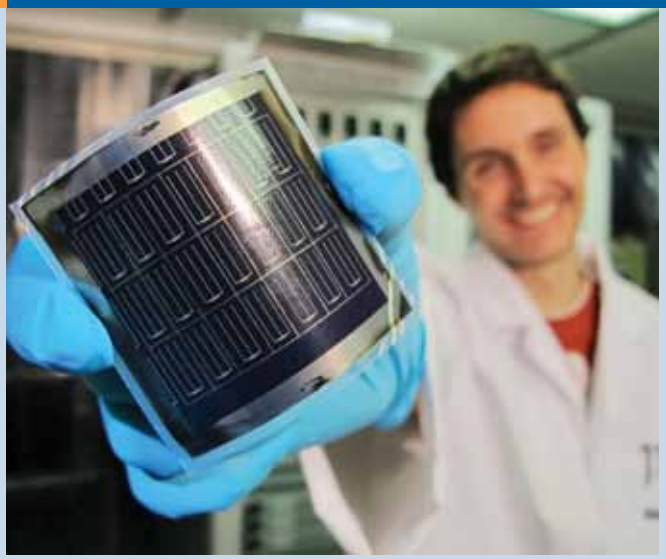

Fig. 2 - A new world record efficiency for flexible CIGS solar cells of 20,4 % was achieved at EMPA (photo: EMPA).

Fig. 3 - Coloured thin film BIPV modules are developed at the PV-Lab of EPFL (photo: EPFL).

key competence centres continued their efforts in their respective domains (solar cells, modules and systems) while increasing their cooperation with industry and on the international level.

The support of the national PV RTD programme can be expected to continue with a focus on innovative research activities, rapid technology transfer, industrial developments, new products for niche markets and ongoing international involvement. Due the strong Swiss currency, global competition for the heavily export oriented industry remains an issue. Nevertheless, the efforts to bring Swiss technology to the market place continue. Efforts in the technology development will concentrate on short to medium term market oriented approaches and continuous quality assurance.

The strategy to promote international co-operation on all levels will continue, related to activities in the 7th Framework Programme of the European Union, the European PV Technology Platform, the IEA PVPS programme and in technology co-operation projects.

While costs of photovoltaics are rapidly coming down, the policy debate in the new energy strategy for 2050 continues, in particular concerning possible adaptations to the regulatory framework. In parallel, increased interest and market activities can be observed on the utility side.

NATIONAL PROGRAMME

Switzerland has a dedicated national photovoltaic RTD programme which involves a broad range of stakeholders in a strongly coordinated approach (www.photovoltaic.ch). This national photovoltaic programme focuses on R&D,D in a system and market oriented approach, from basic research, over applied research, product development, pilot and demonstration projects all the way to accompanying measures for market stimulation. On the technical level, thin film solar cells, their variations and building integration continue to be the topics of highest priority. The programme is organised along the entire value chain and addresses the critical gaps from technology to the market place. Thorough component and system analysis, as well as testing, aim at increasing efficiency and performance. Accompanying measures to raise the quality and reliability of photovoltaic power systems include work on standards and design tools.

RESEARCH, DEVELOPMENT AND DEMONSTRATION

In 2012, more than 75 projects, supported by various national and regional government agencies, the European Commission and the private sector, were conducted in the different areas of the photovoltaic energy system. Innovative solutions, market orientation, cost reduction, industrial viability and transfer as well as increased efficiency and reliability are the main objectives of the technical R&D.

For solar cells, the main focus remains on thin film solar cells with projects in a wide variety of materials (amorphous and microcrystalline silicon, compound semiconductors, dye-sensitised and organic solar cells). Work on thin film silicon at the Swiss Federal Institute of Technology (EPFL) in Neuchâtel concentrated on micromorphous solar cells with a particular emphasis on silicon oxide intermediate reflector layers. Significant progress was also achieved in the area of high-efficiency heterojunction silicon solar cells. Industry co-operation was extended with various companies. A new photovoltaic technology centre will be built up at the laboratories of CSEM (Centre Suisse d'électronique et microtechnique) in Neuchâtel.

