National Survey Report
of PV power applications in Sweden
2009

Courtesy of Per-Oskar Westin

IEA PVPS

Prepared for the IEA PV Power Systems programme
Funded by the Swedish Energy Agency

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
2009

Prepared by Adam Hultqvist
Ångström Solar Center,
Uppsala University
P.O. Box 534, SE-751 21 Uppsala, Sweden

The making of this report was sponsored by the Swedish Energy Agency

May 2010

Contents

List of abbreviations

BIPV	Building integrated PV
BOS	balance-of-system
CD	Compact Disc
CIGS	$Cu(In,Ga)Se_2$
GPV	Gällivare photovoltaic
FiT	Feed in tariff
IEA-PVPS	International Energy Agency Photovoltaic Power System Programme
NSR	National Survey Report
OECD	The Organisation for Economic Co-operation and Development
REC	Renewable Energy Corporation
RPS	Renewable Portfolio Standards
PV	Photovoltaic
PVE	PV Enterpirse
SEK	Swedish Krona
SSF	The Swedish Foundation for Startegic Research
VINNOVA	The Swedish Govermental Agency for Innovation Systems
VR	The Swedsih Research Council

i Foreword

The international Energy Agency (IEA) has been a self supporting part of the Organisation for Economic Co-operation and Development (OECD) since 1974. Primarily the goal of IEA is to act as a framework for cooperation and information dissemination about energy policies between the 21 member countries.

A subgroup, IEA Photovoltaic Power System Programme (IEA-PVPS), within IEA that specifically works with direct conversion of sunlight into electrical energy was formed in 1993. IEA-PVPS primarily acts as a source of information about solar cell activities and experiences within the member countries, a source that can be accessed by both member and non member states.

Currently the members of IEA-PVPS are Australia (AUS), Austria (AUT), Canada (CAN), Denmark (DEN), France (FRA), Germany (DEU), Israel (ISR), Italy (ITA), Japan (JPN), Korea (KOR), Malaysia (MAL), Mexico (MEX), the Netherlands (NLD), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), Turkey (TUR), the United Kingdom (GBR), the United States of America (USA), the European Photovoltaic Industry Association (EPIA), the European Commission and the Solar Electric Power Association (SEPA).

An Executive Committee where all of the participating countries and organizations are represented governs the IEA-PVPS. Projects within the programme are called Tasks and are led by Operating Agents. Information about current and previous Tasks can be found on the IEA-PVPS homepage, www.iea-pvps.org.

ii Introduction

This National Survey Report (NSR) consists of information on the photovoltaic (PV) market, industry, applications, module production, power installation and active guidelines in Sweden during 2009. The statistics and information of this and the other member countries national reports are used to compile the international IEA-PVPS report “Trends in Photovoltaic Applications”. Additional information about the part of the world market that is not contained within the member states is externally acquired or carefully estimated.

This NSR is primarily produced for the Swedish PV research programs, companies, politicians, decision makers and community.

1. Executive summary

1.1 Installed PV power

During the first half of 2009 there was no active PV subsidy in Sweden. This limited the amount of larger PV system installations during this period to a handful of overdue systems from the last subsidy. A new direct subsidy for grid-connected systems similar to the previous one that existed between 2005 and 2008 started July 1st 2009 and will cease at the end of 2011. The new subsidy was turned down from 70 % to 60 % and is now eligible for every type of system and owner compared to only being eligible for building integrated PV (BIPV) on public buildings as before. Despite having an early selection of systems that were awarded with the new subsidy in September, the money and thereby the systems have been delayed by the processing at various governmental instances. Thus the overall installation in Sweden during 2009 was only a mere 854 kW_p, mostly because of the small amount of grid-connected systems, due to the lack or delayed payment of the subsidy. The outlook for 2010 is positive since the systems that were selected and initiated in 2009 will be finished along with the systems that get selected in the 2010 call.

Off-grid systems including both domestic and non-domestic continued to follow the trend of roughly 300 kW_p being installed per year. The installations were predicted to go down because of the recession making the public less willing to spend their savings, but it is possible that it was counteracted by the increased media attention for environmental problems and the lowered module prices.

