

# National Survey Report of PV power applications in Sweden 2010

# IEA PVPS



An off grid-system with a module from Eco Supplies AB at Dundret, Gällivare in northern Sweden.  
Courtesy of Eco Supplies AB

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**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  
2010**

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## Definitions, Symbols and Abbreviations

### List of abbreviations

PV	Photovoltaic
BIPV	Building integrated PV
CIGS	Cu(In,Ga)Se <sub>2</sub>
FiT	Feed in tariff
SEK	Swedish Krona
VAT	Value added tax
Wp	Watt peak
R&D	Research and development
EU	The European Union
CD	Compact Disc
DSC	Dye-Sensitized solar cell
DSO	Distribution system operator

For the purposes of this and all IEA PVPS National Survey Reports, the following definitions apply:

PV power system market: The market for all nationally installed (terrestrial) PV applications with a 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<sup>2</sup>, cell junction temperature of 25°C, AM 1,5 solar spectrum – (also see ‘Rated power’).

Rated power: Amount of power produced by a PV module or array under STC, written as W<sub>p</sub>.

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: A company producing solar cell modules. In the case of silicon technology, starting from solar cell wafers, which are assembled into arrays, encapsulated and finished.

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as ‘stand-alone PV power system’. Can also provide power to domestic and community users (plus some other applications) via a ‘mini-grid’, often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural 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 to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer’s premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc.

They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

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 system 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, electricity utility businesses etc.

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.

Currency: The currency unit used throughout this report is SEK (Swedish krona).

PV support measures:

Enhanced feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh somewhat higher than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price

PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies (usually characterized by a broad, least-cost approach favouring hydro, wind and biomass)
PV requirement in RPS	a mandated requirement that a portion of the RPS be met by PV electricity supplies (often called a set-aside)
Investment funds for PV	share offerings in private PV investment funds plus other schemes that focus on wealth creation and business success using PV as a vehicle to achieve these ends
Income tax credits	allows some or all expenses associated with PV installation to be deducted from taxable income streams
Net metering	in effect the system owner receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and netted over the billing period
Net billing	the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity fed into the grid is valued at a given price
Commercial bank activities	includes activities such as preferential home mortgage terms for houses including PV systems and preferential green loans for the installation of PV systems
Activities of electricity utility businesses	includes 'green power' schemes allowing customers to purchase green electricity, operation of large-scale (utility-scale) PV plants, various PV ownership and financing options with select customers and PV electricity power purchase models
Sustainable building requirements	includes requirements on new building developments (residential and commercial) and also in some cases on properties for sale, where the PV may be included as one option for reducing the building's energy foot print or may be specifically mandated as an inclusion in the building development



## 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 22 participating countries are Australia (AUS), Austria (AUT), Canada (CAN), China (CHN), Denmark (DNK), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MYS), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission, the European Photovoltaic Industry Association, the US Solar Electric Power Association and the US Solar Energy Industries Association are also members.

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, 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 website [www.iea-pvps.org](http://www.iea-pvps.org)

## Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of photovoltaic power systems. An important deliverable of Task 1 is the annual Trends in photovoltaic applications report. In parallel, National Survey Reports are produced annually by each Task 1 participant. This document is the Swedish National Survey Report for the year 2010. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

The PVPS website [www.iea-pvps.org](http://www.iea-pvps.org) also plays an important role in disseminating information arising from the programme, including national information.

## **1 EXECUTIVE SUMMARY**

### **1.1 Installed PV power**

The total PV power installed in Sweden in 2010 increased significantly compared to previous years and a total of approximately 2700 kW<sub>p</sub> was installed. The off-grid market grew slightly, from 340 kW<sub>p</sub> in 2009 to 580 kW<sub>p</sub> in 2010, due to lower module prices and a growing interest in PV. The large increase of installed systems occurred within the submarket of grid-connected systems. Around 2100 kW<sub>p</sub> was installed in 2010 which is four times more than what was installed in 2009. The explanation for this large increase is that funds from the direct capital subsidy that started in mid 2009 begun to reach the system installers and several projects that were initiated in 2009 were put into operation in 2010. Another positive factor for grid-connected installations was the elimination of the grid tariff for small PV systems that became statutory in April 2010.

### **1.2 Costs and prices**

The increased demand and high installation rate in 2010, due to the subsidy, enabled module retailers and system installers to import larger shipments and make the installation process more efficient. This along with falling prices on the world market for modules and system components caused prices in Sweden to decrease a great deal and are now closer to the prices in some of the bigger markets in Europe. A single module did typically cost 27 SEK/W<sub>p</sub> in 2010 compared to 50 SEK/W<sub>p</sub> in 2009 and the cost for a larger grid-connected system was reduced from 47 SEK/W<sub>p</sub> in 2009 to 35 SEK/W<sub>p</sub> in 2010.

### **1.3 PV Production**

In 2010 there were five major silicon module producers which almost exclusively exported all their modules. The demand on the world market grew in 2010 which enabled the production of modules in Sweden to grow slightly, from 173 MW<sub>p</sub> in 2009 to 180.8 MW<sub>p</sub> in 2010. The overall production capacity also increased. However, in 2010 it became apparent that the world trend that more and more PV companies move their production to Asian countries also applies to Sweden when the biggest producer in Sweden, REC ScanModule AB, at the end of 2010 closed down their production in Sweden and moved to a new factory in Singapore.

### **1.4 Budgets for PV**

The total public budget for PV applications was approximately 123.5 million SEK in 2010. Of this, 61 million SEK belongs to the direct capital subsidy, which was 39 million less than in 2009. Almost all of the rest went to research and development which is almost the same amount that was granted to the area in 2009.

## 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.

For the purposes of this report, PV installations are included in the 2010 statistics if the PV modules were installed between 1 January and 31 December 2010, although commissioning may have taken place at a later date.

### 2.1 Applications for photovoltaics

Historically, the Swedish PV market has almost only consisted of a small but stable off-grid market where systems for recreational cottages have constituted the majority. This domestic off-grid market is still stable and is growing slightly.

