Semi-transparent PV modules in JM's building at Sickla udde, Hammarby Sjöstad. Photo by Lars Hansson

National Survey Report of PV Power Applications in Sweden 2002

Prepared for the
IEA - PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

International Energy Agency
CO-OPERATIVE PROGRAMME ON
PHOTOVOLTAIC POWER SYSTEMS

Task 1
Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Sweden 2002

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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 research projects (tasks) is the responsibility of Operating Agents. Eight tasks have been established, and currently five are active. Information about these tasks can be found on the public website www.iea-pvps.org. A new task concerning urban-scale deployment of PV systems is being developed. 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.

ii Introduction

The purpose of the National Survey Report of PV Power Applications in Sweden 2002 is that information about the general status of PV power systems in Sweden is to be collected and disseminated. The information that is gathered concerns the PV industry, research, the installed capacity of PV systems and major demonstration programmes. Apart from this there are sections on new initiatives and initiatives in non-IEA countries.

The information in this report is mainly directed towards the Swedish PV community but another important application for the information is the compiling of data from all the IEA-PVPS countries. The National Survey Reports are the basis for the report called "Trends in photovoltaic applications– survey report of selected IEA countries", which covers the status of the PV power systems development in the IEA-PVPS countries.

iii Definitions, symbols and abbreviations

PV power system market The market for all nationally installed (terrestrial) PV applications with a peak PV power capacity 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 °C, AM 1,5 solar spectrum.

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 Wp 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 centralized PV power system Power production system performing the function of a centralized power station.

Turnkey price Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are 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 in a remote area are excluded).

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

1.1 Installed PV-power

The PV power installed during 2002 in Sweden amounted to 265 kW, which is a slight increase compared to the past few years. This means, however, that the trend for the cumulative installed power still is best described as a linear increase. The exponential increase that can be observed when analysing the installed power in all the IEA countries is not present in Sweden. This is probably due to the lack of government subsidies and long term PV goals.

1.2 Costs & prices

The cost of a PV system in Sweden has been more or less unchanged for the past few years, and 2002 saw no drastic changes either. However, one retailer has cut their selling price by circa 10 %.

1.3 PV production

There are two active PV module manufacturers in Sweden. The largest one, Gällivare PhotoVoltaic AB, expanded its production capacity during the year, securing its position as the leading producer in Sweden. In 2002 the company reached a production volume of 6 MW, while their maximum capacity amounted to 15 MW. GPV has plans for expansion through the use of an automated assembly line, which will be launched in 2003.

The second module manufacturer, ArcticSolar AB, which started production in 2001 has also expanded its production since the start and in 2002 the total production was 3 MW. For both GPV and ArcticSolar, most of the production is exported. More than 90 % of GPV's modules are exported, while in ArcticSolar's case all of the production is sold abroad.

There was a third module producer in Sweden, but in 2002 the company, called SunPeak AB, was liquidated. SunPeak AB started its module production in 2001, and was located in Porjus in the north of Sweden.

1.4 Budgets for PV

The research on PV in Sweden is dominated by the Ångström Solar Center, which is working with thin film Cu(In,Ga)Se_2 (CIGS) cells and dye-sensitised (Grätzel) cells. These two research teams have a total budget of 16 MSEK/year, and are funded by the Foundation for Strategic Environmental Research and the Swedish Energy Agency.

Another research initiative in the PV field is the Solel 00-02 programme, which is funded by a number of organizations, including government agencies and business representatives. The programme is controlled by the energy companies' collaborative organization for research, Elforsk AB.

There is a national programme for ecological sustainability (Local Investment Programme, LIP) that is distributing 1,6 GSEK to different projects that

Table 1: The cumulative installed power in four sub-markets

	Year										
Sub-market/ application	1992 kW	1993 kW	1994 kW	1995 kW	1996 kW	1997 kW	1998 kW	1999 kW	2000 kW	2001 kW	2002 kW
Off-grid domestic	590	760	1020	1285	1452	1640	1823	2012	2216	2376	2595
Off-grid non-domestic	205	265	293	304	364	394	433	448	465	507	544
Grid-connected distributed	5	15	24	31	33	93	114	124	124	149	158
Grid-connected centralized	-	-	-	-	-	-	-	-	-	-	-
Total	800	1040	1337	1620	1849	2127	2370	2584	2805	3032	3297

promotes ecological sustainability during the period 1998 – 2002. It is, however, difficult to discern how much of these subsidies that has gone into the PV-sector.