1.2 Costs and prices

In Sweden the cost of PV system components is strongly related to the world market, since a significant part of the components are imported from Asia or other European countries. However, it is hard to calculate a reliable grid connected system cost per Watt since there were so few systems installed.

1.3 PV production

Sweden hosts five silicon module producers that almost exclusively export all of their modules. Because of this they all experienced a tough start of 2009 because of the global recession and the falling international module prices, but saw improvements towards the end of the year as the international demand increased. In the end despite the ups and downs the production remained almost unchanged from 185 MW_p in 2008 to 173 MW_p 2009. Additionally, some of these companies are not part of a vertically integrated production scheme and they do therefore need to sign agreements or engage in partnerships in order to secure a sufficient solar cell supply. Cell supply was however not a limiting factor for any of the module producers during 2009.

1.4 Budgets for PV

Even though there was no subsidy for the first half of 2009 an amount of 100 MSEK was designated through two calls for the new direct capital subsidy. The main fields of Swedish PV funding outside of the subsidy are demonstration, development and research.

2. The implementation of PV systems

The data and statistics of this report are based on systems that are larger than 40 W_p. Additionally, the costs of control electronics, modules, inverters, batteries and installation are defined to be included in the system price.

2.1 Applications for photovoltaics

Following the strong years of 2007 and 2008 the market growth halted during 2009 due to fewer grid-connected installations, while maintaining a stable off-grid market. The drop in installed grid-connected systems is due to a lack of subsidy and the delayed payments from the new subsidy.

Off-grid applications Sweden has historically had a stable off-grid market and this trend continued for 2009 despite the global recession. This could possibly be explained by the increased media attention for renewable energy and the falling module prices. The domestic off-grid systems are installed in places where there is no grid connection such as boats, cottages and station wagons to provide a sufficient amount of electricity to run lighting, refrigerators, water pumps and other electronics. Additionally, non-domestic off-grid systems are installed on parking meters, road gates, lamp posts and antennas on remote locations or to save power within cities. Approximately 90 % of the off-grid systems are domestic and the remaining 10 % are non-domestic. Generally the off-grid systems are connected to water heaters or batteries to extend their working hours.

Year	Sub market/application				Total [kW_p]
	Off-grid domestic [kW_p]	Off-grid non-domestic [kW_p]	Grid-connected distributed [kW_p]	Grid-connected centralized [kW_p]	
2009	318	20	456	60	854

Table 1: Total photovoltaic power installed during 2009

Grid-connected applications

The first grid-connected systems were installed as research and demonstration projects to expand the knowledge about PV systems and as showcases to generate interest from the public and companies. During the years of 2005 to 2008 the installation rate quickly increased due to the 70 % direct capital subsidy for systems situated on public buildings as sport arenas, train stations, hospitals, schools and government buildings. This subsidy spread the systems to more types of locations and diversified the type of owners, which led to a significant public interest towards the end of 2008. During 2009 it once again became evident that the subsidy is vital for grid-connected installations as hardly any installations were made in the subsidy gap or in the following period when the money of the new subsidy had yet to reach the future system owners. On the other hand the interest for the new subsidy was excellent and since the new subsidy applies for any type of

system it is expected that the installation and the owner types will continue to diversify. Finally, 2009 was the year when the very first grid-connected centralized systems were installed in Sweden.

Figure 1: An example of a grid-connected roof top mounted PV system located at Kungsmadskolan, Växjö
(Courtesy Mats Andersson)

2.2 Total photovoltaic power installed

2.2.1 Methods and accuracy of data

Interviews with stakeholders, fiscal year reports, online price comparison tools, stock market values and questionnaires to stakeholders have been used to gather the data for this report. Most of the time it is not a problem to acquire data from companies, there are however some exceptions where the company has refused or did not reply. Due to the data gathering methods and the estimated values for the missing company data, the installed power and the produced power might vary by ±15 %.

Off-grid markets Since the off-grid systems are not affected by the subsidy the installation rate for these systems have previously been stable. During 2009 however the rate was expected to decrease due to the harsh financial times that generally make the public more reluctant to spend their savings. On the other hand because of the recent attention in media for renewable energy sources and the cost of the modules going down the installations of domestic off-grid systems was 318 kW_p and 20 kW_p for non-domestic systems, which is comparable to recent years.