Since the introduction of the first subsidy in 2005 the grid-connected PV capacity in Sweden has been growing rapidly. The first subsidy was directed only to public buildings which had the consequence that a number of larger grid-connected distributed systems were installed. The second subsidy, which was launched in mid 2009 and will continue until the end of 2011, is however open for all. This together with a legislative amendment introduced in 2010 which makes it cheaper to connect small systems to the grid has resulted in that more small private PV systems now are being connected to the grid.

### 2.2 Total photovoltaic power installed

PV power installed in Sweden increased significantly in 2010. It was especially the number of grid-connected systems that increased due to the active capital subsidy and a change in rules regarding grid charges. Although the installation rate increased in 2010, the Swedish PV market is still very small and represents only a tiny fraction of the total electricity production.

#### 2.2.1 *Methods and accuracy of data*

Almost all of the gathered data used in this report comes directly from company representatives. It is usually not a problem to acquire data from the industry and for this report none of the contacted companies has refused to submit data. So the figures regarding installed PV power and the total module production do not contain any estimation done by the author. However, the quality of the data acquired from different companies varies. Most companies provided very accurate data while a few only provided good estimations. The accuracy of the data for module production and the annual installed power may therefore vary by  $\pm 5\%$ .

The figures for the cumulative installed capacity in Sweden are much more uncertain. It is impossible to know how many of all off-grid systems that are still in use and are producing electricity. The figures of the cumulative installed off-grid PV capacity should therefore more be seen as figures over the total off-grid PV power installed over the years rather than the total off-grid PV capacity in place and running today. The situation for grid-connected system is slightly better, and a number of systems that has been reported to been taken out of operation has been withdrawn from the figures.

Sub-market/ application	off-grid domestic	off-grid non- domestic	grid-connected distributed	grid-connected centralized	Total
PV power installed in 2010 (kW <sub>p</sub> )	501	76	1878	232	2687

Table 1: PV power installed during calendar year 2010 in 4 sub-markets.

### 2.2.2 The Off-grid market

The market for off-grid system in Sweden has for many years been small but stable and in the last ten years around 250-300 kW<sub>p</sub> has been installed per year. Off-grid systems are not entitled funds from the direct capital subsidy that started in 2009 and the installation rate has therefore not been affected by the introduction of this scheme. However, in 2010 approximately 577 kW<sub>p</sub> was installed which is 239 kW<sub>p</sub> more than what was installed in 2009. The reasons are probably lower module and system prices and a growing interest for PV in Sweden.

Cumulative installed capacity as at 31 December					
Year	Off-grid domestic (kW <sub>p</sub> )	Off-grid non- domestic (kW <sub>p</sub> )	Grid- connected distributed (kW <sub>p</sub> )	Grid- connected centralized (kW <sub>p</sub> )	Total (kW <sub>p</sub> )
1992	590	205	5	-	800
1993	760	265	15	-	1040
1994	1020	293	24	-	1337
1995	1285	304	31	-	1620
1996	1452	364	33	-	1849
1997	1640	394	93	-	2127
1998	1823	433	114	-	2370
1999	2012	448	124	-	2584
2000	2216	465	124	-	2805
2001	2376	507	149	-	3032
2002	2595	544	158	-	3297
2003	2814	573	194	-	3581
2004	3070	602	194	-	3866
2005	3350	633	254	-	4237
2006	3630	665	555	-	4850
2007	3878	688	1676	-	6242
2008	4130	701	3079	-	7910
2009	4448	721	3535	60	8764
2010	4949	797	5395	292	11433

Table 2: The cumulative installed PV power in 4 sub-markets.

### 2.2.3 The grid-connected market

The grid-connected PV market in Sweden has historically been very small but the number of installed systems has in the second half of the decade increased significantly. The reason is that capital subsidies have been available for installation of grid-connected PV systems since 2005. The first subsidy with a total budget of 150 million SEK was introduced in 2005 and continued until 2008. This subsidy was available only to installations on public buildings. The second subsidy which started in mid 2009 and is planned to continue until the end of 2011, with a total budget of 210 million SEK, is however open for all. The two subsidies have enabled the installation rate of grid-connected systems to speed up. A notable decrease in the installation rate occurred in the gap between the two subsidies, which reveal how dependent on support schemes the grid-connected market in Sweden is. In addition to the support subsidy the grid connection rules were changed in 2010 to the benefit of those who want to connect smaller systems to the grid. One no longer needs to pay the fee charged by the distribution system operators (DSO's) to connect a small PV system to the grid. Moreover, it is now statutory that the DSO's should pay for the necessary electricity meter. Previously the producer had to rent the meter at a high cost. The new rules together with the support subsidy and lower system prices have enabled a large number of grid-connected systems to be installed in 2010. Approximately 2110 kW<sub>p</sub> was installed, a record for Sweden and four times more than what was installed in 2009. The grid-connected PV capacity was at the end of 2010 for the first time larger than the off-grid capacity. Most grid-connected systems are still distributed systems but some more centralized systems were installed in 2010.

