

# SWITZERLAND

## PV TECHNOLOGY STATUS AND PROSPECTS

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ON BEHALF OF THE SWISS FEDERAL OFFICE OF ENERGY (SFOE)



*Fig. 1 – La Ferme des Trois Epis, Aigle (VD). This chicken farm has an integrated system with 160 kWp solar tiles "oryon" (Solar Fabrik cells) and Swiss inverter SolarMax 80C (2 units); by Solstis, Switzerland (photo Solstis, Switzerland).*

### GENERAL FRAMEWORK

Concerning energy research, the Swiss framework as a whole has basically remained unchanged in 2008: The energy research strategy is defined by a 4 year energy RTD master plan, with 2008 as the first year of the present period 2008 – 2011. 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.energieforschung.ch](http://www.energieforschung.ch)). It confirms the important position of photovoltaic RTD in the Swiss energy RTD landscape.

The framework for photovoltaic technology development in the public sector experienced a number of changes: Research and development were considerably increased compared to the level of previous years where as support for new pilot and demonstration systems continued to be very limited. Industry development continued to be strong with new entrants and production facilities being ramped up.

Turning to energy policy, 2008 saw the introduction of the new feed-in tariff scheme for new renewable energy technologies. In the course of the year, the scheme became operational as far as the application of projects for the new support scheme is concerned. A large number of projects was announced and photovoltaics constituted by far the largest amount of projects (~ 80 %). First actual payments of the feed-in tariff will start in 2009.

To support the deployment of renewable electricity through the feed-in tariff model, a levy up to 0,6 cCHF per kWh consumed electricity is being perceived; yielding a total annual amount

of about 320 Mio. CHF. This amount is divided into maximum contributions from each of the renewable energy technologies. Concerning photovoltaics, these maximum contributions begin with 5 % of the available financial envelope and can increase over time, as the PV generation costs come down, up to a maximum of 30 %. Both the total envelope, as well as the possible contribution by photovoltaics are thus capped. This has resulted in a long waiting list of the filed applications. This cap and its possible future change are presently the subject of an ongoing political debate in the Swiss government and parliament.

### NATIONAL PROGRAMME

Switzerland has a dedicated national photovoltaic RTD programme which involves a broad range of stakeholders in a strongly coordinated approach ([www.photovoltai.ch](http://www.photovoltai.ch)). This national photovoltaic programme focuses on R&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. As indicated above, activities in pilot and demonstration projects continued to be limited during 2008. On the technical level, thin film solar cells and building integration are the foremost topics of priority. The programme is organised along the entire value chain and addresses the critical gaps from technology to the market place. Thorough component – in particular for photovoltaic modules and inverters – and system analysis aims at increasing efficiency and performance. Accompanying measures to raise the quality and reliability of photovoltaic power systems include work on standards and design tools. On the market side, up to 2006, deployment has mainly been driven by voluntary green power

marketing programmes of utilities. This will now change to the feed-in tariff scheme as explained above and market is expected to increase. Finally, the programme places emphasis on information and communication in order to raise the awareness for opportunities involving photovoltaics.

Through the bias of Task 9 of the IEA PVPS Programme, the subject of technology co-operation with developing countries continues to be expanded. During 2008, the interdepartmental platform for the promotion of renewable energy and energy efficiency in international co-operation – REPIC – started a new 3-year term ([www.repic.ch](http://www.repic.ch)). This platform supported different photovoltaic projects of Swiss entities in developing countries.

### RESEARCH, DEVELOPMENT AND DEMONSTRATION

During the year 2008, a detailed photovoltaic research plan for 2008 – 2011 was approved by the Federal Commission for Energy Research (CORE). In the first year of this new period, overall 57 projects, supported by various national and regional government agencies, the research community and the private sector were conducted in the different areas of the photovoltaic energy system. Market orientation, cost reduction, industrial viability and transfer as well as increased efficiency and reliability are the main objectives of the technical R&D.

