International Energy Agency

Co-operative Programme on Photovoltaic Power Systems

Task 1
EXCHANGE AND DISSEMINATION OF INFORMATION ON PV POWER SYSTEMS

National Survey Report on PV Power Applications in Switzerland 2002

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May 2003

For the
Swiss Federal Office of Energy

Table of Contents

i Foreword

The International Energy Agency (IEA), founded in November 1974, is an autonomous body within the framework of the organisation for Economic Co-operation and Development (OECD), which carries out a comprehensive programme of energy co-operation among its 23 member countries. The European Commission also participates in the work of the Agency.

The IEA Photovoltaic Power Systems Programme (IEA-PVPS) is one of the collaborative R & D agreements established within the IEA and, since 1993, its participants have been conducting a variety of joint projects in the applications of photovoltaic conversion of solar energy into electricity.

The twenty participating countries are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Mexico (MEX), The Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), The United Kingdom (GBR) and The United States of America (USA). The European Commission is also a member.

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents.

Information about the active and completed tasks can be found on the IEA-PVPS public website: www.iea-pvps.org.

The objective of Task 1 is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems.

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ii Introduction

This National Survey Report gives a brief overview of what has been achieved in the photovoltaic (PV) power area in Switzerland in the year 2002. It is only a summary of the most important developments and applications of photovoltaic power systems and does not pretend to be complete in any way. A more comprehensive view of PV research and pilot / demonstration plant is available from the Swiss Federal Office of Energy (www.photovoltaic.ch).

iii Definitions, symbols and abbreviations

For the purposes of this report, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a PV power of 40 W or more.

Installed PV power: Power delivered by a PV module or a PV array under standard test conditions (STC) – irradiance of 1 000 W/m^2, cell junction temperature of 25^{o}C, AM 1,5 solar spectrum – (also see 'Peak power').

Peak power: Amount of power produced by a PV module or array under STC, written as W.

PV system: Set of interconnected elements such as PV modules, inverters that convert d.c. current of the modules into a.c. current, storage batteries and all installation and control components with a PV power capacity of 40 W or more.

Module manufacturer: An organisation carrying out the encapsulation in the process of the production of PV modules.

Off-grid domestic PV power system: System installed in households and villages that are not connected to the utility grid. Usually a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'.

Off-grid non-domestic PV power system: System used for a variety of applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed on consumers' premises usually on the demand side of the electricity meter. This includes grid-connected domestic PV systems and other grid-connected PV systems on commercial buildings, motorway sound barriers. etc. These may be used for support of the utility distribution grid.

Grid-connected centralised PV power system: Power production system performing the function of a centralised power station.

Turn-key price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid system, the prices associated with battery maintenance/replacement should be excluded. If additional costs are incurred for reasons not directly related to the PV system, these should be excluded. (e.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication systems a remote area should not be included.)

Field Test Programme: A programme to test the performance of PV systems/components in real conditions.

Demonstration Programme: A programme to demonstrate the operation of PV systems and their application to potential users/owners.

Market deployment initiative: Initiatives to encourage the market deployment of PV through the use of market instruments such as green pricing, rate based incentives etc. These may be implemented by government, the finance industry, utilities etc.

NC: National Currency

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

1 Executive summary

In 2002, Swiss photovoltaics effort was characterized by continuity in the research area and increased activity in the market-oriented fields. The latter can be illustrated by the fact that new co-operation projects with industry were set up, particularly in the area of the production of thin-film cells and modules, where R&D findings are being transferred and up-scaled to produce commercially viable industrial products and solutions. In the research area, the main focus remained on the further development of thin-film solar cells and on the integration of PV in buildings. Many pilot & demonstration projects were once more to be found in the integration of PV in the built-up environment. Apart from the installation of standard products in flat and sloping roofs and facades, the projects also included the full integration of PV elements in the building materials themselves.

Installed PV power

The total installed PV power in Switzerland rose once more and reached a total of 19.5 MW of which 16.7 MW (86%) is delivered by grid-connected installations. The increase in total installed capacity of 1.9 MW, when compared with 2001 (2.3 MW), illustrates the slacking off of growth in the Swiss PV market. Although the number of new installations (75) was lower than in 2001 (125), the increase in installed power stayed relatively high. This can be explained by the fact that the average installed power per installation increased (21 kW as opposed to 15 kW in 2001) - a result of several larger installations being built in connection with the so-called “solar stock exchanges”, which buy in PV power from independent producers at rates that cover production costs.