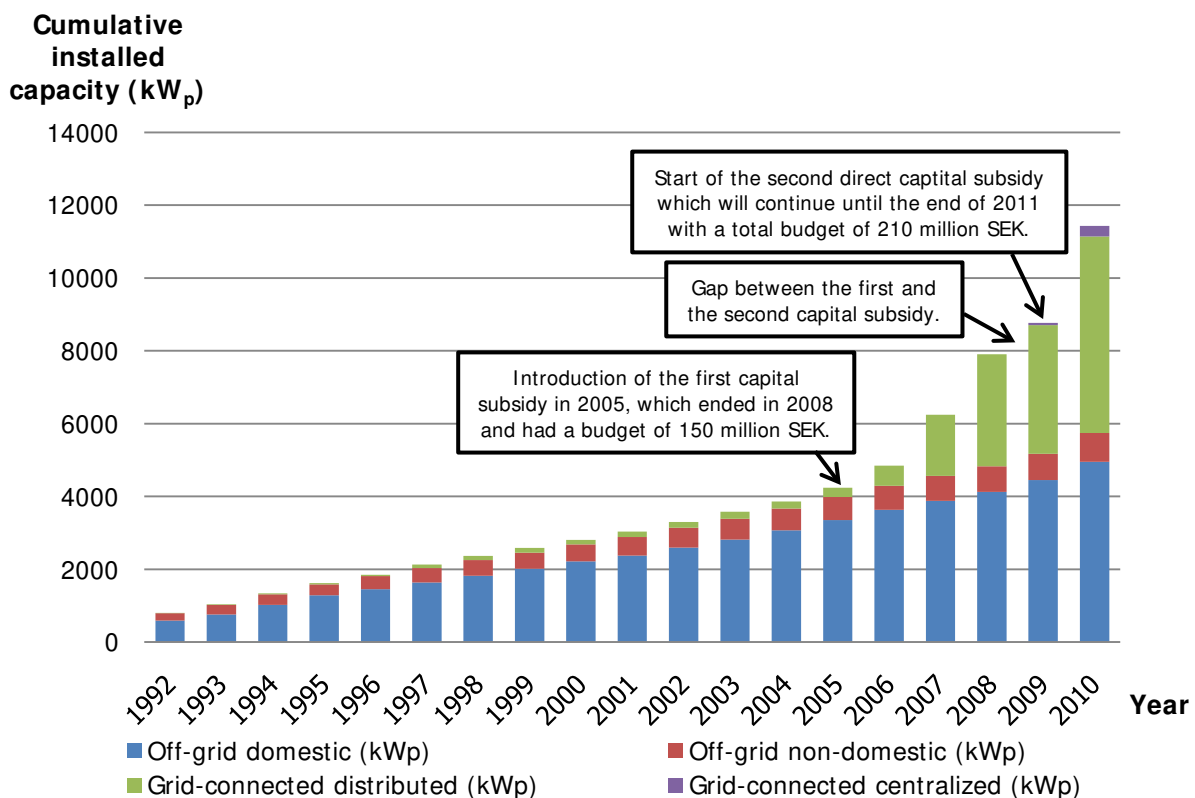


Figure 1: The cumulative installed PV power trends.

Total national PV capacity as a % of total national electricity generation capacity.	New PV capacity as a % of new electricity generation capacity in 2010.	Total PV electricity production as a % of total electricity consumption in 2010.
0.03 %	0.39 %	0.006 %

Table 3: PV power and the broader national energy market

## 2.3 PV implementation highlights, major projects, demonstration and field test programmes

### 2.3.1 *The ongoing investment subsidy*

From the first of July 2009 a direct capital subsidy has been active in Sweden which will continue until 31<sup>st</sup> of December 2011. The subsidy is valid for all types of grid-connected PV-systems and cover 60% (55% for big companies) of installation cost, including both material and labor costs. The subsidy has an upper limit in cost at 2 million SEK per photovoltaic system and a maximum of 75 000 SEK plus VAT per installed kW<sub>p</sub>. In 2009 100 million SEK were granted to different system applications and in 2010 58.5 million SEK. The budget for 2011 is 58.5 million SEK. The form of the subsidy has in some ways been criticized because it often takes a long time from when a project has been allocated funds until the money is paid. At the end of 2010 33.3 million SEK had been dispersed out of the 142.7 million that had been granted in both 2009 and 2010. The long waiting time, sometimes up to one year, is the reason why an increased installation rate in grid-connected systems can be seen first in 2010 and not in 2009 when the subsidy started.

There is some apprehension over what will happen to PV installation rates in Sweden when the subsidy ends after 2011. A proposal for introduction of monthly net-billing has been proposed from the PV industry and is now being considered at the Ministry of Enterprise, Energy and Communications (Näringsdepartementet).

### 2.3.2 *New grid charges legislation*

Electricity producer are obligated to pay a grid tariff, administrated by the DSO's, to be allowed to deliver electricity to the grid. However, since the first of April 2010 exceptions are made for small producers of electricity. An electricity subscriber who has a fuse subscription at a maximum of 63 ampere and are producing electricity with a maximum effect of 43.5 kW<sub>p</sub> will no longer need to pay the grid tariff to enter the grid. This applies however, only if the electricity subscriber during one calendar year draws more electricity from the grid than the subscriber enters. The DSO's are now also obliged to cover the cost of the meter that registers all excess electricity that is entered into the grid and to pay a compensation for the reduced losses in the grid, which are around 0.05 SEK/kWh. Until the first of April, 2010, the holders of small PV systems needed to pay those grid tariffs to be able to connect to the grid. The DSO's previously set a pretty high fee for the tariffs which lead to that PV systems were dimensioned to never give any excess electricity and that some small producers did not care to measure the excess electricity fed into to the grid and therefore was not paid for it.



Figure 2: The second of the two systems that are covered by the FiT agreement in Sala-Heby. The system has a capacity of 78 kW. (Courtesy Solel i Sala & Heby ekonomiska förening and Hans Nyhlén)

### **2.3.3 Interesting projects and regions**

#### **Sala and Heby municipalities**

In 2009 the first FiT agreement in Sweden was established between the local power utility company Sala-Heby Energi AB and a small PV community. The power utility company has agreed to buy all the electricity that the PV community produces for ten years to come to a price of 3.71 SEK/kWh, compared to the average system spot price of 0.5 SEK/kWh. In the beginning of 2010 a second system was installed and the community now has a total production capacity of 125 kWp. Each of the 170 members in the community has bought at least one share for a price of 10 000 SEK. The initial profits for the community will be spent on increasing the production capacity but after five years part of the profit will be distributed to members according to number of shares. The community is slowly expanding with more members from all over the country and is planning for a third system that will be installed in 2011.

#### **The region of Skåne**

Skåne hosts several large-scale solar installations. Malmö, the region capital, is one of the most solar dense cities in Sweden with a wide range of both solar heating systems and PV systems. Malmö also hosts Europe's first installed solar-powered Stirling engine. A Stirling engine generates electricity using heat, in this case heat from the sun, which is concentrated onto the engine by a large parabolic mirror. The system generates approximately 15 MWh/year.