**TABLE 1: SWISS PHOTOVOLTAIC ENERGY STATISTICS FROM 1989 - 2007 (GRID-CONNECTED SYSTEMS)**

| YEAR | NUMBER OF NEW SYSTEMS | TOTAL NUMBER OF SYSTEMS | INSTALLED CAPACITY [MWp DC] | ENERGY PRODUCTION [MWh] | SPECIFIC ENERGY-PRODUCTION [kWh / kWp] |
|------|-----------------------|-------------------------|-----------------------------|-------------------------|----------------------------------------|
| 1989 | 60                    | 60                      | 0,3                         |                         |                                        |
| 1990 | 110                   | 170                     | 0,8                         | 400                     |                                        |
| 1991 | 210                   | 380                     | 1,8                         | 1 100                   |                                        |
| 1992 | 110                   | 490                     | 3,1                         | 1 800                   | 800                                    |
| 1993 | 110                   | 600                     | 4,0                         | 3 000                   | 810                                    |
| 1994 | 80                    | 680                     | 4,8                         | 3 500                   | 800                                    |
| 1995 | 60                    | 740                     | 5,4                         | 4 000                   | 815                                    |
| 1996 | 80                    | 820                     | 6,2                         | 4 700                   | 825                                    |
| 1997 | 130                   | 950                     | 7,4                         | 6 000                   | 880                                    |
| 1998 | 150                   | 1 100                   | 9,2                         | 7 100                   | 860                                    |
| 1999 | 125                   | 1 225                   | 11,0                        | 7 700                   | 770                                    |
| 2000 | 100                   | 1 325                   | 13,0                        | 10 000                  | 810                                    |
| 2001 | 125                   | 1 450                   | 15,0                        | 11 000                  | 800                                    |
| 2002 | 75                    | 1 525                   | 16,6                        | 12 000                  | 810                                    |
| 2003 | 75                    | 1 600                   | 17,9                        | 15 100                  | 875                                    |
| 2004 | 100                   | 1 700                   | 19,5                        | 15 200                  | 815                                    |
| 2005 | 200                   | 1 900                   | 23,6                        | 18 200                  | 850                                    |
| 2006 | 250                   | 2 150                   | 26,1                        | 21 000                  | 845                                    |
| 2007 | 525                   | 2 675                   | 32,6                        | 25 700                  | 875                                    |



*Fig. 2 - Grödenmoos Stadium. Switzerland's largest solar power plant with an installed capacity of 56 kWp made of roofing membrane with integrated thin-film photovoltaic cells. The Grödenmoos Stadium in St.Gallen is the venue of the international CSIO horse riding competition in Switzerland. Surface: 1 200 m². Owner: Sankt Galler Stadtwerke (photo energiebüro, Switzerland).*

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 cells). During 2008, emphasis on transfer from R&D to industrial processes, manufacturing and products continued. Work on thin film silicon at the University of Neuchâtel concentrated on the efficiency and reproducibility of micromorphous solar cells as well as the rapid large area deposition of its individual layers of amorphous and microcrystalline silicon, including work on transparent conductive oxides (TCO) and intermediate reflector layers. In the area of thin film silicon, strong co-operation with the companies VHF-Technologies and oc oerlikon continued. During 2008, the equipment manufacturer oc oerlikon extended its activities as a leading supplier of manufacturing systems of thin film silicon solar cells on glass and increased the staff to some 1 000 workplaces. With regard to CIGS solar cells, the Federal Institute of Technology in Zurich focused the work on high efficiency flexible CIGS cells on plastic and metal foils. During 2008, the spin-off company FLISOM, active in this solar cell technology, continued its efforts towards an industrial product. For dye-sensitised solar cells, work continued on new dyes and electrolytes as well as high temperature stability of the devices. Exploratory work was undertaken on new solar cell concepts (organic solar cells) at the Swiss Federal Laboratories for Materials Testing and Research EMPA. An increasing interest for photovoltaic technology can be observed for 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 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. A dedicated website deals with the topic of BIPV ([www.bipv.ch](http://www.bipv.ch)) and includes information about available products.

