

SWITZERLAND

PV TECHNOLOGY STATUS AND PROSPECTS

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GENERAL FRAMEWORK

The general policy framework is set by the new Swiss energy programme, SwissEnergy (www.swiss-energy.ch). SwissEnergy is a Swiss federal government programme for the promotion of renewable energy and more efficient use of energy. It involves the collaboration of the cantons and of a great many local authorities as well as the private sector, and various environmentalist and consumer groups. SwissEnergy is the follow-up to the Energy 2000 Action Programme and like it will have a duration of 10 years.

The objectives that have been set for the new SwissEnergy programme are derived from the Swiss federal constitution, the federal energy law and the CO₂ law, and also reflect Switzerland's commitments under the international convention on climate warming. Specifically, these objectives are as follows:

- The consumption of fossil fuels in Switzerland and the corresponding CO₂ emissions must be reduced by 10 per cent between 2000 and 2010.
- The growth of electricity demand must not exceed 5 per cent.
- Hydropower's share of final electricity consumption must not be reduced despite deregulation of the Swiss electricity market.
- The contribution made by other forms of renewable energy must increase to 0,5 Terawatt-hours (TWh) or 1 per cent of total electricity production, and in the case of heating energy to 3 TWh or 3 per cent of the total.

Other important SwissEnergy objectives that are less easy to measure include the development of a greater awareness of the energy dimension among the general public as a prerequisite for the optimum implementation of voluntary measures; ever closer co-operation among all partners; a spirit of innovation in all fields and an overall strengthening of the Swiss economy at the end of the day.

Following a negative public vote in 2002, the Swiss electricity market will not yet be liberalised as originally foreseen by the legislator. This electricity law would have favoured renewable electricity with free transmission for 10 years and immediate full market liberalisation. It remains to be seen how this situation will evolve under the given circumstances of the liberalised European electricity market. For the time being, renewable electricity is promoted by the stringent labels "naturemade basic®" and "naturemade star®" for green power products (www.naturemade.ch), which include portfolio approaches of different technologies. For the "nature made star®" label, 2,5 % of the total energy delivered in a service area has to be from new renewable energies (photovoltaics, wind, biomass). Using these labels, green electricity is now also promoted as part of the SwissEnergy programme.

The framework for the RTD activities is given by the Swiss energy research concept, a 4 year plan presently valid for the period 2000 - 2003, developed by the Swiss energy research commission (CORE) and the Swiss Federal Office of Energy.



Fig. 1 - Dock Midfield: 283 kWp multifunctional system at the airport of Zurich.

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. To increase the quality of new systems, a number of software tools for improved project design and recommendations for project implementation are available. Further accompanying measures which help to support and promote market deployment include the customer-oriented promotion in the campaign "solar electricity from the utility". Finally, the programme emphasizes information and communication in order to raise the awareness for opportunities involving photovoltaics. Direct promotion of the market through incentive schemes has become the responsibility of the cantons on a voluntary basis. This has led to regional



Fig. 2 - Sunny Woods: 6 kWp amorphous silicon system in an energy optimised multifamily house in Zurich.

differences whereby the governments of the cantons define their priorities between promotion of energy efficiency and/or renewable energies. Support for photovoltaics through direct subsidy schemes is limited to a few cantons presently.

On the technical level, thin film solar cells and building integration remain the foremost topics of priority. Through the bias of Task 9 of the IEA PVPS Programme, the subject of technology co-operation with developing countries has received increased interest and new, stronger strategies are being developed which will increase Switzerland's efforts in this area.

RESEARCH, DEVELOPMENT AND DEMONSTRATION

The Swiss Photovoltaic RTD Programme is based on a 4 year RTD concept, presently covering the period from 2000 – 2003. Overall, 80 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 micro-crystalline silicon, silicon-germanium, compound semiconductors, dye-sensitised cells). Transfer to industry of these RTD activities has continuously increased over the past years. At the end of 2002, the board of the equipment manufacturer Unaxis has taken the decision to considerably invest into a new thin film solar cell activity which builds on the strong synergies with the company's expertise for production equipment of flat panel displays. This new venture of Unaxis with the Institute of Microtechnology at the University of Neuchâtel intends to develop a leading position in the industrial production equipment of thin film "micromorphous" silicon solar cells.

A strong emphasis is placed on 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 are becoming topics of high priority. Three centres of competence have been established which evaluate products such as PV modules, inverters and components for building integration. 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 20 years of operation. In 2002, a new activity looking into the energy rating of photovoltaic modules has started.

International co-operation continues to form a strong pillar of the R&D activities with about 20 projects running in the RTD-programmes of the European Union. International projects are also carried out as part of programmes such as the European Union Altener Programme or the European Space Agency. The co-operation within the IEA PVPS programme has remained a further strategic activity for which target-group specific dissemination is crucial.