Solar Region Skåne is a network and knowledge center for solar energy activity in the Skåne province. The aim of the association is to in a neutral and objective way disseminate knowledge and information about solar technologies, thus increasing the interest and skills of various stakeholders in the solar industry and among the public. The association organizes training courses, seminars, exhibitions, field trips, theme days, conferences and briefings, and is working with counselling.



## 2.4 Highlights of R&D

### Solel 08-11

Solel 08-11 is a national R&D program for PV systems that is financed by the Swedish Energy Agency (Energimyndigheten), utilities, the real estate industry and companies with an interest in photovoltaic applications. The program has been running in various stages for over 15 years and an extensive network has been built around the program. The program has become an important platform for dialogue between the building and property sector, the government, industry, utilities and solar energy companies.

In 2010 several projects with focus on building integrated PV (BIPV) was allocated funds from the program along with projects about grid connection and standardisation issues and projects about collection and dissemination of information.

### Thin-film solar cells

Comprehensive research in  $\text{Cu(In,Ga)Se}_2$  (CIGS) thin film solar cells are being carried out by the Ångström Solar Center at Uppsala University. The objectives of the group are to achieve high performing cells and simultaneous utilizing processes and materials that minimize the production cost and the impact on the environment. The Ångström Solar Center is in close collaboration with the old spin-off company Solibro Research AB but is also doing projects together with other Swedish companies.

### Energy & Building Design

At University of Lund the division of Energy & Building Design is studying energy-efficient buildings and how to integrate PV and solar thermal into those buildings.

### Polymer and Organic Solar Cells

An ongoing collaboration between Linköping University, Chalmers University of Technology and Lunds University, under the name Center of Organic Electronics, carries out research on organic and polymer solar cells. The group mainly focuses on development of new polymers with improved absorption and formation of charge ability, alternative component structures of stable inexpensive and simple devices and alternative component structures for optical switching.

### Dye-sensitized solar cells

Research on dye-sensitized solar cells in Sweden is carried out from a platform called Center of Molecular Devices which is a collaboration between Uppsala University, the Royal Institute of Technology (KTH) in Stockholm and the industrial research institute Swerea IVF in Mölndal. The objectives for the center are to increase understanding of fundamental processes, material properties, device testing and up-scaling. The scientific highlight during 2010 was the discovery and development of a new effective electrolyte based on cobalt.

#### 2.4.1 Industrial research

##### Midsummer AB

Midsummer AB's business concept is to sell small compact and cheap production systems for CIGS-solar cells. The company gets inspiration from the CD-industry and the absorber layer in the solar cells is manufactured by sputtering instead of the conventional evaporation process. In 2010 Midsummer AB launched its turn-key production line for CIGS solar cell manufacturing. The first system was sold to a Chinese customer. Midsummer is also ramping up its own production line in its facilities in Järfälla, north of Stockholm.

##### M2 Engineering AB

The former optical disc and recently CIGS thin film solar cell company M2 Engineering went bankrupt in the second half of 2010.



Figure 3: On the roof of the hospital in Härnösand stand solar panels that generate both power and heat simultaneously. (Courtesy Absolicon and Joakim Byström)

#### **Solibro Research AB**

The CIGS thin film solar cell company Solibro are since 2009 fully owned by the German company Q-cells. The two production factories are located in Germany, but the process development remains in a pilot factory in Uppsala Sweden under the name Solibro Research AB. Solibro started as a spin-off company from Uppsala University and there is still a close collaboration, which also has increased during 2010, between the company and the university. Solibro Research AB slightly increased their number of employees during 2010.

#### **Absolicon Solar Concentrator AB**

A section within PV, which has become something of a Swedish specialty, is combined low-concentrating PV and solar thermal power generation. Absolicon is one of the leading companies within this field and has managed to realise their research and technology development into a commercial product. In 2010 the company increased their production capacity and sold and installed systems with a total electrical power of 40 kWp and thermal power of 160 kWp, both in Sweden and abroad. The development of their commercial product X10 also continued with extensive tests at the Technical Research Institute of Sweden (SP) and ENEA in Italy.

#### **Solarus AB**

Solarus is a solar energy company with three different solar panel product lines: one thermal, one combined PV and solar thermal product line and one PV only. Their systems use modules that in part receive direct sunlight and in part receive focused light from a reflective trough mounted underneath the module. The heat generated by the PV module from the sunlight is collected by water pipes and/or solar cells on the backside and on top of the modules. An advantage of using both concentrated and non-concentrated sunlight is that the system performs better under diffuse light conditions. In 2010, the company started its commercial production and thus took another important development step.

### **Global Sun Engineering**

Another Swedish company that has developed a technique for low concentrating combined PV and solar thermal power generation is Global Sun Engineering. Their product use parabolic mirrors forming a disc that focus the sunlight on solar panels made up of solar cells and heat exchangers that generate heat by circulating water that absorbs heat radiation from the sun. The system has a tracking function which allows it to follow the sun. Global Sun Engineering is planning to launch their commercial unit in the second quarter of 2012.

### **NLAB Solar**

Dye-Sensitized solar cells (DSC) have the potential to achieve a low cost per Watt, but have so far lacked conversion efficiency on an industrial scale. The company NLAB Solar has addressed this problem and has demonstrated two solutions that improve the efficiency of the dye-sensitized solar cells without losing the possibility of mass production. The planning for the building of a 2 MW capacity DSC pilot line was initiated in the second half of 2010. The year of 2011 is dedicated to installation, testing and integration of individual process steps. Overall test runs will start in the beginning of 2012.

### **Sol Voltaics AB**

The nanotechnology company Sol Voltaics AB idea is to fabricate high efficiency nanowire solar cells for concentrating PV systems. The spin-off company from the Nanometer Structure Consortium of Lund University is using a production method based on guided self-assembly of nanowires in gas phase. Nanowire solar cells have the potential to reach a high efficiency since they are not limited by the same physics as regular planar solar cells and to be cheap since they can be deposited as a thin film on larger surfaces. The company is currently trying to raise funds for a pilot production line.

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

### 2.5.1 Budgets for market stimulation

The budget for the direct capital subsidy program distributed by the Country Administrative board (Länsstyrelsen) was 61 million SEK in 2010. Of these 58.5 million has been granted to different projects while 2.5 million has gone to administrative costs.