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 Burgdorf and Lugano carefully evaluate products such as PV modules, inverters and new systems. The test infrastructure is continuously expanded and recently includes the

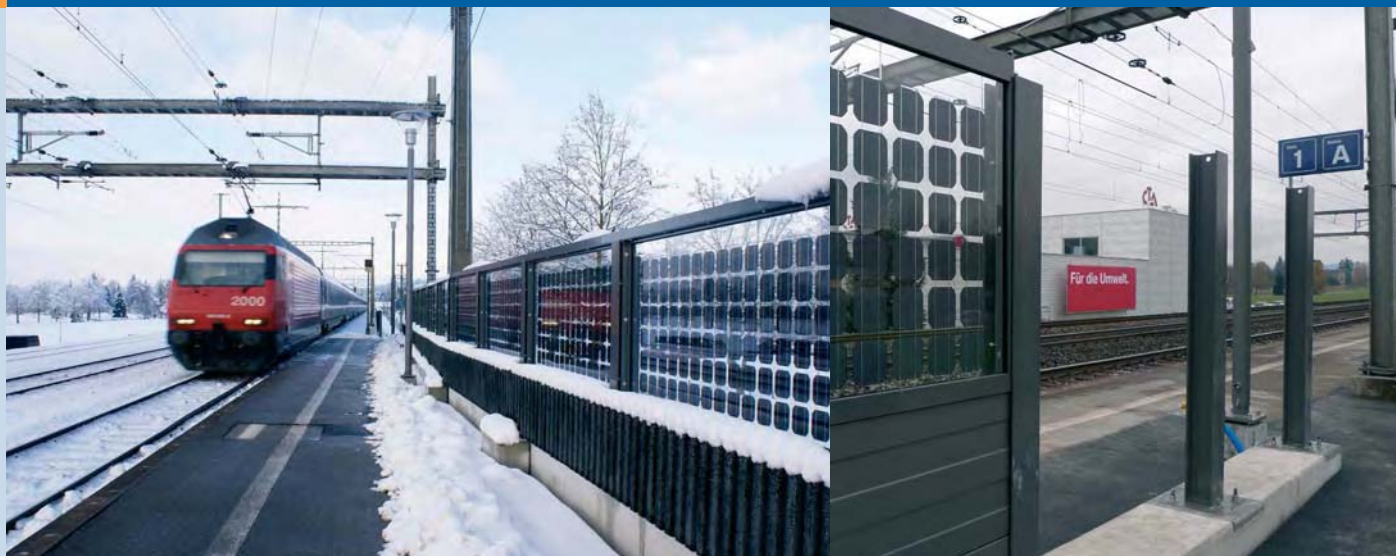


Fig. 3 – Bifacial Photovoltaic Noise Barrier Münsingen. The world's first bifacial PV system along a railroad has a surface of 115 m<sup>2</sup>. It has an installed capacity of 7,25 kWp on the front side and an additional 5,6 kWp on the back side, with the PV modules facing east and west (photo TNC Consulting, Switzerland).

largest solar simulator for inverter testing up to 100 kW capacity (Burgdorf) as well as new laboratory equipment for IEC module certification (Lugano). Long term experience with the operation of photovoltaic power systems is carefully tracked for a number of grid-connected systems, ranging between 10 and 25 years of operation. Continuous development of system solutions has resulted in a number of industrial products well positioned in the export market.

Visionary projects such as the solar powered airplane SolarImpulse ([www.solar-impulse.com](http://www.solar-impulse.com)) by Bertrand Piccard and the solar powered boat PlanetSolar ([www.planetsolar.org](http://www.planetsolar.org)), both of which plan to travel around the world by air respectively on water in the coming years, have entered their component testing and construction phase.

International co-operation continues to form a strong pillar of the R&D activities with 12 projects running in the 6<sup>th</sup> and 7<sup>th</sup> framework RTD programmes of the European Union during 2008, of which three are integrated projects. During 2008, a first joint call was conducted together with other European PV RTD programmes in the field of polymer and molecular solar cells. Two projects with Swiss participation emerged out of this initiative. The co-operation within the IEA PVPS programme has remained a further strategic activity. Founded in 2005, a national IEA PVPS pool receiving support from the electric utilities of the city of Zurich, the Cantons of Basel-City as well as Geneva, the Mont-Soleil Association and SWISSOLAR contributed to the Swiss expert participation in IEA PVPS.

On the programme level, international co-operation is also taking place through the European PV-ERA-NET project ([www.pv-era.net](http://www.pv-era.net)) and the European Photovoltaic Technology Platform ([www.eupvplatform.org](http://www.eupvplatform.org)).