Costs & prices

Turn-key prices for PV Installations have started to drop once more as world-wide production has caught up with increased demand. The average price of an installed PV Watt-peak for grid-connected, single-family home plant fell by around 10% to an average of around CHF 11.00, larger installations, however, with installed power over 10 kW, fell slightly less to an average of around CHF 9.20 per watt (range: CHF 8.00 – 10.50, depending to a certain extent on mounting method used).

PV industry

No traditional cell production occurs in Switzerland. In the area of micromorph thin-film cells, however, industry co-operation is moving laboratory-scale production technology to the industrial scale. Emphasis here is on the development of production machinery. Other areas of industrial co-operation covered the improvement of light-capture for amorphous cells using roughened substrates and the feasibility of optical nano-gratings for nano-crystalline cells for the same purpose. The initial production runs of a pilot production plant for the production of PV-foils using VHF deposition were promising.

Budgets for PV Promotion

Subsidies for PV are only available in certain Swiss Cantons; the main part of promotional funding for PV installations and market incentives occurs within the framework of pilot and demonstration (P+D) projects. In 2002 a total of around CHF 2

million was made available for such projects. In the R&D and technology area, however, Federal funding amounted to around CHF 10,3 million.

2 The implementation of PV systems

The PV power system market is defined as the market of all nationally installed (terrestrial) PV applications with a PV capacity of 40 W or more. A PV system consists of modules, inverters, batteries and all installation and control components for modules, inverters and batteries.

2.1 Applications for photovoltaics

In Switzerland, the majority of PV Installations are grid-connected plant, built mostly on the roofs of buildings. Larger installations (> 50 kW) are usually flat-roof mounted on commercial buildings, offices etc. Several combined PV / noise barrier installations along motorways and railway track form an exception to this rule. The smaller grid-connected PV installations (typically around 3 kW) can normally be found on the roofs of single-family homes. Traditionally, off-grid installations are relatively small (< 1 kW), with combined PV - diesel or PV - small hydro for the operation of farm buildings in remote alpine areas forming the exception.

In 2002, work on the dissemination of PV Technology was once more characterised by its orientation towards PV applications and PV marketing. Know-how-transfer and up-scaling of new technologies was important in the thin-film area. Around 85 projects were being worked on by Swiss technical institutions, industry and professionals, 45 of the projects were active P+D projects.

Another area where several Swiss technical institutions are active is in the provision of monitoring and quality assurance services for both PV components and system technology. Quality assurance and energy yields of various types of PV modules and inverters are being looked at as well as the long-term behaviour of grid-connected PV plant, for example.

2.2 Total photovoltaic power installed

Our assessment is based on the following data:

- On-grid PV: Swiss Federal Office of Energy / Swiss Association of Electricity Enterprises, PV Statistics 2002
- Off-grid PV: SOFAS (Swiss Professional Association for Solar Energy) annual survey for 2002.

Table 1 Cumulative installed PV power in 4 sub-markets.

Sub-market/ application	31 Dec. 1992 kW	31 Dec. 1993 kW	31 Dec. 1994 kW	31 Dec. 1995 kW	31 Dec. 1996 kW	31 Dec. 1997 kW	31 Dec. 1998 kW	31 Dec. 1999 kW	31 Dec. 2000 kW	31 Dec. 2001 kW	31 Dec. 2002 kW
off-grid domestic	1 540	1 675	1 780	1 940	2 030	2 140	2 210	2 300*	2 390*	2 480*	2 570*
off-grid non-domestic	70	100	112	143	162	184	190	200*	210*	220*	230*
Grid-connected distributed	2 200	2 900	3 600	4 050	4 850	5’950	7 630	9 420	11 220	13 340	15 140
Grid-connected centralised	900	1 100	1 200	1 ’350	1 350	1 450	1 470	1 480	1 480	1 560	1 560
TOTAL	4’710	5 775	6 692	7 ’483	8 392	9 ’724	11 500	13 400	15 300	17 ’600	19 500

* Author’s estimates. Exact figures for the proportion of off-grid power for domestic and non-domestic applications are not available.

Compared with 2001, cumulative installed power increased by about 11%

Figures for on-grid centralised plant cover larger installations that are operated on the production side (often by utilities or public authorities) and are not integrated into buildings (i.e. free-standing plant and installations on noise-barrier structures.