### 2.5.2 Budgets for demonstration/field test programmes

A part of the SoIEI 08-11 research program budget was spent on demonstration/field test programmes in 2010. A demonstration installation by Solarus in Moldavia has also been granted public funds from a demo environment program which is aimed to introduce modern, environmentally friendly technology solutions in developing countries.

### 2.5.3 Budgets for PV research

The majority of the Swedish Government's funds to PV research are distributed by the Swedish Energy Agency which is responsible for energy related issues in Sweden. Other organisations that can dispense governmental money to PV related research are The Swedish Research Council (VR), The Swedish Governmental Agency for Innovation Systems (VINNOVA) and The Swedish Foundation for Strategic Research (SSF)

	R & D [SEK]	Demo/ Field test [SEK]	Market incentives [SEK]
National/federal	59.5 million	3 million	61 million
State/regional	-	-	-

Table 4: Public budgets for R&D, demonstration/field test programmes and market incentives.

## **3 INDUSTRY AND GROWTH**

### **3.1 Production of feedstocks, ingots and wafers**

Sweden did not produce any feedstock or wafers in 2010 and there are currently no plans for this kind of production in the future.

### **3.2 Production of photovoltaic cells and modules**

In 2010 there were five module producers in Sweden that mounted imported crystalline silicon solar cells. The overall production slightly increased with 8 MW and the maximum capacity increased with 49 MW from 2009 to 2010. Almost all of the modules were exported to the European market.

Sweden also now hosts a small production of combined low-concentrating PV and solar thermal power generation products. In 2010 two companies, Absolicon Solar Concentrator AB and Solarus AB got their commercial production up and running. The production quantities are still very small but both companies are ramping up and to go from being an explicit R&D company to have a commercial production is an important step in the right direction. Although both companies have started their production they still put much effort into R&D in 2010 and they are described in more detail under that section of the report. Both companies buy their cells from abroad.

#### **3.2.1 Eco Supplies Solar AB**

The company former known as Gällivare Photovoltaic AB was reconstructed in 2010 and got a new owner in form of Eco Supplies Europe AB. In this process the company changed their name into Eco Supplies Solar AB. The module production decreased slightly in 2010 compared to 2009, while the maximum capacity remained unchanged. The solar cells were imported from several different manufacturers, mostly from Germany and Asia, and the completed modules were exported mainly to Germany and Italy.

#### **3.2.2 Arctic Solar AB**

Arctic Solar AB is a module producer focussing on mounting modules using multicrystalline silicon solar cells located in northern Sweden. The company is owned by the Finnish company NAPS and the German company Alfa Solar. Both the production and the capacity increased in 2010. All of the Arctic Solar AB's products are taken by their partners and most modules are sent to installations in Europe.

#### **3.2.3 REC ScanModule AB**

Sweden's largest module producer has until 2010 been REC ScanModule AB, a subsidiary company of the Norwegian company Renewable Energy Corporation (REC). The module production in the top modern module factory in Glava Sweden increased in 2010. However, in September REC decided to close down the factory and move their production to their new factory in Singapore due to the lack of profitability in the Swedish solar module plant. The facilities and most of the equipment in Glava has been sold to a newly formed company called SweModule AB. It is the Swedish company Perfect Holding AB and the Norwegian company Innotech Solar AS that has formed the new company and the plan is to hire around 100 of the former 330 employees of ScanModule AB and produce modules from the restored solar cells that Innotech Solar AS will supply. The planned production will however not be near the quantities that REC ScanModule produced.

### 3.2.4 PV Enterprise Sweden AB

PV Enterprise Sweden AB was in 2010 affected by the increased competition from the up and coming Asian countries and the declining interest for modules produced in Europe. In order to tackle the new conditions, the polycrystalline module manufacturer started a process of renewal, in which the production in Sweden now is more focused on designed and tailored solutions for BIPV while the production of more standardized modules is handled by partners in China. Although the company increased its total production in 2010 with the agreements in China, the production in Sweden decreased due to the new strategy to produce smaller batches with specially designed modules. The maximum production capacity in Sweden remained unchanged.

### 3.2.5 Latitude Solar AB

The polycrystalline silicon module producer Latitude Solar AB continued their expansion during 2010 and increased their production capacity with another 16 MW to 40 MW. The annual production for 2010 also went up compared to 2009. The company buys their cells from the German company Q-Cells and assembles them into modules that are mainly sold to Germany, Italy, France and Belgium.

Module manufacturer	Technology	Total Production (MW <sub>p</sub> )		Maximum production capacity (MW <sub>p</sub> / yr)	
		Cell	Module	Cell	Module
<i>Wafer-based PV manufactures</i>					
<b>Eco Supplies Solar AB</b>	Mono/Poly-Si	-	16	-	50
<b>Arctic Solar AB</b>	Poly-Si	-	10.1	-	30
<b>REC ScanModule AB</b>	Mono/Poly-Si	-	137.5	-	150
<b>PV Enterprise Sweden AB</b>	Poly-Si	-	4	-	20
<b>Latitude</b>	Poly-Si	-	13	-	40
Total		-	<i>180.6</i>	-	<i>290</i>
<i>Low-concentrating combined PV and solar power generation manufactures</i>					
<b>Absolicon Solar Concentrator AB</b>		-	0.04 electrical (0.16 thermal)	-	0.1 electrical
<b>Solarus AB</b>		-	0.2 electrical (0.8 thermal)	-	0.4 electrical
<b>TOTALS</b>		-	<b>180.8</b>	-	<b>290.5</b>

Table 5: Production and production capacity for 2010.

### 3.3 Module prices

The module prices in Sweden followed the world market trend with falling prices in 2010. The typical price per watt for larger order did not change much in 2010 but the price for a single module made a significant drop and was at the end of 2010 almost half of what it was in 2009. The price for a single module in Sweden is now only slightly higher, 10-20 %, than the typical price in some of the larger markets in Europe.

Year	2003	2004	2005	2006	2007	2008	2009	2010
Typical single module prices	70	70	70	65	63	61	50	27
Typical large order prices	26	26	32	30	28,5	25,5	18	20

Table 6: Typical module prices (SEK/W<sub>p</sub>, excl. VAT) for a number of years.