## IMPLEMENTATION

Up to 2006, market implementation of PV systems was mainly driven by green power marketing schemes of utilities. Since the introduction of the naturemade® labels for renewable electricity, utilities have started introducing different product brands, some with a mix of different renewable energy sources and others with technology specific products, e.g. the product "Premium Solar" by the utility of the city of Zurich. Solar electricity is thus part of mixed green power products, according to naturemade star® labelled brands. With a strong and consistent marketing approach, typically around 5 %

of the customer base can be attracted to pay the comparatively high prices for solar electricity, in the best cases. With mixed products, more customers can be attracted. Small scale private, domestic and non-domestic systems form a complementary part of the Swiss photovoltaic market which is served by local businesses.

In expectation of the introduction of the new feed-in tariff scheme, interest for photovoltaic projects strongly increased since 2007. As the new promotion scheme includes a retroactive clause for projects realised back to 2006, many new projects were initiated in 2007 and 2008. The Swiss legislation foresees the possibility of switching between the feed-in tariff and the voluntary green power marketing approach. The respective roles and contributions of these two instruments in the future photovoltaic market mix remains to be seen.

## INDUSTRY STATUS

Some years ago, Swiss industrial PV products covered mainly system components such as inverters, both for grid-connected and stand-alone applications, components for electrical connection, mounting systems for building integration and custom designed PV modules. More recently, industrial activities in the area of solar cells, solar modules and manufacturing equipment for both of these areas have considerably increased. The Swiss PV industry is thus active along the full value chain starting from materials and manufacturing, over diverse components and products all the way to system planning and implementation.

In the inverter area, some products have achieved a high export rate. The Sputnik Company produces grid-connected inverters at a capacity of 275 MW/year and presently ranges as number 3 in the European market. The Studer Company produces stand-alone inverters and is also very successful in exporting. On the PV industry supply side, different products count among the world leaders, e.g. for wire-sawing machines from Applied Materials Switzerland (formerly HCT) as well as from Meyer Burger; and measuring equipment for PV module manufacturers from Pasan (now a part of Swiss Solar Systems – 3S). Solar plugging systems are offered by Multicontact as well as Huber & Suhner. The Alustand® and SOLRIF® mounting systems for building integrated applications have been very successful on the market. Sarnafil, which has developed a flexible, watertight flat roof PV system based on thin film silicon solar cells, is taking part in a joint venture with the American company Solar Integrated Technologies (SIT).