On-grid distributed covers building-integrated plant on houses, offices, factories etc. (usually privately owned) They are often used for in-house generation (e.g. single family homes) or supply energy for “solar stock-exchanges”. The latter installations are mostly in the range of 50 kW to 150 kW.

2.3 Major projects, demonstration and field test programmes

In 2002, a total of 45 PV pilot and demonstration (P+D) projects were active of which 10 were newly started. As usual, several projects were in the process of being assessed by the Federal Office of Energy at the start of 2002. The one-to-one testing of new technologies and components in pilot installations played an important role in Switzerland's P+D activities in 2002. PV integration in the built-up environment remained an important area of P+D activities.

Both the testing of new components and the demonstration of PV for the general public were represented In the P+D projects started in 2002. Most projects are concerned with the integration of PV systems in buildings and the built-up area. In the following examples of new P+D projects are given.

On the flat roof of a supermarket building in Zurich, for example, an 18-field installation with 6 different types of thin-film cells - each in three standard modes of mounting - will allow the direct comparison of the performance of different technologies and manufacturers. For reference a "conventional" field with mono-crystalline silicon cells is also being monitored.

In the alpine resort of St. Moritz, the Corviglia cable railway has installed 17.8 kW of PV along the tracks and a 13.5 kW facade-integrated PV installation on the mountain station and restaurant on the Piz Nair at 3 050 meters above sea level.

A new form of roof integration called "Freestyle" is being demonstrated using amorphous triple-cells in Lutry near Lausanne. The multifunctional use of PV modules as sun shading for an atrium and for power generation is being realised in Chur in the Grisons using special, semi-transparent modules with CIS cells.

A further example of integration of PV with building materials is being demonstrated by a roofing system that allows PV modules to be mounted directly on thermal insulation panels.

At the Palexpo Exhibition Centre in Geneva, a 70 kW on-grid, roof-mounted installation has been commissioned by the Swiss Solar Energy Society. Two charging stations for electric cars also form part of this project that is to increase public awareness of PV power.

The "Obelisk", an advertising column with an autonomous PV energy supply, is a somewhat novel form of PV application

Multi-functional, semi-transparent CIS modules are used in a 27 kW P+D project for the simultaneous provision of shading for an atrium and power generation.

Switzerland is partaking in a multi-national P+D project called RESURGENCE – Renewable Energy Systems for Urban Regeneration in Cities of Europe. In the framework of this project, a total of 1.3 MW of PV power is to be installed in 5 countries.

A new PV module mounting system is being demonstrated in a 27 kW installation in Hünenberg.

Among the running P+D projects, several were once more the winners of the Swiss and European solar prizes.

The “Sunny Woods” project won both the European Solar Prize for solar building and the Swiss Solar Prize for the best integrated installation. This 6-apartment house in Zurich integrates both the architectural and energetic aspects of building in an exemplary manner.

Another prize-winner in the architectural category is the multifunctional shading installation on the new Terminal E (Dock Midfield) at Zurich airport; a third roof-mounted PV plant on a multi-storey car park in Geneva also won a Swiss solar prize.

During the Swiss “Expo 02” national exhibition, three PV-powered catamaran shuttles carried many hundreds of thousands of visitors to the Monolith – an iron-clad cube floating in the Lake of Murten that housed an important part of the exhibition.

Another solar-powered 150-passenger catamaran operating on the Lake of Bienne looked back on a successful season. This ship has carried around 10,000 passengers in the first two years of charter operation and is very popular: the feeling of gliding over the water in an almost silent manner is very impressive. The catamaran will continue charter operation but will also be working some regular services for the general public.

The 10 kW PV- “green roof” project, active now for some time, has proven that plant growth has been to plan and also showed excellent electrical performance.

Other plant producing good results as far as power production is concerned were various installations using thin-film cells. The CIS-installation at the ice-rink in St. Moritz reached a figure of 1055 kWh/kW – not unexpected for an installation in the mountains. More surprising was the performance of the same cells in (lowland) Burgdorf, where 1091 kWh/kW was attained. At the same location (the Newtech project) an array with amorphous silicon triple cells reached an above-average figure of 1033 kWh/kW.

In the area of monitoring of PV installations, the “Newlink” monitoring system with wireless transmission of alarms and data on the basis of SMS text-messages sent via GSM allows the simple and effective, low-cost monitoring of PV power plant, especially where the uninterrupted production of power in commercial installations is of utmost importance.

