

SWITZERLAND

PV TECHNOLOGY STATUS AND PROSPECTS

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Fig. 1 - 200 kWp solar power system on the football stadium St. Jakob in Basel (architect: Herzog & de Meuron, PV design, installation and photo: energiebüro®).

GENERAL FRAMEWORK

Throughout 2006, the framework for photovoltaic technology development in the public sector did not experience particular changes: Research and development activities persisted on the level of previous years whereas support for new pilot and demonstration systems continued to be very limited. The latter poses a barrier to the rapid transfer of results from R&D into industrial solutions and products. On the other hand and driven by the rapid growth of the worldwide photovoltaic market, industry development continued to be strong.

Different matters related to energy policy are presently on the political agenda. In part, this concerns the introduction of a CO₂ tax on fossil fuels. The legal basis for the introduction of such a tax is defined by the Carbon Law which has been in force for a number of years. Following the introduction of voluntary measures for the mobility sector through the creation of the Climate Cent Foundation in 2005, the introduction of a CO₂ tax on fossil fuels in the heat and power sector continued to be debated in the parliament during 2006. The second issue on the policy level, of greater relevance for photovoltaics, is a new proposal for a liberalisation of the electricity market. After the rejection by public referendum of the first attempt on this subject in 2002, a new law has been proposed. Within this proposal, a goal of additional 5 400 GWh from "new" renewable

energies by 2030 is formulated. During 2006, there was a strong debate on this subject in the Swiss Parliament. To support the deployment of renewable electricity, a levy of 0,6 cCHF/kWh was proposed, yielding a total annual amount of 320 MCHF.

The feed-in tariff model was decided as the support scheme to be used. The main debate on this part of the new law concerned the contributions from the different renewable energies and in particular whether photovoltaics should also benefit from a limited support. At the end of 2006, the debate was still ongoing with differences between the two chambers of the parliament on the issue of photovoltaics (meanwhile, a consensus was reached that photovoltaics should also benefit from the support of the feed-in tariff scheme). If the matter progresses as planned, the details will be worked out throughout 2007 and the new framework would become effective in 2008. This would represent a major advance for the Swiss photovoltaic market deployment. Ideally, it would allow the photovoltaic sector to have a steady albeit limited growth over the years to come.

Finally, the framework for the energy research remains otherwise unchanged: The energy research strategy is defined by a 4 year energy RTD master plan, presently for the period 2004 – 2007. The master plan developed by the Federal Commission for Energy Research (CORE), in cooperation with the Swiss Federal Office



Fig. 2 - Solar water pumping applications in Mali (photo: Solsuisse).

of Energy (SFOE), is based on strategic policy goals (energy & environment, science & education, industry & society). By the end of 2006, work for the next 4 year energy RTD master plan, covering the period 2008 – 2011 was terminated and ready for discussion with the different stakeholders.

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). 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 market stimulation. As indicated above, activities in pilot and demonstration projects were limited during 2006. 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 marketplace. Thorough component – in particular for photovoltaic modules and inverters – and system analysis aims at increasing efficiency, reliability 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, deployment is presently mainly driven by voluntary green power marketing programmes of utilities. Finally, the programme places emphasis on information and communication in order to raise the awareness for opportunities involving photovoltaics. Direct promotion of the market through incentive schemes is within the responsibility of the cantons on a voluntary basis. However, photovoltaics is generally not a priority and support through direct subsidy schemes is presently limited to a few cantons.

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 2006, the recently formed interdepartmental platform for the promotion of renewable energy in international co-operation – REPIC – was continued (www.repic.ch) and supported photovoltaic projects of Swiss entities in developing countries (Fig. 2).

RESEARCH, DEVELOPMENT AND DEMONSTRATION

The Swiss Photovoltaic RTD Programme is based on a 4 year RTD master plan, presently covering the period 2004 – 2007. Overall,

50 projects, supported by various national and regional government agencies, the research community and the private sector are 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.