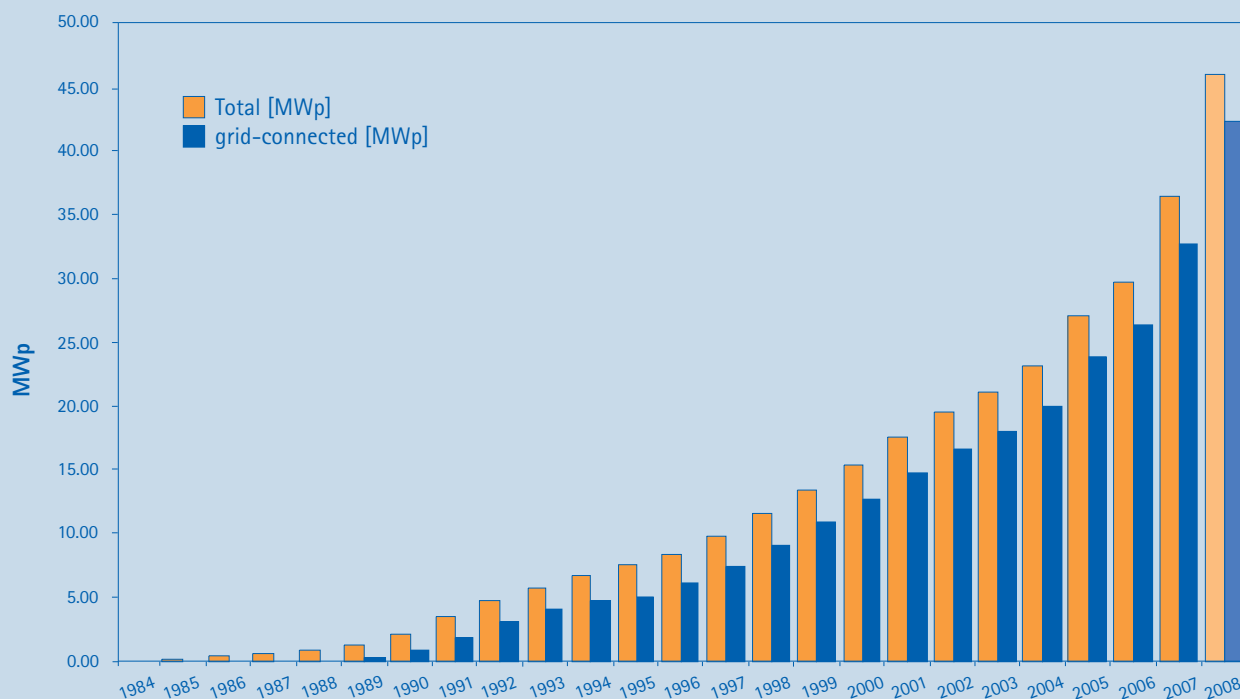


Fig. 4 - Evolution of the installed photovoltaic capacity in Switzerland between 1984 and 2008 (total and grid-connected, estimated values for 2008).

As indicated above, industrial activities evolve in the field of process equipment (oc oerlikon) and products based on thin-film technology (Flexcell® from VHF-Technologies, FLISOM). In 2008, oc oerlikon received a number of large orders for industrial production equipment of amorphous silicon solar cells and further developed the production equipment for micromorphous solar cells. Using oc oerlikon's technology, the project of a 30 MW production line by the Pramac company is being implemented in the southern part of Switzerland near Locarno. During 2008, VHF-Technologies built their production facility for a 25 MW production line of thin film silicon solar cells on flexible substrates. Furthermore, Swiss Solar Systems (3S) is building some of the world's largest PV module laminators.

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. The export volume of Swiss photovoltaic products is rapidly growing and is estimated to more than 1 500 MCHF in 2008.

Besides an increased interest from the manufacturing industry, the finance sector continues to promote financial services directed towards renewable energy. Increased investments have occurred in the renewable energy sector, including photovoltaics, and dedicated funds are operated by important finance organisations. This trend is manifested by the regular investment analysis reports published by the Bank Sarasin.

#### MARKET DEVELOPMENT

The market development, which was formerly mainly driven by green power marketing schemes from utilities, has experienced a strong development in expectation of the new feed-in tariff support scheme. The annual market volume for grid-connected systems is

estimated to a value around 10 MWp, considerably higher than the previous year (6,5 MWp). The total installed capacity has thus risen to about 46 MWp (Figure 4), corresponding to 9,5 Wp/capita. The PV energy statistics have been established by tracking the energy produced by grid-connected PV systems and their statistical distribution since 1992 (Table 1). The total energy production of grid-connected photovoltaic systems up to 2007 is thus approaching 26 GWh.

#### FUTURE OUTLOOK

Regarding photovoltaic technology in Switzerland, the broad support of the national PV programme can be expected to continue and further increase with a focus on rapid technology transfer, industrial developments, new products for niche markets and ongoing international involvement. For solar cells and modules, the efforts to bring Swiss technology to the market place is expected to materialise in further industrial activity. Efforts in the technology development will concentrate on short to medium term market oriented approaches and continuous quality assurance. In parallel, the more basic and longer term research activities are being increased. The strategy to promote international co-operation on all levels will continue, related to activities in the 7<sup>th</sup> Framework Programme of the European Union, the European PV Technology Platform, the IEA PVPS programme and increasingly in technology co-operation projects. Stronger co-operation with other European PV RTD Programmes and further joint projects will be established in the framework of the PV-ERA-NET project.

With the introduction of the feed-in tariff scheme in 2008, becoming operational in 2009, the next years will be most interesting concerning the domestic market development. On the supply side, new players can be expected, leading to increased competition. On the demand side, stronger marketing activities and end-user orientation will need to take place in order to reach and satisfy new customers. Due to the present limits built in the feed-in tariff scheme, some of the high expectations may not be fulfilled in the short term and the policy debate is expected to continue.