Among the P+D projects finished in 2002 were the Project with LonWorks field bus connected inverters, the three 10 kW noise-barrier / PV installations along the motorway near Zurich, a solar-powerd rental motorboat on the Lake of Zurich and Héliotram – the 800 kW installations in Geneva and Lausanne with direct DC supply for the tramway systems in these cities.

A long-standing data-collection project – the 1-Megawatt Solar Chain – was finished in 2002. Data from several PV installations have been collected and analysed over the period 1997 – 2001.

Table 2: Summary of major projects, demonstration and field test programmes

The following table lists a selection (by no means complete) of Swiss P+D projects:

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2002 /problems and lessons learned	Funding	Project management	Remarks
Newtech, Burgdorf University of applied science, 2000	*Comparison of three 1 kW thin-film installations*	*Direct, long-term comparison of installations using a-tandem cells, a-triple cells and CIS cells*	*Surprisingly good results delivered by the installations with CIS and triple cells*	*SFOE*	*ADEV Burgdorf / Fachhoch-schule, Burgdorf*	*2 installations with above average yields*
Thin-film test installation, Migros, Zürich, 2002	*Comparison of 6 types of thin-film modules, each in 3 application modes*	*Direct, long-term comparison of various types of commercially available thin-film modules. Conventional sc-Si for comparison*	*Installed in September 2002. Data as of November 2002*	*SFOE, EWZ, private (solar stock exchange project)*	*Energiebüro, Zürich*	*Mounting variants: flat, thermally insulated; flat, open back; inclined, open back.*
"Sunny Woods" 16 kW installation	*PV pilot installation on a ultra-low energy-consumption residential building using amorphous triple cells*	*Integration in an architectural concept, Verification that PV yield meets power demands of heat pumps*	*PV-production measurements as of September 2002*	*Private, SFOE*	*Beat Kämpfen, Architect, Zurich*	*Winner of European and Swiss Solar Prizes for architectural and energetic integration*
St. Jacob's Park, Basel	*150 kW plant on the roof of the new football stadium*	*Architecturally well-integrated installation – a typical "solar stock exchange" PV plant*	*Economically viable operation: 120'000 kWh in spite of unfavourable module orientation*	*Private. (solar stock exchange project)*	*ADEV Solarstrom AG, Liestal*	*Private project. Swiss Solar Prize 2002*

Project Date plant start up	Technical data/Economic data	Objectives	Main accomplishments until the end of 2000/problems and lessons learned	Funding	Project management	Remarks
Ice rink, St. Moritz, 2000	*16.8 kW pilot installation using CIS technology*	*Demonstration of CIS technology, detailed measurement campaign*	*High efficiency (PR=0.81) noted. Differences between parallel operated monitoring systems*	*SFOE, Rätia Energie*	*SUSPI, DCT, LEEE-TISO, Canobbio*	*Some strings with lower production (partial shading, inverter overload*
BIPV Würth GmbH, Chur, 2002	*3.9 kW shading/PV installation for the atrium of an office building*	*Demonstration of semi-transparent CIS panels as a shading element, measurement campaign*	*In operation since October 2002*	*Private, SFOE*	*Enecolo AG, Mönchaltorf*	*Building-integrated PV with striped CIS panels*
NewLink PV monitoring system, 2002	*Low-cost monitoring system for PV installations*	*Realisation of an easy-to-use, low-cost monitoring system using GSM wireless transmission*	*First field tests completed*	*Private, SFOE*	*NewLink E. Anderegg, Füllinsdorf*	*Improvements being made in 2003*
Terminal E (Dock Midfield), Unique Airport Zurich, 2001	*5-part 290 kW plant, integrated into the terminal's roof*	*Demonstration of multi-functional building integration including shading for passenger lounges*	*Went into operation in April 2002. Integration of measurements in building automation system expected in March 2003*	*SFOE, Unique Airport*	*ZAYETTA consortium, Zurich Airport*	*Public production display as soon as Terminal opens (Autumn 2003)*

2.4 R&D Highlights

Swiss research and development projects deal with all important PV materials and technologies. A particular emphasis is placed on thin-film and multi-layer cell concepts, with new industry co-operation projects showing the way towards the transfer of technology to industrial production methods. In the area of silicon solar cells, for example, work was continued on micromorph thin film cells, where co-operation with industry is moving laboratory-scale production technology to the industrial scale. Other areas of industrial R&D co-operation covered the improvement of light-capture for amorphous cells using roughened substrates and the feasibility of optical nano-gratings for nano-crystalline cells for the same purpose. Low-band-gap silicon cells for thermo-PV applications were also worked on. Apart from work in the thin-film silicon technology area, work on CIGS and cadmium-telluride cells was carried further. Also, the development of dye-sensitised nano-crystalline cells was continued. The long-term characteristics of dye-sensitised cells were investigated in a on-going series of outdoor tests. Within the framework of the NANOMAX EU project, alternative ways of manufacturing these types of solar cell were investigated.