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 2006, emphasis on transfer from R&D to industrial processes 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). In the area of thin film silicon, strong co-operation with the companies VHF-Technologies and oerlikon (formerly Unaxis Solar) continued. During 2006, the equipment manufacturer oerlikon extended its activities as a leading supplier of manufacturing systems of thin film silicon solar cells on glass. 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 aluminium. During 2006, the spin-off company FLISOM, active in this solar cell technology, received different awards as a promising and innovative high-tech company. For dye-sensitised solar cells, work continued on new dyes and high temperature stability of the devices. Flexible solar cells were also a subject for this technology. Exploratory work was undertaken on new solar cell concepts (organic solar cells) at the Swiss Federal Laboratories for Materials Testing and Research EMPA.

Emphasis continues to be given to the application of building integration, both for new solutions involving thin film solar cells as well as for new mounting systems and structures for sloped roofs and facades.

With the ongoing market development, quality assurance of products and systems, as well as standardisation, continue to be of high priority. The centres of competence at the Technical Universities of Burgdorf and Lugano carefully evaluate products such as PV modules, inverters and new systems. Long term experience with the operation of photovoltaic power systems is carefully tracked for a number of grid-connected systems, ranging between 10 and almost 25 years of operation. Continuous development of system solutions has resulted in a number of industrial products which are increasingly being exported.

Following the example of the project SolarImpulse (www.solar-impulse.com) by Bertrand Piccard for a non-stop flight around the world in a solar powered airplane, another visionary project of this kind was announced in 2006: The project PlanetSolar (www.planetsolar.org) plans to sail around the world by a boat powered by solar photovoltaic energy. The concept study of the



Fig. 3 - Concept of the solar boat for a cruise around the world by solar power (photo: Planet-Solar).

boat (Fig. 3) foresees a trimaran of 30 m length and 16 m width powered by 180 m² of solar cells corresponding to some 30 kW peak power, yielding an average cruising speed of 10 knots. International co-operation continues to form a strong pillar of the R&D activities with 10 projects running in the 5th and 6th Framework RTD programmes of the European Union during 2006, of which 3 are integrated projects. Swiss research groups are participating in the new integrated projects PV-ATHLET and PERFORMANCE. International projects are also carried out as part of programmes such as the European Space Agency: The project ENVISOLAR aims at the increased use of satellite based solar radiation information in solar energy industries. The co-operation within the IEA PVPS programme has remained a further strategic activity for which target-group specific dissemination continued: In 2006, a workshop for the financial and investment community was organised in Zurich under the leadership of the Swiss and Japanese Task 1 experts (see also Task 1, p. 12). Founded in 2005, a national IEA PVPS pool receiving support from the electric utilities of the city of Zurich, the Cantons of Basel as well as Geneva, the Mont-Soleil Association and SWISSOLAR contributed to the Swiss expert participation in IEA PVPS. The support to Swiss IEA PVPS activities could thus be broadened, in particular for activities in Tasks 2 and 10. On the programme level, international co-operation is also taking place through the PV-ERA-NET project (www.pv-era.net) and the European Photovoltaic Technology Platform (www.eupvplatform.org).

IMPLEMENTATION

For the time being, market implementation of PV systems continues to be 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. Market implementation is further supported by regional initiatives, for example in the cantons of Basel and Geneva. Small scale private, domestic and non-domestic systems form a complementary part of the Swiss photovoltaic market which is served by local businesses. With the ongoing policy debate in parliament and the accompanying media coverage, a growing interest can be observed from a broad public in this market segment.

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. Over the past years, industrial activities in the area of solar cells, solar modules and manufacturing equipment for both of these areas have considerably increased.

In the inverter area, some products have achieved a high export rate. The Sputnik Company produces grid-connected inverters at a capacity of 145 MW DC/year and presently ranks 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 HCT as well as from Meyer & Burger; and measuring equipment for PV module manufacturers from Belval.