With regard to CIGS solar cells, the Swiss Federal Laboratories for Materials Testing and Research EMPA focused the work on high efficiency flexible CIGS cells on plastic and metal foils. As a highlight, a new record efficiency of 20,4 % was announced for CIGS solar cells on plastic substrates (Fig. 2), thus representing a substantial increase of the last record of 18,7 % achieved the year before. This efficiency record is slightly higher than that for CIGS cells on glass and in the range of best multicrystalline silicon solar cells. For dye-sensitised solar cells, work continued at EPFL on new dyes and electrolytes as well as high temperature stability of the devices. An increasing interest for photovoltaic technology can be observed at various research institutions as well as from industry. In line with the international trend to a broader scientific and technological base, increased activities take place in the fields of nanotechnology, chemistry and numerical modelling.

On the part of application oriented research, emphasis continues to be given to building integrated photovoltaics (BIPV), both for new solutions involving thin film solar cells as well as for new mounting systems and structures for sloped roofs and facades (Fig. 3).

Fig. 4 - Arrival of the boat PlanetSolar in Monaco after completion of the first world tour by solar energy (photo: NET).

A dedicated website deals with the topic of BIPV (www.bipv.ch) and includes information about available products. Various other PV applications on built infrastructure, e.g. ski lifts or snow avalanche protections, have recently been proposed and realised in pilot installations.

As a recent topic, grid integration has continued to generate interest and recent projects have extensively analysed the implications of PV on the distribution grid. With the ongoing market development, quality assurance and reliability of products and systems, as well as standardisation, continue to be of high priority. The Swiss centres of competence at the Technical Universities of Lugano and Burgdorf carefully evaluate products such as PV modules, inverters and new systems. The test infrastructure is continuously expanding and includes the accredited test centre for IEC module certification (Lugano, http://www.supsi.ch/isaac/swiss_pv_module_test_centre.html) as well as the largest solar simulator for inverter testing up to 100 kW capacity (Burgdorf, www.pvtest.ch). Long term experience with the operation of photovoltaic power systems is carefully tracked for a number of grid-connected systems, ranging between 10 and more than 30 years of operation. Continuous development of system solutions has resulted in a number of industrial products well positioned in the export market.

Work continues on the first prototype of the solar powered airplane SolarImpulse (www.solar-impulse.com) by Bertrand Piccard which has meanwhile demonstrated various flights under specific conditions. Based on this experience, a second airplane will be built. As a particular highlight of such visionary projects, the solar powered boat PlanetSolar (www.planetsolar.org) has completed the first tour around the world by solar energy in May 2012 in Monaco (Fig. 4). On its way, the boat has stopped in many prestigious places to convey the message of the possibilities of solar photovoltaic energy.

International co-operation continues to form a strong pillar of the R&D activities with more than 20 projects running in the 7th framework RTD programmes of the European Union during 2012. The co-operation within the IEA PVPS programme has remained a further strategic activity.

Regarding international co-operation on the programme level, a new European ERA-NET project (www.solar-era.net) started in November 2012, covering both PV and concentrated solar power (CSP). The collaboration with the European Photovoltaic Technology Platform (www.eupvplatform.org) continued throughout the year.

INDUSTRY AND MARKET DEVELOPMENT

Since a few years, Swiss industrial PV products cover the full value chain starting from materials, production equipment and small scale manufacturing of solar cells, over diverse components and products all the way to system planning and implementation.

On the PV industry supply side, different products count among the world leaders, e.g. for wire-sawing machines from Meyer Burger as well as from Applied Materials Switzerland; and measuring equipment for PV module manufacturers from Pasan (now a part of Meyer Burger Group). Solar plugging systems are offered by Multicontact as well as Huber & Suhner.