In the building integration area, development of composite PV modules that directly combine thin-film solar cells with facade and roofing elements was continued. Here, several Swiss companies and institutions were involved in EU projects.

In the systems technology area, the main emphasis lay on the quality assurance of components (modules, inverters) and standardisation of both products and testing procedures. The long-term tests on the 20-year old modules of the LEEE-TISO 10 kW installation were continued.

In the area of thermo-photovoltaics work is being continued, primarily with the goal of operating conventional fossil-fired boilers without external electricity supplies.

Other R&D work covered the development of aids for the design of PV installations such as the calculation of irradiation from satellite data and the provision of on-line data. In the thermo-PV area, a project in co-operation with industry was continued which aims to develop heating boilers that no longer require an external feed of electrical power.

2.5 Budgets for market stimulation, demonstration and R&D

Table 3 Budgets (in Millions of CHF) for R&D, demonstration programmes and market incentives.

	R & D	Demo	Market	Total
National/federal	10,3	1,0	0,5	11,8
State/regional	4,0	1,0	3,8*	8.8
Total	**14,3**	**2.0**	**4,3**	**20,6**

* including grants / subsidies for private persons

The Swiss Federation runs a system of global grants to cantons, which has replaced direct federal funding to a certain extent. Not all Cantons yet have the appropriate legislature to augment and distribute these funds, and the situation concerning grants for RD&D and market incentives varies greatly. Some cantons set their emphasis on market measures (investment incentives and direct contributions for private persons, companies and organisations), others on installing their own PV demonstration installations or on the support of local “solar stock-exchanges”.

The figure on the level of regional funding for market promotion quoted is the sum of those figures given for 2002 by 23 Swiss Cantons. The actual total may be somewhat higher, as not all figures are available.

The Canton of Geneva supported PV plant installed in connection with the local solar stock exchange with CHF 4 000 per kW. In this way, 400 kW of additional PV power was installed in 2002.

The City and Canton of Basle’s incentive levy on electricity is still providing a very important impulse for PV. The income from this levy is partly reserved for the promotion of PV power and, in 2002, helped fund 253 kW of additional PV power with over CHF 1.4 million.

3 Industry and growth

There is no large scale industrial cell production in Switzerland. The Unaxis company, specialised in vacuum technology and the production of thin-film coatings (for LCD displays, for example), is, however, working together with the Swiss Federal Institute of Technology in Lausanne and the Institute for Micro-Technology in Neuchatel on the up-scaling of thin-film PV technology to the industrial production scale.

Other, "spin-off" companies are working on the commercialisation of the new thin-film technologies developed in Swiss technology institutes and universities of applied technology. The VHF Technologies SA company in Le Locle, for example, is working on the production of amorphous cells on polyimide substrates in a continuous process.

The following table provides a quick overview of PV module production in Switzerland for 2002.

3.1 Production of photovoltaic cells and modules

Table 4: Production and production capacity information for 2002 for each module manufacturer

Module manufacturer	**Technology** (sc-Si, mc-Si, a-Si, CdTe)	**Total Production** (MW) Cell	Module	**Maximum production capacity** (MW)
1 Star Unity (SunnyTile)	mc-Si	-	0.02	0.1
2 Solterra SA	sc-Si	-	See note	N/A
3 SES, Société d'Energie Solaire SA (Sunslates)	sc-Si	-	See note below	2 MW
4 Swiss Sustainable Systems	sc-Si and mc-Si	-	0.25	1.0
Thin-film manufacturers				
1 VHF Technologies SA (Thin Film)	a-Si	See note below	See note below	0.06

Notes on manufacturers:

No.1: Star-Unity buys in mono-crystalline cells and integrates them into roof tiles with standard dimensions.

No.2: Solterra SA – a company also active in the thin-film coating business, produces various types of PV Panels as well as large-format roofing “tiles”. Figures on production are not available.