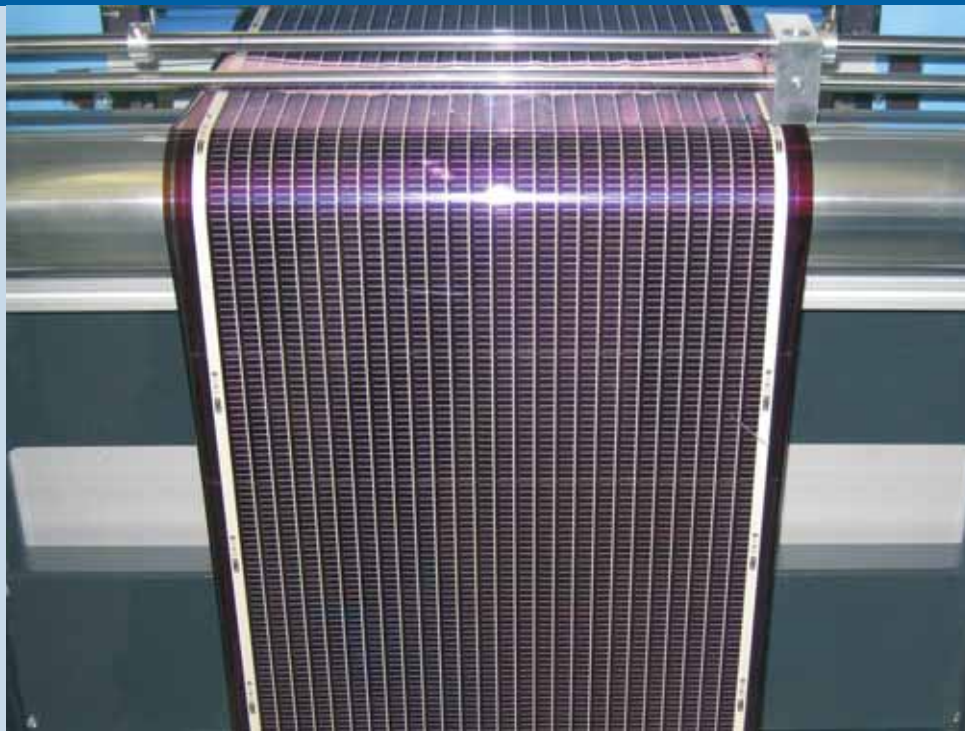


Fig. 4 - Manufacturing of amorphous silicon solar cells on flexible substrates by VHF Technologies (photo: NET).

Solar plugging systems are offered by Multi-contact 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).

As indicated above, industrial activities evolve in the field of process equipment (oerlikon) and products based on thin-film technology (Flexcell® from VHF Technologies, FLISOM). In 2006, oerlikon received a number of large orders for industrial production equipment of amorphous silicon solar cells. During 2006, VHF Technologies (Fig. 4) built a 2 MW pilot production line for thin film silicon solar cells on flexible substrates. The German company Q-cells has selected VHF Technologies as one of its diversification options in thin film solar cells with an investment of some 7 MEUR. The goal of this operation is to industrialise VHF's technology, in particular for building integration applications. Furthermore, Swiss Solar Systems (3S) is building some of the world's largest PV module laminators. 3S has continued the strategic cooperation with the German company Schmid and is the first Swiss manufacturer dedicated solely to photovoltaics which has gone public in 2005. In 2006, other Swiss photovoltaic industries have made their IPO.

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 estimated to 400 MCHF in 2006; thus corresponding to roughly 10 times the size of the national market. 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 has been mainly driven by green power marketing schemes of utilities, supported by promotional programmes and actions in some cantons. The annual market volume for grid-connected systems is estimated to a value around 2,5 MWp, similar to previous years. The total installed capacity has thus risen to about 30 MWp (Fig. 5), corresponding to about 4,3 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 2005 is thus approaching 18 GWh.