In 2002 the programme PV-NORD started, with the objective to demonstrate building integrated PV in five countries in northern Europe.

2 The implementation of PV systems

2.1 Applications for photovoltaics

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 necessary installation and control components.

The most significant use of photovoltaics in Sweden can be found in the off-grid domestic sector, where most systems contain one or two modules and are used to power remote cabins, campers and caravans. Most systems that are used in the marine sector, which also is a significant PV market sector, are smaller than 40 W module power and thus not included in the PV power system market figure presented here.

Lately more large-scale systems have been installed, mostly as demonstration programmes for future possibilities of building integration. The housing project Hammarby Sjöstad, which is being built on old industrial grounds in South Stockholm has a “green profile”, and several of the individual building projects incorporate grid-connected PV.

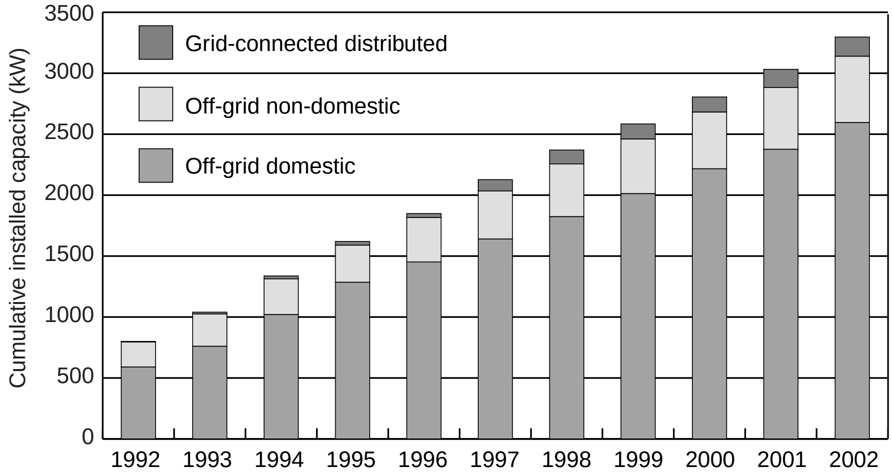

Figure 1: The cumulative installed capacity in sub markets and in total

2.2 Total photovoltaic power installed

During the year 2002 the total amount of PV power installed was 265 kW, broken down into the four principal categories according to Table 1. This signifies a slight increase in the total installed power for 2002 compared to the years 2001 and 2000. The cumulative installed power now amounts to circa 3,3 MW and most of that is represented by off-grid domestic systems. The market share of the off-grid domestic systems was 83 % during 2002, which is an increase from the year before.

Apart from the general trend, that the power installed each year is roughly constant (between 200 and 300 kW), it is difficult to discern any trends as to whether the grid-connected systems increase their share or not. This is because the grid-connected systems can all be categorized as R,D&D projects and one single project may significantly influence the total figure.

2.3 Major projects, demonstrations and field test programmes

During the year 2002 four major PV demonstration programmes were taken into use. Two of them are part of the Hammarby Sjöstad housing area in South Stockholm. One of them, the largest installation in Sweden during the year, is a residential building at Sickla udde, and the other one is installed in the Hammarby Sjöstad environment information centre, GlashusEtt. The third project is installed at the Stockholm Central Station, and the fourth is situated in Visby, at the Almedalen Library.

Centralstationen

The PV system that has been installed at the Stockholm Central Station consists of previously used modules, which earlier were mounted on the roof of a shopping centre in South Stockholm. The system comprises modules with an output power of 2,6 kW and has been designed to power diode lighting inside the main station hall.

Sickla udde

This project is the largest one of the four that were started during 2002, with a PV-array power of 11,4 kW, divided between two residential houses with 5,7 kW each. The modules are integrated into a semi-transparent roof with a total area of 71 m^2, and is the first example of building integrated PV in Sweden where the solar cells have been an integral part of the design from the start. The area Hammarby Sjöstad is meant to have a special "green profile", and more PV is to be installed in the coming years at this site.