Grid-connected markets There was only a few grid-connected installations in 2009 totaling a power of 516 kW_p, a decrease compared to the 1403 kW_p of 2008. The decrease is reflecting the half a year with no subsidy and the slow bureaucratic process of delivering the new subsidy. Installed systems during 2009 consist of overdue systems from the last subsidy, early systems of the new subsidy and systems constructed outside of the subsidy.

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

Even though the installations were down during 2009 the year included some positive noteworthy highlights as well.

Year	Sub market/application				
	Off-grid domestic [kW_p]	Off-grid non-domestic [kW_p]	Grid-connected distributed [kW_p]	Grid-connected centralized [kW_p]	Total [kW_p]
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

Table 2: Cumulative installed power

2.3.1 New Investment subsidy for any type of system and estate

Even if there was no active subsidy in the beginning of a new one was already in the making and was presented for the European Commission. The suggested subsidy was approved in spring 2009 with minor revisions and started with the first call for systems July 1st 2009 and will cease at the end of 2011. The new subsidy is of direct capital type and gives a 60 % refund, 55 % for larger companies, or a maximum of 2 MSEK to cover

system components, installation and planning. Additionally, the subsidy now applies to any type of PV system, including combined solar thermal and PV systems on any type of estate as long as it has a building permit. Initially the funds were split among the years to be 50 MSEK in 2009, 60 MSEK in 2010 and 50 MSEK in 2011. However, since the interest was huge at the first call with applications totaling 200 MSEK, the government decided to add an additional 50 MSEK for 2009. It has unfortunately taken a long time to receive the funds from the new subsidy for the selected systems because of various bureaucratic processes on the government side.

The reception of the new subsidy has been mixed. Positive points are that there is a subsidy and for everyone, but there are also complaints that the initial 160 MSEK later adjusted to 210 MSEK is too low compared to the recently generated interest for PV, in comparison the old subsidy had funds of 150 MSEK. Additionally, there are questions as why Sweden does not have a more offensive policy and implement a Feed in Tariff (FiT), why there is no goal set for Swedish PV in terms of production or capacity, what will happen after 2011 and why there is not a more consistent policy so that there are no subsidy gaps and no all of a sudden extra funds to apply for.

Figure 2: A roof top installation through the new investment subsidy at Pennfäktaren in central Stockholm
(Courtesy Glacell)

From the government's investigation on small scale electricity production several proposals for future changes have been made. First of all the previous grid fees and the requirement of hourly metering are proposed to be eliminated if the system has a current rating of les than 63 Ampere and if the installation node is a net consumer of power throughout the year. Additionally, a working metering system is free of charge if the

system requires one. Even if these costs are removed a system that receives the 60 % subsidy will not be able to make a profit within its lifetime. The original proposal therefore included a net billing scheme, since replacing bought electricity is more profitable compared to selling produced electricity to the grid. This part of the proposal was however dropped in the most recent version and has caused some turmoil in the PV community. It remains to be seen what the final decision will be.

2.3.2 Interesting projects, regions and stakeholders

Skåne Solar Region Skåne formerly known as Solar City Malmö recently changed its name to reflect that its activities have spread outside the town of Malmö. Solar Region Skåne was formed 2007 by the local energy agency, the University of Lund and Malmö City and acts as a centre for PV knowledge and as a place to meet other actors in the PV community. Among its activities are PV seminars, counseling, courses, events, exhibitions and study visits. As an example a solar race event was arranged in 2009 in which elementary school pupils had built their own small PV race cars. The organization has also been involved in installing a significant part of Sweden's grid-connected PV and continued to do so in 2009 with a 100kW$_p$ system.

Sala and Heby municipalities Because of a public interest for PV in the Sala-Heby region of Sweden a community was formed to investigate the possibilities of building PV systems. In 2009 the community made an agreement with the local power utility company Sala Heby Energi AB in which the company guaranteed to buy electricity at a higher price compared to the normal spot price from initially two PV systems, thus Sweden's first FiT scheme was formed. The first system of 47 kW$_p$ was built in 2009 without the national direct capital subsidy and the second system will be finished in early 2010. Currently each member of the community owns a share of the systems and they are entitled to a certain part of the profit. The initial profits for the community will be spent on expanding the two systems and in the future additional systems will be constructed. Additionally, the community hopes to spread this local FiT idea to more municipalities in Sweden and in the long run to change the national policies as well.