IMPLEMENTATION

The majority of the market implementation of PV systems continues to be driven by the campaign for "solar electricity from the utility". By the end of 2002, more than 130 utilities (1996: 7) provided solar electricity to their customers. Different financial models are being used according to the preferences of the utilities. About 50 % of the Swiss population meanwhile have access to solar electricity and more than 30 000 customers annually subscribe to about 5 GWh of this new energy service. Through the past 5 years, this concept has enabled more than 6 MWp of PV systems installed with a high awareness effect among the public. The campaign has proved to be a successful approach, involving different stakeholders, provided a strong and consistent marketing is undertaken. Benefits were iden-



Fig. 3 - Parking de l'Etoile: 143 kWp on the roof of a parking house in Geneva.

tified also by the utilities in introducing new customer relationships. Since the introduction of the naturemade® labels for renewable electricity (see above), 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. The willingness to pay the comparatively high prices for solar electricity is typically around 5 % of the customers in the best cases and requires a strong and consistent marketing approach.

The trade of renewable electricity through a certificate system, e.g. RECS (www.recs.org), is starting to be implemented using the naturemade® labels and individual product brands, e.g. "Pure-Power Graubünden" by Rätia Energie. Many of these developments are to be seen as bottom-up initiatives which favour market and customer oriented approaches. Solar electricity can be part of the renewable energy mix, namely through naturemade star® labeled products.

INDUSTRY STATUS

Swiss industrial PV products cover 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. On the PV industry supply side, different products count among the world leaders, e.g. for wire-sawing machines and measuring equipment for PV module manufacturers. In the past years, assembled PV modules based

on crystalline silicon technology were introduced into the market to form aesthetically attractive products for building integration. Whilst the main market driver, the campaign "solar electricity from the utility", has favoured least cost solutions on flat roofs, industrial development shows a trend to higher integration and innovation, partly with thin film technologies.

More recently, industrial activities have started in the field of process equipment (see above, Unaxis solar) and small scale products based on thin-film technology (Flexcell). This development reflects the existing technological know-how within the research community, combined with an increasing awareness of new market opportunities by the industry.

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.

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 clearly demonstrates the growing perception of the renewable energy sector as a field of increasing business opportunities.

TABLE 1: SWISS PHOTOVOLTAIC ENERGY STATISTICS FROM 1989 – 2001

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

(grid-connected systems)

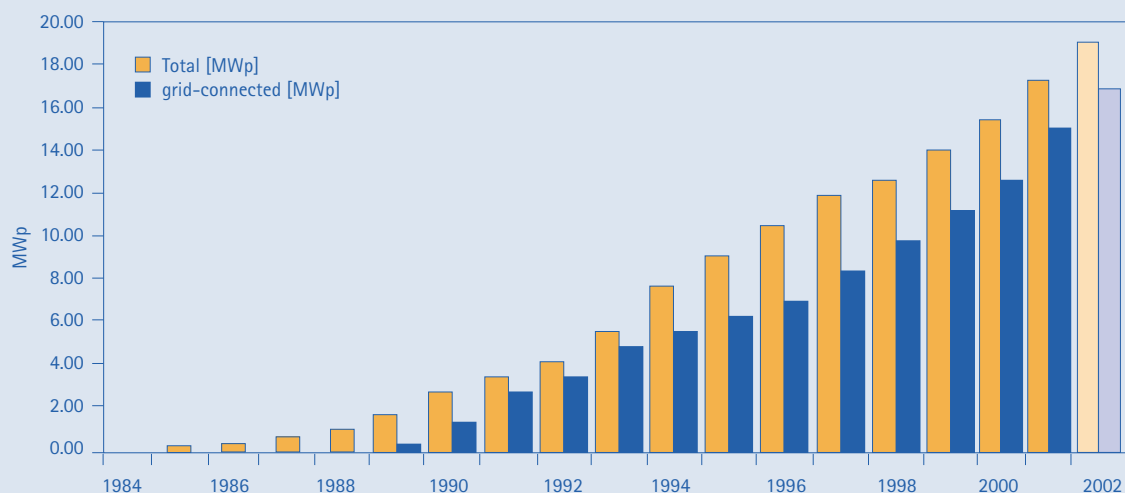


Fig. 4 – Evolution of the installed photovoltaic capacity in Switzerland between 1984 and 2002 (total and grid-connected, estimated values for 2002)

MARKET DEVELOPMENT

The market development has been mainly driven by the federal campaign "solar electricity from the utility", supported by promotional programmes and actions in some cantons as well as pilot & demonstration projects within the national programme. The annual market volume for grid-connected systems is estimated to about 1,7 MWp, which would be lower than in previous years. The total installed capacity thus rises to about 19 MWp (Figure 4), corresponding to about 2,7 Wp/capita. The PV energy statistics has been established tracking the energy produced by grid-connected PV systems and their statistical distribution since 1992 (Table 1).

FUTURE OUTLOOK

Regarding photovoltaic technology in Switzerland, the broad support of the national PV programme can be expected to continue with an ever-increased 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.

PV market implementation will continue to be limited to indirect promotion measures within the federal energy programme, the activities of regional authorities and the initiatives by the utilities. The strategy to promote international co-operation on all levels will continue, related to activities in the 6th framework programme of the European Union, the IEA PVPS programme and increasingly in technology co-operation projects.