GlashusEtt

As Sickla udde, described above, this project is a part of the Hammarby Sjöstad building area. The solar cells, with an effect of 3 kW, are being used to produce hydrogen from water with the aim to use the hydrogen together with biogas to power a fuel cell. The building is an environmental information centre, where the techniques that are being used in Hammarby Sjöstad in order to achieve the environmental goals are exhibited.

Almedalen library

This project was originally started in late 2001, but due to problems with the inverters the launch was postponed to February 2002. The system contains modules yielding a total of 5 kW and is mounted on a moveable solar shade. The electricity from the array is used to power the pumps of a heating/cooling system that exploits the sea water. The project was funded by the municipality of Visby and the University of Gotland, in an attempt to display the integration of PV into the architecturally sensitive environment of the medieval city of Visby.

The PV-NORD programme

On 1 January 2002, the programme PV-NORD was launched. This programme is co-financed by the European Commission and local government agencies, with the aim to promote building integrated PV projects in five countries in northern Europe (Sweden, Norway, Finland, Denmark and The Netherlands). In Sweden two buildings in Hammarby Sjöstad are being built with integrated PV, but the systems have not been taken into use during 2002.

Future projects

The major projects that have been planned for the foreseeable future include a number of installations of building integrated PV in Hammarby Sjöstad, where the construction company NCC and the housing company Familjebostäder are building residential houses. The two NCC houses at Sickla Kaj will incorporate PV in the balcony-screens and in semi-transparent windows. This project is one of the two contained in the Swedish part of PV-NORD.

In the Familjebostäder case, the PV installations will take the form of solar screening and a roof-top installation. Here there will be one PV-equipped house right next to a reference house, which is similar but without the PV. This is, as in the NCC case above, included in the PV-NORD programme.

A third residential house is being built, which incorporates the use of solar energy in the form of combined solar thermal collectors and PV. The three projects described here have been awarded in total 12 MSEK from the Local Investment Program in Stockholm in a competition to build the most environmentally friendly buildings.

There is also a major demonstration programme being planned in the city of Visby, which is called USHER (Urban Integrated Solar to Hydrogen Energy Realisation Project). In this project 2500 m^2 of CdTe thin-film cells will be installed, giving an output power of circa 200 kW. The power will be used for electrolysis of water to hydrogen, which is then to be used in fuel cell driven town buses. The project is funded by the municipality of Visby together with the European Commission and the Swedish Energy Agency.

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

	Centralstationen
Project and start-up year	Centralstationen (Stockholm), 2002
Technical data	2,6 kW, sc-Si
Objectives	To demonstrate roof integration
Accomplishments and problems	The energy is used to power diode lighting
Funding and management	Fortum teknik & miljö
	Sickla udde
Project and start-up year	JM in Hammarby Sjöstad, 2002
Technical data	11,4 kW, mc-Si (Grid-connected)
Objectives	To gain experiences in building with PV
Accomplishments and problems	- Early integration of PV in the building project - Problems with the inverters postponed the launch
Funding and management	JM and Fortum teknik & miljö AB

Table 2 (continued)

	GlashusEtt
Project and start-up year	GlashusEtt in Hammarby Sjöstad, 2002
Technical data	3 kW
Objectives	To inform about new energy technology
Accomplishments and problems	-
Funding and management	Stockholm Vatten and Fortum AB
	Almedalen Library
Project and start-up year	Almedalen Library (Gotland) Solar screening, 2002
Technical data	5 kW, mc-Si
Objectives	- To increase knowledge about PV as a building component - PV in sensible environment
Accomplishments and problems	Works fine
Funding and management	Technical authority, building department (Visby)
	Harmonihuset
Project and start-up year	Harmonihuset (Malmö – Bo01) Solar shading, 2001
Technical data	8 kW, mc-Si (semi-transparent)
Objectives	A first experience in installing and maintaining a PV system
Accomplishments and problems	-
Funding and management	Sydkraft
	Universeum
Project and start-up year	Universeum Göteborg (roof), 2001
Technical data	4,3 kW, a-Si
Objectives	To promote sustainable electricity generation
Accomplishments and problems	-
Funding and management	Universeum (owned by a foundation with many different partners)
	Carl Bro
Project and start-up year	Carl Bros kontorshus (façade), 2001
Technical data	2,3 kW, mc-Si
Objectives	To show the technology in-house
Accomplishments and problems	Ownership related problems
Funding and management	Sydkraft