### 3.4 Manufacturers and suppliers of other components

#### ABB

The business of system components in Sweden was in 2010 rather small. The far biggest company in the area was ABB. The international company has a wide range of products for and connected to the PV industry, including solar inverters, components for solar tracking, low voltage components and accessories. ABB also offers some products and solutions for the manufacturing of photovoltaic modules and solar cells, and equipment to the intermediate-and high-voltage grids. Most of the products are being produced in other countries but the production of low voltage components such as contactors, switches and meters are situated in Sweden.

#### Midsummer AB

Midsummer sold in 2010 the company's first CIGS solar cell production system to a Chinese customer and is expecting more orders for production systems in 2011.

### 3.5 System prices

In 2010 prices for both grid-connected and off-grid systems decreased. In Sweden the prices for grid-connected systems are depending on two factors. The global market for modules and balance-of-system components and the demand, which will enable system installer companies to cut their prices. In 2010 the demand for grid-connected systems in Sweden was high due to the direct capital subsidy and at the same time the global prices for systems continued to decrease. This led to a quite big drop in system prices for grid-connected systems.

Category/ Size	Typical applications	Price (SEK/ W <sub>p</sub> )
OFF-GRID Up to 1 kW	Typical roof mounted system for a vacation house	70
OFF-GRID > 1 kW	Typical roof mounted system for a vacation house	60
ON-GRID Specific case	Façade integrated glass modules with special dimensions	95
ON-GRID up to 10 kW	Typical roof mounted system	45
ON-GRID > 10 kW	Typical roof mounted system	35

Table 7: Average turnkey system prices of typical applications.

For many years there has been a small, stable and slowly growing market for small off-grid systems in Sweden. The demand for off-grid systems in Sweden is much less dependent on support measures than the demand for grid-connected systems. That is why the decline in off-grid system prices in 2010 almost entirely can be connected to the drop of prices at the global market, and why the decrease in prices was not as big as for grid-connected systems.

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010
ON-GRID > 10 kW	-	200	-	60	60	60	67	47	35
OFF-GRID Up to 1 kW	165	100	100	100	100	95	90	80	70

Table 8: National trends in system prices (SEK/W<sub>p</sub>, excl. VAT) for small off-grid and big on-grid applications.



### 3.6 Labour places

The number of people with a job related to the Swedish PV industry increased with some 110 persons in 2010 and is now approximately 740 persons. The majority of the people working with PV in Sweden are working at Sweden's five large module producing companies. There are several small R&D companies in Sweden that slowly expand their business and the number of people involved with production and company related research is now 50 more than in 2009. The numbers of employees within this group will most likely decrease in 2011 since REC at the end of 2010 closed their production in Sweden and moved it to Singapore. University and governmental based research is the second largest employment group. This workforce is also slowly growing because of long running research programs that continue to expand. Due to the direct capital subsidy system installation and distributor companies were able expand and more people are now working within this section than previously.

Research and development (not including companies)	75
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	605
Distributors of PV products	10
System and installation companies	40
Electricity utility businesses and government	5
Other	5
<b>Total:</b>	<b>740</b>

Table 9: Estimated PV-related labour places in 2010.

### 3.7 Business value

Even though the number of installations increased in 2010 and the business value of this section increased from 58 to 122 million SEK, the installation market must still be considered to be small. The PV business value in Sweden is therefore dominated by the module production and the estimated business value of this section did not change much in 2010.

Sub-market	Capacity installed in 2010 (kW <sub>p</sub> )	Price (SEK/ W <sub>p</sub> )	Value (million SEK)
Off-grid domestic	501	65	32.6
Off-grid non-domestic	76	65	4.9
Grid-connected distributed	1878	40	75.1
Grid-connected centralized	232	40	9.3
Totals			121.9
Export of PV products			3620
Change in stocks held			n/a
Import of PV products			3077
<b>Value of PV business</b>			<b>665</b>

Table 10: Value of PV business

## 4 FRAMEWORK FOR DEPLOYMENT (NON-TECHNICAL FACTORS)

### 4.1 Direct PV support measures, new initiatives and market stimulation

Since 2009 a direct capital subsidy has been active that will continue until the end of 2011. A total budget of 222 million SEK has been set aside for the subsidy over the three years. The subsidy is valid for all types of grid-connected PV-systems and cover 60% (55% for big companies) of installation, including both material and labor costs. The big increase of grid-connected installations that occurred during 2010 in comparison with 2009 is in direct correlation with this direct capital subsidy.

Sweden also has a unique local FiT program. A local power utility company in the Sala-Heby municipal area has agreed to buy PV power from a small PV power community to a price higher than the normal spot price. For ten years to come Sala Heby Energi AB will buy the community's PV power to a price of 3.71 SEK/kWh.

Both the direct capital subsidy and the local FiT are described in more detail previously in the report.

	On-going measures	Measures that commenced during 2010
Enhanced feed-in tariffs	A small local feed-in tariff	-
Capital subsidies for equipment or total cost	National	-
Green electricity schemes	-	-
PV-specific green electricity schemes	-	-
Renewable portfolio standards (RPS)	National	-
PV requirement in RPS	-	-
Investment funds for PV	-	-
Income tax credits	-	-
Net metering	-	-
Net billing	-	-
Commercial bank activities e.g. green mortgages promoting PV	-	-
Activities of electricity utility businesses	A small local feed-in tariff	-
Sustainable building requirements	-	-

Table 11: PV support measures.

#### **4.1.1 The green electricity certificate system**

In 2003, a tradable green electricity certificate system was introduced in Sweden to increase the use of renewable electricity. The objective is to increase the electricity production from such energy sources by 17 TWh from the 2002 level until 2016. The basic principle of the system is that producers of renewable electricity receive certificates from the government for each MWh produced. Meanwhile, electricity supplier companies are obliged to purchase green certificates representing a share of the electricity they sell, the so-called quota obligations. The sale of certificates gives producers an extra benefit in addition to revenues from electricity sales. The energy sources that are entitled to receive certificates are wind power, some hydro, some biofuels, solar, geothermal, wave and peat in power generation. In 2010, the quota obligation for Electricity supplier companies was 0.179 or 17.9 percent. In 2009 the average cost of electricity certificates for electricity consumers where 0.073 SEK/kWh and the system has approximately generated 9 TWh of renewable electricity so far.