No.3: SES, based in Geneva, produces and sells the “SUNSLATES”, “SUNWALL” and “SUNSHADE” lines – standardised building elements for roofing and facades- as well as customer-specific modules.

No.4: The Swiss Sustainable Solutions company produces custom laminates on 6mm glass with a power rating of around 135 W using bought-in cells. A 20-year warranty for 80% power is given. Also, special laminates on thick glass are manufactured. MegaSlate – a new roof integration system, is being developed.

Thin-film manufacturers

No.1: VHF Technologies produces thin-film amorphous cells on plastic foil (polyimide) substrate. Initial applications are in small electronics applications and various products are commercially available. A pilot line for larger foil-modules was in operation in 2002, production figures are confidential. Forecast production capacity by 2008: 40MW.

Module Prices during the period 1992 – 2002

We are not able to quote many figures for prices during this period, the 3S company quotes CHF 7.50 per watt for their laminates on the basis of 20 kW projects. For Star Unity’s tiles a figure of CHF 20-30 / W is quoted. For the thin-film modules, no price information is available.

3.2 Manufacturers and suppliers of other components

Table 5 Price of inverters for grid-connected PV applications.

Size of Inverter	<1 KVA	1-10 KVA	10-100 KVA	>100 KVA
Average Price per kVA (NC)	1,200	930	780	-

As a result of the reduced impetus in the Swiss PV market, one of the pioneer Swiss companies in the inverter business has decided to stop the development and production of inverters.

Another area in which Switzerland is continuing to be active is the area of manufacturing equipment for the world-wide PV industry, such as wire-sawing machines, connector systems and measuring equipment.

One of these companies, HCT Shaping Systems, is involved in an EU-project called RE-SI-CLE, which is developing new processes for the extraction of raw silicon from silicon wastes, thus addressing an important problem in the resource-management of crystalline silicon.

3.3 System prices

Table 6: Prices of typical applications

Category/Size	Typical applications and brief details	Price per W in CHF
OFF-GRID Up to 1 kW	Roof-mounted, chalets, leisure activities, road building-sites (emergency telephones)	20.00 – 35.00
OFF-GRID >1 kW	Roof-mounted, holiday homes, remote homes	20.00 – 30.00
ON-GRID Specific case	3 kW roof-mounted system, single-family home	10.00 – 13.00
ON-GRID Up to 10 kW	Small modular plant (AC-Modules) roof-mounted, private owner	9.00 - 12.00
ON-GRID >10 kW	Commercial and P+D plant around 50 – 100 kW mostly flat-roof mounted, also on noise-abatement structures	8.00 – 10.50

Prices exclude sales tax. The figures are estimated on the basis of data provided by engineering offices and consultants involved in the building of PV installations.

Table 6a: National trends in system prices for on-grid standard installations (Prices in CHF / W for 10 - 20 kW flat roof and 3 to 4 kW residential systems)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
10-20 kW	13.00	13.00	12.50	11.80	11.00	10.40	10.20	10.10	9.90	9.40	9.20
3-4 kW	13.40	13.30	13.20	12.80	12.60	12.30	12.30	11.90	12.50	12.20	11.00

3-4 kW residential systems
After a rise in prices in 2000, caused by tighter conditions on the market for buyers resulting from increased promotional measures in Switzerland's neighbouring countries, the average price for 3 – 4kW residential systems has dropped once more in 2002 as production capacities word-wide were augmented.

Home System Kits
Small PV units are available in several varieties that can be easily set up by the “man on the street”. These units can be plugged into a normal power socket and require no installation work. The units with a ratings between 100 – 200 W comprise one or two standard PV

modules, a built-in inverter with a connecting cable and a simple mounting system. Off-the-shelf end-consumer prices (incl. VAT) range from CHF 13.30 to 13.80 /W

3.4 Labour places

No exact figures are available for the number of persons employed in the PV area. The following figures are an estimate based on installed power, imports and budgets for research and development in 2002.

Category	R&D	Cell / Module Manufacturing	Planning / Installation	Manuf. facility suppliers	Total
Labour places	around 140	around 20	around 130	around 200	around 490

3.5 Business Value

The total end financial value of PV plant installed is estimated at around CHF 21 Million. This is estimated on the basis of PV power installed in 2002 and average turn-key prices.

As practically all cells and the greater part of PV modules in Switzerland are imported, the added value figure is probably more interesting: This amounts to around CHF 10 million.