Table 2 (continued)

	Bergsjö skola
Project and start-up year	Bergsjö skola (school), 2001
Technical data	1 kW, mc-Si
Objectives	Pilot school in the "Nordic PV School Program"
Accomplishments and problems	-
Funding and management	-
	Kullaviksskolan
Project and start-up year	Kullaviksskolan (school), 2001
Technical data	1 kW, mc-Si
Objectives	Educational Purpose
Accomplishments and problems	-
Funding and management	Funded by the school and Naps Sweden
	Lars Kaggskolan
Project and start-up year	Lars Kaggskolan (school), 2001
Technical data	3 kW, mc-Si
Objectives	Educational purpose
Accomplishments and problems	-
Funding and management	-
	Nordens ark
Project and start-up year	Nordens ark (roof), 1999
Technical data	- 10 kW, mc-Si - Grid connected - Net metering
Objectives	- Demo system - Publicity for Vattenfall AB
Accomplishments and problems	There has been problems with the grid connection due to the use of power intensive equipment. These problems are thought to have been solved.
Funding and management	Vattenfall AB
	Naturhistoriska Museet
Project and start-up year	Naturhistoriska Museet Göteborg (roof), 1998
Technical data	- 1,8 kW, sc-Si
Objectives	- To demonstrate renewable energy technology
Accomplishments and problems	-
Funding and management	Naturhistoriska Museet and Göteborg Energi AB

Table 2 (continued)

	Göteborg Energi AB
Project and start-up year	Göteborg Energi AB façade, 1998
Technical data	- 6,8 kW, a-Si - 180 m^2 - Grid connected
Objectives	- To demonstrate façade grid-connected system
Accomplishments and problems	- Works well - For safety reasons an extra protective glass was added - Low maintenance has been demonstrated
Funding and management	Göteborg energi AB & Fortum Advanced Energy Systems Sweden AB
	Kristianstad Österängen
Project and start-up year	Residential houses in Kristianstad, 1998
Technical data	- 11,8 kW, mc-Si - Grid connected
Objectives	- To monitor parameters on both AC & DC sides, plus ambient and solar cell temperatures
Accomplishments and problems	- New "hook on" method for fast installation and replacement
Funding and management	Kristianstadsbyggen AB
	IKEA
Project and start-up year	Roof & façade system in Älmhult, 1997
Technical data	- 60 kW, sc-Si & a-Si - Grid-connected
Objectives	- To demonstrate a large scale grid-connected system - To monitor energy production an reliability
Accomplishments and problems	- Close to optimal performance of the sc-Si roof system - Spread in the a-Si module performance and lower voltages than specified
Funding and management	IKEA
	Härnösand Länsmuseum
Project and start-up year	Härnösand Länsmuseum (façade), 1994
Technical data	4 kW, sc-Si (grid-connected)
Objectives	First Swedish façade system
Accomplishments and problems	- Local opposition to cutting down shadowing trees - Inverter problems have been solved after three years, and the system works well
Funding and management	Landstingsfastigheter, Härnösand

Table 2 (continued)

	Borlänge högskola
Project and start-up year	Dalarna University (Roof), 1994
Technical data	1,8 kW, sc-Si (grid-connected)
Objectives	Educational purposes
Accomplishments and problems	System efficiency has been lower than expected, which is thought to depend on the maximum power point tracker.
Funding and management	Dalarna University
	Bullerö
Project and start-up year	The island of Bullerö, 1988
Technical data	- 1,45 kW - Stand-alone - 48 V/751 Ah NiCd batteries - Adjustable tilt angle
Objectives	- To demonstrate stand-alone PV systems - To provide electricity for residential buildings
Accomplishments and problems	- Earlier battery problems seem to have been solved
Funding and management	The user
	Huvudsta
Project and start-up year	Huvudsta in Solna (roof), 1984
Technical data	2,1 kW, mc-Si (grid-connected)
Objectives	- To demonstrate PV in buildings - To gain experience with installation and operation of grid-connection of PV
Accomplishments and problems	- Reliable operation for 18 years - Stable module performance with low maintenance - Long sequence of collected data - New inverters increased performance substantially
Funding and management	Riksbyggen

2.4 Highlights of R&D

The most extensive research programme that performs research on photovoltaics is the Ångström Solar Center (ÅSC) at Uppsala University. This programme incorporates research on thin film Cu(In,Ga)Se_2 (CIGS) solar cells and dye-sensitised (Grätzel) cells. There is a third part of the programme that performs research on energy efficient window materials, which allows the transparency of the glazing to be adjusted according to different needs.