Other interesting organizations Even if the installation rate was low for grid-connected systems during 2009 there are some major organizations that have previously installed a lot of PV and that are likely to do so in the new subsidy. One of them is Akademiska hus, a governmental company who owns almost all university buildings in Sweden and another is the Swedish church that owns a majority of the churches in the nation. Soluppgång i väst is an organization consisting of several municipalities in south western Sweden that are working with both solar thermal and PV.

Figure 3: Sweden's first FiT system and also Sweden's first grid-connected centralized system, located in Sala (Courtesy Per-Oskar Westin)

2.4 Highlights of R & D

Dye-sensitized solar cells Uppsala University, The Royal University of technology and the institute Swerea IVF has formed a framework for their collaborate research on Dye-sensitized solar cells called Center of Molecular Devices. Their objective is to expand the knowledge about the material properties, the fundamental processes, device testing and up scaling for production.

Energy & Building Design The division of Energy & Building Design at the University of Lund is studying the integration of PV and solar thermal systems into buildings.

Polymer and Organic Solar Cells Collaborative research on organic and polymer solar cells by Linköping University and Chalmers University of Technology is found within the Center of Organic Electronics.

Thin-film solar cells In depth research on Cu(In,Ga)Se_2 (CIGS) solar cells is performed by the Ångström Solar Center at Uppsala University. Some of the work is in corporation with the old spin-off company Solibro Research AB and with M2 engineering a newcomer on the field.

There is also collaboration on CIGS between the Swedish CIGS company Midsummer AB and Chalmers University of Technology. One of their projects addresses the possibilities of recycling of CIGS solar cells.

Figure 4: A thin film PV system installed at the roof top of the public bath Rosenlundsbadet, Jönköping
(Courtesy Glacell)

Systems research The research on systems is divided between Chalmers University of Technology where new technological innovations due to the subsidy are researched and Uppsala University where distribution of PV power to the grid is investigated.

SolEl 08-11 SolEl 08-11 is a research and development program that funds projects as PV education, PV events, seminars, building integrated PV (BIPV), collection and dissemination of information and show case systems.

Several projects concerns system solutions. One project specifically looks on different existing BIPV solutions and their advantages, another on how to setup a system so that it is optimized for the non physical external conditions like subsidies. A third project addresses the challenges of implementing solar cells in the early building plans of new houses.

Collection of system data and experiences is an ongoing project that continued through 2009. The main goal of the project is to create a knowledge database from the installed systems to prevent installation, maintenance and operation mistakes in future systems.

A final project example is to monitor how the new subsidy works out in practice and what effects that it will have on the Swedish market and public interest. The resulting experience along with experience from other countries with different subsidy systems will be used to form a proposition for Swedish post 2011 PV subsidies and policies.

2.4.1 Industrial research

Midsummer AB Wafer based CIGS solar cells are still unconventional compared to the monolithically integrated thin film modules that are on the market today. Midsummer AB has developed a unique process inspired by the Comact Disc (CD) manufacturing that will make their production of wafer based CIGS solar cells very cheap. During 2009 the company received an additional 49 MSEK of funding from the Swedish Energy Agency to build a pilot production line. Their current goal is to start producing cells in 2010.

M2 Engineering AB M2 Engineering AB is a leading developer of production machines for optical storage media and has accumulated great experience of thin film deposition over the years. Recently the company entered the PV market through the development of production machines for CIGS cells and modules. A collaboration with Uppsala University has been initiated on this topic.

Solibro Research AB While Solibro's production is situated in two factories in Germany the process development remains in a pilot factory in Sweden under the name Solibro research AB. In 2009 Q-Cells bought the remaining parts of Solibro Research AB and is now the sole owner of the company. Even though the company is now German there is still fruitful cooperation with Uppsala University where from the company once originated as a spin-off.

Sol voltaics AB Fabrication of nanowire solar cells for concentrating PV systems is the idea behind the company Sol voltaics AB. The company was created as a spin-off from the Nanometer Structure Consortium of Lund University. Nanowire solar cells has the potential to have 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 on regular Si wafers. The idea works so far on a small scale and the company is currently trying to rally funds for pilot production.