On the first of July in 2010 the government presented a legislative amendment for an evolved electricity certificate system. The electricity certificate system will now continue until the end of 2035 and the new target for the production of renewable electricity is an increase of 25 TWh by 2020 compared with 2002 levels. New quotas will be valid from 2013.

At the end of 2010 it was also decided that Sweden and Norway as from 2012 will have a common electricity certificate market. The ambition of the common system is that 26.4 TWh of new renewable electricity production will be installed between January 1, 2012 and 2020. At the same time the Norwegian Petroleum and Energy Ministry submitted its proposal for the Norwegian electricity certificate act which is basically a copy of the Swedish act.

The electricity certificates can in the present shape give some economical contribution to existing solar installations. However, in June 2009 there were only six plant owners with nine photovoltaic systems that benefited from the possibility of certificates. That represented only 8% of the grid connected systems in Sweden at that time. From the start until 2008, 68.4 million certificates with a value of 14.8 billion SEK has been allocated, but only 183 certificates with a value of 43 000 SEK have been allocated to photovoltaic installations. This indicates that the certificate system of today does not provide any significant financial support for photovoltaic installations in Sweden. There are two reasons why it has been difficult for PV to take advantage of the certificate system. Firstly, it is difficult for small producers to reach a production off 1 MWh of electricity. Second, the meters that register the electricity produced at a building are often placed at the interface between the building and the grid. This means that it is only the excess electricity of a PV system that can generate certificates and the electricity produced and used internally in the building is never included if not the extra cost for an internal meter is paid.



Figure 4: The 767 m<sup>2</sup> big photovoltaic installation on Ekologihuset at Lund University is expected to produce about 70 000 kWh annually and won the award as the photovoltaic installation of the year in 2010. (Courtesy Fojab arkitekter)

### 4.3 Indirect policy issues

The Swedish government has decided on a national policy that Sweden shall reduce its greenhouse gas emissions by 40 percent in the non-trading sector until 2020 and in 2050 Sweden will have no net emissions of greenhouse gases.

#### 4.3.1 Grid-connection legislation

For grid-connected PV systems the DSO's are required to install a meter with associated collection equipment at the electricity producer's entry point. With the entry point referred to the point where the electricity is fed into the national electricity grid. As a general rule, the producer pays for the cost of metering equipment and installation. Small systems that are not able to deliver more than 1 500 kW are however excluded from paying the cost of meters and installation. The producer also needs to pay a grid tariff that is decided by the DSO's. However, new regulations that were set in 2010 make exceptions for small systems. A producer that has a fuse at a maximum of 63 ampere and is producing electricity with a power of maximum 43.5 kW will no longer need to pay for the grid tariff as long as the producer during one calendar year draw more electricity from the national grid than the producer feeds in.

#### 4.3.2 Taxes

In Sweden taxes and fees are charged at both the production of electricity and at the consumption of electricity. Taxes that are associated with production of electricity are property taxes, taxes on fuels, taxes on emissions to the atmosphere and tax on nuclear power. For consumption it is mainly the energy tax on electricity and the related VAT, but there are also charges to fund agencies. In addition, utilities pay the state income tax (28 percent corporate tax on profit before tax) as all other companies do. A new system of certificates was also introduced on the first of May 2003 and replaced the previous schemes for renewable electricity.

The industry paid 0.005 SEK/kWh in energy tax in 2010. For other customers the tax varied between 0.187 SEK/kWh and 0.283 SEK/kWh. Additionally, value added tax is applied on top of the regular tax.

Taxes and fees on the production of electricity was approximately 7.5 billion SEK in 2010. Energy Taxes on the consumption level contributed to approximately 20 billion SEK. Together with VAT receipts, certificates and authority charges fees, adding another 13 billion, the estimated total taxes and fees from the electricity sector reached nearly 40 billion SEK in 2010.

### **4.3.3 Emissions trading**

The EU system for emissions trading began on the first of January 2005. Emissions trading is one of the so-called flexible mechanisms defined in the Kyoto Protocol. The purpose of the trade is to cost-effectively reduce greenhouse gas emissions in the EU. Countries and companies are able to choose between implementing measures to reduce emissions in their own country / company or to buy allowances which generate reductions in emissions elsewhere. This will lead to the least expensive measures being implemented first so that the total cost of meeting the Kyoto Protocol is as low as possible. In Sweden, the carbon dioxide tax has already led to that many of the least expensive measures have been implemented and there are only more expensive measures left.

The first trading period ran from 2005 to 2007. The current trading period runs from 2008-2012, the same as the Kyoto Protocol commitment period. The next trading period will start in 2013 and expire in 2020. For each trading period the total emissions cap in the system is lowered. So far, the emission allowances have been handed out free of charge to operators, but as from 2013, allowances to all electricity production facilities shall be auctioned instead. In the energy sector, all individual plants with a capacity greater than 20 MW<sub>p</sub> or district heating systems, where plants together have a greater effect than 20 MW<sub>p</sub> are covered by the system.

Since the introduction the price per allowances has varied between the initial 7 €/tonne to over 30 €/tonne. The price in 2010 has been around 14 €/tonne and stable. An applicable rule of thumb is that a price of 10 €/tonne results in a spot price of almost 0.08 SEK/kWh at the Nordic electricity retailing market (Nord Pool).

### **4.3.4 International spread of environmental technologies**

The Swedish Agency for Economic and Regional Growth (Tillväxtverket) has on behalf of the Swedish International Development Cooperation Agency (Sida) been running a demo environment program which is aimed to introduce modern, environmentally friendly technology solutions in Sida's collaboration countries. Solarus AB and Midsummer AB were granted funds for projects within this program in 2010.