The now ongoing activities are part of the second phase of the ÅSC programme, ranging from 2001 through 2004, and it is a continuation of the first phase of ÅSC but with more focus on industrial production. The CIGS group has the current world record of efficiency for a thin-film mini-module, at 16,6 %, but normally these 5 cm × 5 cm modules exhibit efficiencies of 14-15 %. Currently a spin-off company is under developement, which will start up-scaling the CIGS film deposition process.

The group that work with the more recently discovered Grätzel cells (also called nanostructured solar cells) have routinely achieved efficiencies of about 5 % using a press technique that will allow very cost efficient production. The low production costs can facilitate large scale PV production that will counterbalance the relatively poor efficiency of the cells.

Some research concerning whole systems is taking place at the energy company Vattenfall AB, where the focus is directed towards combined systems of solar cells and solar thermal collectors, and the integration of these techniques in systems with other energy generating components.

Other research and development activities include those carried out within the demonstration programmes that have been launched and are planned for the future. The construction companies, together with the utility companies, have examined methods for installation of PV in buildings as well as different ways of metering when the system is grid-connected. At the University of Lund research has been carried out on building integrated PV. These projects are all contained in a programme called Solel 00-02, which is led by the energy companies' cooperative R&D company, Elforsk AB. It is funded by STD (Previously AI-företagen), Formas, the Swedish energy companies through Elforsk AB, the Swedish Energy Agency, Fortum, SBUF and White Arkitekter.

2.5 Public budgets for market stimulation, demonstration/fields test programmes and R&D

The largest part of the public funds for PV goes to the cell research at Ångström Solar Center, Uppsala University. The annual budget for the two PV research groups included there is 16 MSEK. The research at Uppsala university also receives funds from the European Union within the project PROCIS. Furthermore, the budget of the Solel 00-02 programme amounted to 3,3 MSEK in 2002.

There were also public funds distributed to demonstration programmes in 2002, in total circa 2 MSEK. Of these, 1,35 MSEK were awarded to the PV-NORD programme and 0,6 MSEK were awarded to the Sickla Udde project in Hammarby Sjöstad. The funds for PV-NORD were national (from the Swedish Energy Agency) and from the European Commission, while the funds for the Sickla Udde project were part of the prize money in a competition held by the Local Investment Programme in Stockholm.

The USHER project in Visby has also recieved public funding, both nationally and from the European Commission, but the project is excluded here because it has not lead to any installed PV system yet.

Table 3: Public budgets for R&D, demonstration/field test programmes and market incentives

	R & D [MSEK]	Demo/field test [MSEK]	Market [MSEK]
National	19,3	0,62	-
Regional		0,60	-
E.U.	1,30	0,73	-
Total	20,60	1,95	-

3 Industry and growth

3.1 Production of photovoltaic cells and modules

There are two operative manufacturers of PV modules in Sweden, and both are situated in Gällivare in the northern part of Sweden. There was a third company, Sun Peak AB, that started its production in 2001, but went out of business during 2002.

The oldest and largest module manufacturer is called GPV (Gällivare Photo-Voltaic AB) and is now fully a subsidiary of the German company SolarWorld AG. In 2002 SolarWorld bought the remaining 3,7 % of the company, and owns today 100 % of the shares. GPV employs 30 people working with solar cells.

GPV buys cells (mc-Si) and manufactures modules. During the year 2002, GPV expanded its production capacity to 15 MW per year, and the production during 2002 amounted to 6 MW. The modules exhibit efficiencies of about 12 to 13 %, and more than 90 % of the production is exported. The expansion during 2002 has been acheived in parallell with the building of a new production line with computer controlled assembly machines. The production at GPV is conducted in accordance with ISO 9001:2000 standard.

The second module manufacturer in Sweden is ArcitcSolar AB where the German company Alfasolar and the Finnish company NAPS are the major owners. The production started in 2001, and during 2002 there has been an expansion, which led to a maximum production capacity of 6 MW. All of the modules produced at ArcticSolar, in total 3 MW, were exported.