NLAB Solar Dye-Sensitized solar cells have the potential to achieve a very 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.

Global Sun Engineering Global Sun engineering a spin-off company from Luleå University of Technology is on the verge of commercializing their low concentrating combined PV and solar thermal systems. Their products use parabolic mirrors forming a disc that focuses light on solar cells which heats up. The excess heat is transferred to circulating water on the backside of the solar cell and led to a heat water tank. To improve the performance of the system a two axis sun tracking function is included in the design.

Solarus Solarus is another company with a combined PV and solar thermal product line that is about to enter the market. Their systems use PV modules that in part receives direct sunlight and in part receives focused light from a reflective through mounted underneath the module. The heat generated by the PV module from the sunlight is collected by water pipes on the backside of the modules. An advantage of using both concentrated and non-concentrated sunlight is that the system performs better under diffuse light conditions.

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

2.5.1 Budgets for PV research

The main PV research funder in Sweden is the Swedish Energy Agency that distributes the majority of the Government's funds to energy related research. The remaining governmental funds are distributed by the three organizations The Swedish Research Council (VR), The Swedish Governmental Agency for Innovation Systems (VINNOVA) and The Swedish Foundation for Strategic Research (SSF) that fund research in general.

2.5.2 Budgets for market stimulation

At the start of 2009 there was no budget for market stimulation due to the lack of a subsidy. As the new subsidy started in July 50 MSEK was assigned for 2009, but before the end of the year an additional 50 MSEK had been added.

2.5.3 Budgets for demonstration/field test programmes

A part of the SolEl 08-11 research programme budget was spent on demonstration/field test pogrammes during 2009.

	R & D [MSEK]	Demo/field test [MSEK]	Market [MSEK]
National	58	1	100
Regional	-	-	-
Total	58	1	100

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

3 Industry and growth

3.1 Production of feedstock and wafers

Sweden did not produce any feedstock or wafers in 2009 and there are currently no plans to start producing these in the future.

3.2 Production of photovoltaic cells and modules

There are five module producers in Sweden that mounts imported crystalline silicon solar cells. Almost all of the produced modules were exported in 2009 since the internal market volume is very small compared to the combined module production capacity of the companies.

During 2009 there was no Swedish solar cell production, although this might change in 2010 when midsummer is expected to start their production of wafer based CIGS solar cells.

Finally Sweden hosts one producer of combined PV and solar thermal systems.

3.2.1 Absolicon AB

Absolicon produces and installs combined solar thermal and PV systems based on a reflective through. Their key product the X 10 focuses low concentrated light on solar cells which heats up water pipes that are placed on the rear side of the solar cells. During 2009 Absolicon received an order and installed a system of 120 m^2 in Spain and some other smaller systems. One of those systems was installed as a show case on the Green Tech Building in Stockholm in 2009. Additionally, the company has been present on PV conferences and seminars and has received awards for being a rapidly growing green tech company with a promising product.

3.2.2 Gällivare Photovoltaic AB

The module production at Gällivare Photovoltaic AB (GPV) decreased slightly in 2009 compared to 2008, while the maximum capacity remained unchanged. Solar cells are imported from Germany and the produced modules are mainly sold to Germany. The remaining part of the modules is sold on the Swedish market where GPV is a key actor. Towards the end of 2009 GPV faced both a financial reconstruction and an increase in module demand.

3.2.3 Arctic Solar AB

Arctic Solar AB is owned by the Finnish company NAPS and the German company Alfa Solar. Even though the cell supply was good during 2009 the production was slightly lower compared to 2008, while the production capacity remained unchanged. Almost all of the modules are exported, but a small part is sold on the Swedish market.

3.2.4 REC ScanModule AB

Sweden's largest module producer is Renewable Energy Corporation's (REC) sub company ScanModule. REC is a major player in the international photovoltaic industry since they incorporate the entire Si solar cell product chain from ingots to modules. 2009 was a tough year for REC because of the financial crisis and the falling prices. The module production at ScanModule was therefore reduced and did not reach the maximum capacity. There are currently no expansions planned for the production in Sweden, but there is a large new plant being ramped up in Singapore that includes wafer, cell and module production. Most of the modules that are produced at ScanModule are exported to either Europe or the US.