## **4.4 Interest from electricity utility businesses**

The interest from the electricity utility business in PV is rather low in Sweden. Except for Sala-Heby Energi AB that offers a FiT scheme for a local PV community, no other electricity utility businesses have been offering any support initiatives or been installing PV systems by their own in 2010. It has also been hard for owners of PV systems to get their excess electricity sold. However, one company, Bixia has in 2010 been offering producers to buy their excess electricity at the Nordic electricity retailing market (Nord pool) spot price, which is a little less than half of what electricity costs for an end customer due to taxes.

## **4.5 Standards and codes**

### **4.5.1 Grid connection rules**

A PV production facility connected to an existing electrical installation must meet certain requirements to be safe and not affect other equipment in a detrimental way.

The requirements are stated by the ELSÄK-FS 2000:1 and ELSÄK-FS 2007:1 legislation.

These refer to technical product standards in agree with European directives. A manufacturer of a product to contained in a power generation facility must also CE mark the product for it to be allowed to be used on the market. The National Electrical Safety Boards (Elsäkerhetsverket) regulations also set that a permanent installation of a production facility shall be performed by a qualified electrician.

Connecting a production facility to an existing electrical installation means that the production facility also is connected to the grid. In the electrical legislation, Ellag (1997:857), it is stated that the transfer of electricity must be of good quality. In order to determine what good quality is, European standards and industry practices are used. Regulations which further specify good quality for the transmission of electricity are currently under formulation by the Swedish Energy Agency (Energimyndigheten).

There are furthermore two important PV specific standards that apply for grid-connected PV system. Swedish Standard SS-EN 61727, Solar power plant - Connection to grid and Swedish Standard SS-EN 61173, Solar power plant - instructions to protect against overvoltage. There are also more general electrical guidelines such as the electrical installation standard SS 436 40 00, the connection of low voltage circuits to the grid standard SS 437 01 40 and the National Electrical Safety Board (Elsäkerhetsverket) directions on how electrical installations shall be executed, ELSÄK-FS 2004:1 that should be followed. A summary of all important standards and guidelines for PV system installation and maintenance has been released in a compilation by the SolEI-program.

### **4.5.2 Building permits**

Installation of PV systems on roofs does normally not require building permits, but it can differ between different municipalities. However, if the installation change the external appearance of a building significantly a building permit is required. Some restrictions on roofing materials and roof angles may apply, particular in culture-sensitive environments and buildings.

### **4.5.3 Public procurement act**

For a procurement of a PV system for a public building the stakeholder planning the system must use an open tender system according to the public procurement act. This unfortunately means that the stakeholder cannot ask a supplier for advice or assistance in the proposition making process. In addition, when it comes to public procurement procedures reference projects are often requested from the installers, which makes it harder for new actors to enter the market.

## 5 HIGHLIGHTS AND PROSPECTS

### 5.1 Highlights

The Swedish grid-connected PV market grew significantly in 2010 due to the currently active direct capital subsidy. A total of approximately 2700 kW<sub>p</sub> was installed in 2010. The grid-connected market accounted for 2100 kW<sub>p</sub>, which is four times more than in 2009. The off-grid market also grew slightly.

Another highlight in 2010, which helped to increase the installation of smaller grid-connected systems, was the change in the grid legislation which means that smaller systems no longer need to pay for the grid tariff and the metering equipment.

The module producers had a decent year and the production increased slightly.

A number of the small R&D companies took important steps forward and two companies within the combined PV and solar thermal section now have a small production.

Sweden's first and only local FIT expanded in 2010 when the PV community added a second larger installation to the first one.

### 5.2 Prospects

The interest for PV in Sweden is growing and in a recent survey 80% of the respondents had the opinion that Sweden should put more effort into solar energy.

The installation rate in 2011 is not expected to change much since the subsidy will continue to run all through the year. However, an increase in the installation could happen if the system prices continue to fall and/or if the Swedish government finally decides to introduce net-billing.

The following years will probably see a decrease in module production since REC ScanModule moved their production to Singapore. The trend is also that some of the other Swedish module companies are moving parts of their production to Asian countries.

If Sweden's relatively large number of R&D companies continue to develop, it may be that Sweden in the future will have a PV industry where the traditional silicon module play a smaller role and where some of the more unconventional techniques, such as thin film solar cells, dye-sensitized solar cells and combined PV and solar thermal play a bigger part.



## ANNEX

### Country information

This information is simply to give the reader some background about the national environment in which PV is being deployed. It is not guaranteed to be 100 % accurate nor intended for analysis, and the reader should do their own research if they require more detailed data.

- 1) Typical retail electricity prices in Sweden 2010 were for a department 2.2 SEK/kWh, a house with electricity warming 1.7 SEK/kWh. The industry paid in 2010 between 1.1 and 0.7 SEK/kWh.
- 2) A Swedish household without electric heating consumes an average of 4500 kWh of electricity per year, which in the current situation represents a cost of approximately 5000 SEK.
- 3) The median income for a person over 20 year in the beginning of 2010 was 231 985 SEK/year.
- 4) The typical fixed 3 month mortgage interest rate started in 2010, due to the financial crises, at the low level of 1.5%. The fixed 3 month mortgage interest rate then increased slowly and ended up just above 3 % at the end of the year.
- 5) Electricity is transported from the major power stations to the regional electricity grids (40-130 kV) via the national grid (220 kV and 400 kV). From the regional grids, electricity is transported via local grids (40 kV or less) to electricity consumers. The voltage in the wall sockets in Swedish homes is 230 V.
- 6) The backbone of the electrical grid, the national grid, is owned by the government and managed by Svenska Kraftnät, whereas power utility companies own the regional and local grids. The base price of the electricity is daily set by the Nordic electricity retailing market, Nord Pool. Electricity supplier companies then use this price as basis for their pricing in the competition for customers.  
  
The Swedish market is dominated by three companies; Vattenfall AB, Fortum and E.ON that are all active in all of three sub markets generation, retailing and transmission and therefore have a big influence on the overall electricity market.
- 7) Diesel fuel prices had a fairly stable value of 9.50 SEK/l in 2010.
- 8) The energy production per installed PV power unit in Sweden in 2010 differs for different kind of systems but a fairly standard system yield approximately 900 kWh/kW.