FUTURE OUTLOOK

Regarding photovoltaic technology in Switzerland, the broad support of the national PV programme can be expected to continue with an ever-increasing focus on industrial developments, new products for niche markets and ongoing international involvement. For solar cells and modules, the effort to bring Swiss technology to the market place will continue. Efforts in the technology development will concentrate on market oriented approaches and continuous quality assurance. The strategy to promote international co-operation on

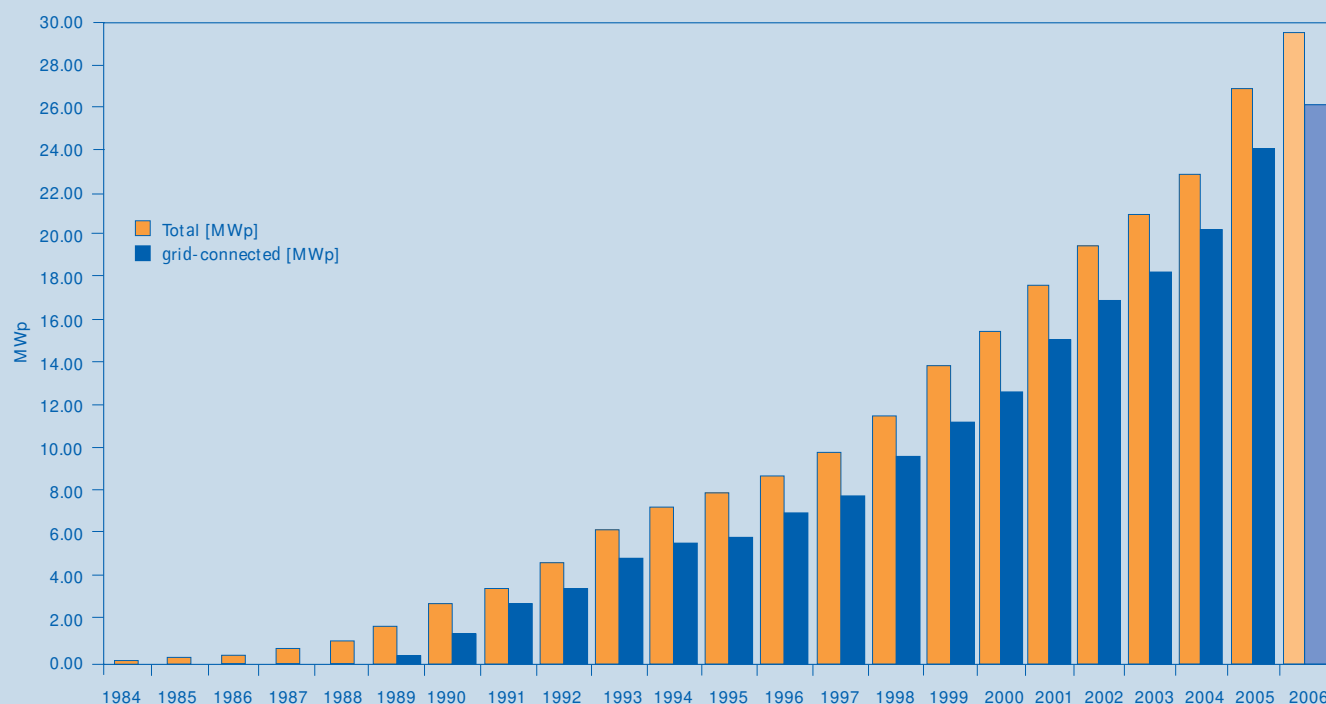


Fig. 5 - Evolution of the installed photovoltaic capacity in Switzerland between 1984 and 2006 (total and grid-connected, estimated values for 2006).

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 increasingly in technology co-operation projects. Stronger co-operation with other European PV RTD Programmes will be established in the framework of the PV- ERA- NET project.

With the chances rising for an increasing national market through the introduction of a feed-in tariff scheme in 2008, the year 2007 may well bear the characteristics of a transition year. Although the support scheme will be valid retroactively for photovoltaic systems installed one year back, the confidence of the investors in the new framework remains to be seen. Furthermore, stronger marketing activities will need to be undertaken in order to reach new customers.

TABLE 1: SWISS PHOTOVOLTAIC ENERGY STATISTICS FROM 1989 - 2005 (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	17,0	12 000	810
2003	75	1 600	17,9	15 100	875
2004	100	1 700	19,5	15 700	815
2005	200	1 900	23,8	17 800	850

(grid-connected systems)