4 Framework for deployment (Non-technical factors)

4.1 New initiatives

With the current national energy legislation, the responsibility for funding promotion activities in the PV area lies with the Swiss Cantons. The activities therefore occur at a regional level: for 2002 no new promotional programmes for PV are to be noted at this level.

In the area of “green electricity” marketing, Swiss labelling institutions and utilities are active in the international area. The RECS (Renewable Energy Certificate System) allows certified producers to sell their ecological added value - not to be confused with the actual electrical power – to utilities and consumers in the form of certificates for the production of a certain amount of “green” power.

In the quality assurance area, labelling schemes for solar and other “green” sources of electricity were continually being promoted in 2002. These labels, such as “Naturemade Basic®”, for example, can be used by electricity companies to designate certified power generated from renewable sources such as existing hydro schemes. A more stringent label, “Naturemade Star®”, is applied to electricity generated from new renewables, such as photovoltaics, small hydro, biomass etc.

In 2002 a futher European Conference on Green Power Marketing was held in St. Moritz.

4.2 Indirect policy issues

Legislature on the liberalisation of the electricity market, the Electricity Market Law, was refused in public voting in 2002. The market liberalisation hoped for that was to open up niche markets for the direct sale of “green” electricity to customers cannot be implemented and on-grid PV electricity generated at low tension (400V) will not be freed from energy transport costs.

4.3 Standards and codes

The projects “European PV Training Accreditation and Certification” and “Quality is the key to the PV market” continued with aim of increasing the quality of PV installations. Also, Switzerland chairs the IEC working group on standards in TC 82.

4 Highlights and prospects

In comparison other countries, the general conditions for the promotion of PV power systems in Switzerland are poor. No broad national PV promotion programme exists at the moment. The promotion of the wide use of PV systems applications is therefore based on private initiative and marketing campaigns and is becoming a question of how good “green” electricity can be marketed. Green power markets (solar stock exchanges) have allowed the Swiss PV market to continue growing, even if the level of previous years has not been reached. How long such marketing can support PV growth is uncertain, as saturation effects in this niche market become noticeable.

After new liberalisation legislation for the electricity market was turned down in 2002 in public voting, possibilities for supporting the production of power from renewable resources have reached an all-time low. The possible introduction - in or after 2005 - of levies on the CO2-production of non-renewable energy sources could help internalise some of the indirect costs of these energy carriers and thus provide the basis for fairer competition for PV in the energy market.

The general interest in PV as a key future technology was demonstrated by the National PV Conference in Lugano in May 2002, when a record number of around 200 persons took the opportunity to keep in contact with the newest developments in the PV area and help promote the use of PV Systems in Switzerland.

On the positive side, it is anticipated that industrial interests and investments in the area of the manufacture of solar cells and modules will continue to increase and thus allow R&D findings to be increasingly transferred to industrial products and applications. Other PV approaches such as thermo-PV projects that combine heat-generation and photovoltaics offer promising prospects for the future. Here, too, industry is showing interest in this new combination of technologies.

In the area of public-oriented PV power plant, a further football stadium is to be fitted with a roof-mounted installation. As a result of lobbying by environmental organisations, the new Swiss National Stadium to be built in Berne is to be equipped with around 5300 m2 of PV modules with a total rated power of 600 kW. The installation is to be built and operated by the regional utility, which will also provide energy management services for the whole of the stadium complex.

Annex A Method and accuracy of data (NSR only)

The Data on PV Installations and plant presented in this report have been collected from federal institutions, manufacturers and their professional associations, engineering and consultancy offices and private and institutional initiators of building projects. Much data is taken from the draft annual reports of the Swiss Federal Office of Energy.

The Figures presented in this national report come from various sources and exhibit various degrees of accuracy. Key figures such as installed power are correct to about +/- 5%. Data concerning national R+D funding are exact. The figure for regional funding of market-oriented activities and subsidies is the sum on data from somewhat more than four fifths of Swiss Cantons. With the shift of responsibility for promotional funding towards the Cantons and even individual municipalities the collection of data has become more difficult. The accuracy of our data in this category is therefore questionable and should be taken as a rough guide with an accuracy of +/- 20%.

Price and market figures are based on information provided by manufacturers, and we can therefore not quote any percentages on the accuracy of these data.

As for our own estimates, we have quoted any base data sources and stated any assumptions made directly in the text of the report.