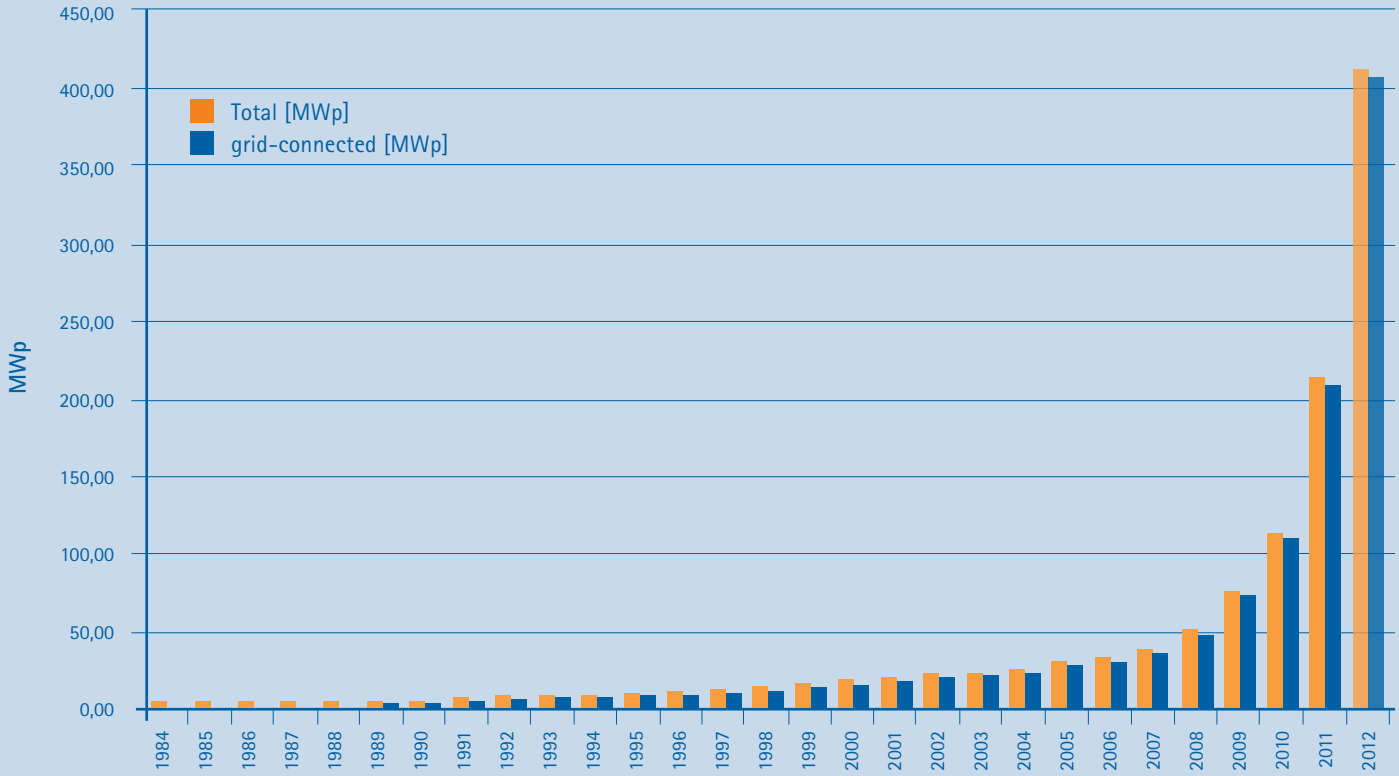

Fig. 5 - Evolution of the installed photovoltaic capacity in Switzerland between 1984 and 2012 (total and grid-connected, estimated values for 2012).

Industrial activities evolve in the field of process equipment (TEL Solar, formerly oc oerlikon) and products based on thin-film technology. Swiss Solar Systems (3S), also part of the Meyer Burger Group, is building some of the world's largest PV module laminators. Roth & Rau, largely acquired by Meyer Burger, has intensified its Swiss R&D activities into heterojunction silicon solar cells. Komax is active in various steps of the module manufacturing chain.

Inverters have proved to be an export success. Sputnik Engineering produces grid-connected inverters with a capacity of 700 MW per year. Studer Innotec has had comparable success with their stand-alone inverters. More recently, ABB has entered the inverter market.

Based on the long term experience and the large number of installed systems, considerable know-how is available amongst engineering companies for the design, construction and operation of a large variety of different applications, ranging from small scale, stand alone systems for non-domestic, professional applications and remote locations, over small domestic grid-connected systems to medium and large size grid-connected systems in various types of advanced building integration. In spite of the pressure on the PV industry, the export volume of Swiss photovoltaic products continues to be high, with more than 80 % of the annual turnover.

Besides an increased interest from the manufacturing industry, the finance sector continues to promote financial services directed towards renewable energy. This trend is manifested by the regular investment analysis reports published by the Bank Sarasin (www.sarasin.ch).

Formerly mostly driven by utilities own green power marketing schemes, there has been a strong development in the framework of the new feed-in tariff support scheme. This PV feed-in tariff distinguishes between three different categories of systems, namely ground based, building applied and building integrated systems (BIPV) for which the highest tariff can be obtained. The applicable tariff also depends on the size of the PV system. In this way, a differentiated scheme is used which is based on regular market analysis to follow the dynamics of the market.

The 2012 annual market volume for grid-connected systems is estimated to a value around 200 MWp, thus doubling the market of 2011. The total installed capacity has thus risen to about 410 MW (Fig. 5), corresponding to more than 50 W/capita.