The numbers for maximum production capacity and yearly production during 2002 for the PV module manufacturers are given in Table 4. These figures do not include PV modules with an output power of less than 40 W.

Table 4: Production and production capacity information for the year for each manufacturer

		Total production (MW)		Maximum capacity (MW)	
Manufacturer	Technology	Cell	Module	Cell	Module
GPV	mc-Si	-	6	-	15
ArcticSolar	mc-Si	-	3	-	6
Total		-	9	-	21

Table 5: Turnkey Prices of Typical Applications

Category/range	Typical application	SEK/W
Off-grid (≤1 kW)	Recreational/professional applications, 75 W	165(100*)
Off-grid (>1 kW)	-	-
Grid-connected specific case	1-3 kW roof-mounted system	65*
Grid-connected (≤10 kW)		- -
Grid-connected (≥10 kW)		- -

* Installation not included

3.2 Manufacturers and suppliers of other components

There are no manufacturers in Sweden that produce PV specific systems equipment, such as inverters, storage batteries, supporting structures or DC switchgear.

3.3 System prices

Most of the PV systems that are installed in Sweden each year are small stand-alone systems for recreational use. These normally include modules, battery, fuses etc. The prices given in Table 5 do not include VAT.

The prices of PV systems in Sweden have been approximately constant over the past few years, with a slight decrease during 2002. With the current prices, and a system lifetime of 20 years, the average price per kWh in normal Swedish insolation conditions would be approximatiely 5 SEK, which is substantially higher than the average price of electricity from the grid.

3.4 Labour places

In total, there are approximately 90 – 100 people working with PV related activities in Sweden. Of these, 55 work in the manufacturing industry, 25 in research and development and some 10 – 20 in the systems related sector. The systems sector includes installation and energy companies, retailers and consultants.

4 Framework for deployment (Non-technical factors)

4.1 New initiatives

There are no general promotion initiatives for PV power production, such as a feed-in tariff or an investment subsidy. For other renewables, such as small scale hydro and wind power, there are subsidies that the public can apply for, however, these subsidies are going to be cut back when the new electricity certificate system is launched (see section 4.2.1). There has been an investment program called LIP (Local Investment Program) that supports sustainable development. This program has partly funded some PV systems in Hammarby Sjöstad.

There are examples of local subsidies given to the PV industry for investments that generate employment opportunities in rural areas. These examples include a major investment subsidy for GPV's capacity expansion and process automation.

4.1.1 Utility and public perception of PV

The Swedish utility companies seem to have, in general, a positive attitude towards photovoltaics, but so far their contact with the subject is mainly through different demonstration and education projects. They have actively taken part in the building of a number of solar cell systems that are meant to be facilities for further exploration of the techniques involved (e.g. installation, metering, power conditioning). Most of these activities are collected within a national collaborative program managed by the utility companies' joint R&D company Elforsk AB.

Apart from the aim to create know-how on building with PV, the programme also covers the international trends and developments concerning PV systems in general, information and education, evaluation of PV applications and activities focused on reducing PV system costs.

The general perception of PV among the Swedish public appears to be positive, as is the case with most environmentally friendly technologies. However, a common belief is that photovoltaics is not for Sweden, since we have too little sun, and since it is in the winter that we have the greatest need for power.

4.2 Indirect policy issues

4.2.1 Electricity certificates

The deployment of an initiative for increased renewable energy production from 2002 to 2010 will be started during 2003. During this period the aim of the project is to increase the production of renewable electric energy by 10 TWh. This corresponds to circa 6 % of the total electric energy production in Sweden today and it will increase the speed of expansion by a factor four.

The initiative is based on a market perspective, and the government subsidies for renewables will subsequently be cut back. An energy producer that produces 1 MWh of renewable electric energy will receive a certificate, and the energy companies and the consumers will be forced to buy a number of these certificates corresponding to the amount of energy used. This is aimed at stimulating energy production from wind, wave, hydro (new and older small scale constructions), geothermic energy, biofuels and PV. Although PV power producers are included among the beneficiaries in this scheme, there is no specific target for PV deployment. This highlights the risk that the certificate programme might not lead to more PV.

4.2.2 Taxes

There are a number of taxes levied on the amount of environmentally hazardous material released, which could potentially promote the use of renewable energy sources. Even though the taxation levels have risen quite substantially during the past few years, they are still too low to make an impact on the PV market in Sweden. The carbon dioxide tax was, at the end of 2002, 0,63 SEK/kg released gas. This is, however, to increase further in 2003. The sulphur tax is presently at 30 SEK/kg released gas for coal and peat, and 27 SEK per cubic meter and per mille sulphur in oil.

4.2.3 National policies and programmes to promote the use of PV in foreign non-IEA countries

The Swedish International Development Cooperation Agency, SIDA, is currently funding a program for rural electrification in Zambia, where a very large part of the population is without supply of electricity. The costs for an extension of the grid are very high, which means that local supply of electricity is crucial in order to increase the electrification. PV systems can solve this problem, but the initial costs are to many people staggering even though the overall costs are lower than for comparable solutions, such as kerosene lamps and batteries. The concept of the project is to support so called ESCOs (Energy Service Companies) that install and maintain the PV systems, which are mounted on their clients houses. The clients then pay a monthly fee for the use of the system.

A total of 400 systems have been installed, and so far the clients have in general paid their fees according to the agreements and there has been no problems with theft or vandalism. The continued interest for the systems is high, with 200-300 applicants on the waiting list. The problems that have been encountered include battery management problems, the shortage of trained installation personnel and the shortage of low-voltage appliances.

4.3 Standards and codes

In the PV systems that have been installed in Sweden, the general regulations for electric power installations are followed as far as possible. If the system voltage of the PV generator is higher that 120 V DC a fence is required around the modules. The Swedish regulations allow the DC part of the system to be ungrounded if the system voltage is lower than 250 V. Electricity delivered to the grid has to follow the European standard EN 50.006 (Swedish standard SS 421 18 11).

Concerning the regulation for connecting small electric power production units to the grid there is a report called AMP (Swedish name: Anslutning av mindre produktionsanläggningar till elnätet) from Svensk Energi (the Swedish utility and service companies' cooperative organization). In this report the regulations that apply when a PV system is connected to the Swedish distribution network can be found. The system must be disconnected during power loss in order to avoid islanding. An application to the local electricity distributor must be made before the power producing system is connected.

4.4 Building permit

As long as the PV system installed is for domestic use only there is no need for a building permit. The opposite is true for larger systems, where there have been some examples of denied applications for aesthetic reasons.

5 Highlights and prospects

The solar cell industry in Sweden has been growing during the past few years, and the growth will continue in 2003, e.g. with the inauguration of the automated assembly line at GPV. In the slightly longer perspective, it is difficult to make predictions about the industry growth, as it is very much dependent on the demand from markets in other countries. The most important market is Germany.

There are no general subsidies for PV, or long term installation targets, but some public funds are being awarded demonstration programmes. In the near future a number of grid-connected systems will be installed in Hammarby Sjöstad, which can improve the public and utility awareness of PV.

The technological developments in the PV field in Sweden are mainly in the area of thin-film and nanostructured solar cells, where the thin-film technology is approaching a commercial stage in the development chain.

Although there are no long term targets specifically for PV, there are ambitious targets for renewables in general. These targets are supposed to be fulfilled through the use of an electricity certificate market, where the power consumers are forced to buy electricity certificates from the producers of renewable energy, who receive these certificates proportionally to their production. The system is designed to give an increase by a factor four in the expansion of renewables production. This scheme might boost the interest for PV, but it is also likely that hydro and wind power will benefit more from it.

Annex

A Methods and accuracy of data

Most of the data has been collected through written enquiries, but also through direct communication with the providers of information (manufacturers, retailers etc.). Some information has also been extracted from the Internet and from printed matter.

In Table 1, the accuracy of the data is much dependent on the accuracy of the figure for 1992, which is somewhat uncertain. The accuracy here is deemed to be circa ±10%, which is also the accuracy of the cumulative installed power to date. This means that the absolute error is probably in the order of ±30 kW. The figures for the grid-connected systems is more accurate, since there were basically no grid-connected systems in use in 1992. The accuracy of this figure is roughly ±5%.

In Table 3 there were some problems discerning what public funds had gone into PV projects but the estimated accuracy of the budget figures are better than ±15%.

For the figures in Table 4, the accuracy of the production and maximum capacity is better than ±10%. The accuracy of the prices in Table 5 is circa ±20%.