3.2.5 PV Enterprise Sweden AB

Since PV Enterprise Sweden AB (PVE) has secured a good cell supply they were able to increase their production in 2009 by 2 MW_p/year while their capacity remained unchanged. The cells are imported from Taiwan, while most of the modules are exported to Europe and the remaining are sold to the Swedish market where PVE is a major player. At the start of 2009 the company endured both the global and an internal economic crisis, but survived and experienced an increase in demand towards the end of the year.

3.2.6 Latitude Solar AB

Latitude Solar formerly known as n67 Solar changed their name during 2009. This has however not affected their good partnership with Q-Cells that currently provides Latitude Solar with polycrystalline cells. Compared to 2008 both the capacity and the production increased in 2009 and both of them are also expected to increase even further during 2010. The finished modules are exported to Europe.

		Total production (MW_p)			Maximum Capacity (MW_p)		
Manufacturer	Technology	Cell	Module	Conc.	Cell	Module	Conc.
GPV	Mono-Si	-	20.7	-	-	47	-
ArcticSolar	Poly-Si	-	7	-	-	14	-
ScanModule	Mono/Poly-Si	-	115	-	-	150	-
PV Enterprise	Poly-Si	-	15	-	-	20	-
Latitude Solar	Poly-Si	-	15	-	-	20	-
Total			173			251	

Table 4: Production and production capacity during 2009 for each manufacturer

3.2.7 General trends

Since most of the modules that are produced in Sweden are exported to the European market, the financial crisis and the falling module prices during 2009 had a strong influence on the Swedish module production. Despite of this module production and

capacity remained almost unchanged from 2008 to 2009, possibly because of the increased international demand towards the end of 2009. The module producers continued to have a good cell supply during 2009 through various partnerships and agreements. As most of the modules are exported the success of the individual companies has a negligible effect on the Swedish installation rate.

3.3 Module prices

Swedish module prices follow the world market prices. However, buying single modules is still pricey compared to other European countries, possibly because the market for single modules is small in Sweden which in turn forces the retailers to import or buy in smaller quantities increasing the cost per module. For larger quantities it is possible to get lower prices that are comparable to other countries, since the deals can be made directly with international or national module producers or indirectly through the installation companies.

	Year						
Module prices	2003	2004	2005	2006	2007	2008	2009
Large orders	26	26	32	30	28,5	25,5	18
Single Modules	70	70	70	65	63	61	50

Table 5: Typical module prices (SEK/W_p, excl. VAT) for a number of years

3.4 Manufacturers and suppliers of other components

There was no manufacturing of system components such as power tracers, inverters, switches or mounting in Sweden 2009. However ABB in Sweden manufactures parts for system components that are assembled elsewhere. Additionally, the combined PV and solar thermal system manufacturing includes to some extent fabrication of mounting structures.

3.5 System prices

In Sweden the cost for grid-connected systems is driven by the national subsidy and for off-grid systems by the retail price.

The global market for modules and balance-of-system (BOS) components dominates the retail prices for off-grid systems in Sweden. Thus as the global economical recession continued in 2009 the prices in Sweden fell in coherence with the global prices.

Since there were so few grid-connected systems installed because of the non-existing or delayed subsidy in 2009 it is hard to get a good estimate of the average system cost per installed Watt peak. It seems however that these systems were affected as well by the drop in module prices in 2009.

Category/range	Typical application	SEK/W_p
Off-grid Up to 1 kW_p	Domestic or professional remote electrification	80
Off-grid (>1 kW_p)	-	n/a
Grid-connected (< 10 kW_p)	Typical roof mounted system	76
Grid-connected (> 10 kW_p)	The largest type of BIPV system in Sweden	47

Table 6: Turnkey prices of typical applications

YEAR	2003	2004	2005	2006	2007	2008	2009
Price [SEK/W_p]	90-110	90-110	90-110	90-110	85-110	55-130	45-120

Table 7: National trends in system prices (SEK/W_p) for off-grid applications (small systems)

3.6 Labor places

The five large module producers employ the majority of Sweden's PV workers at their manufacturing lines, while company related research has increased recently through the creation and expansion of smaller companies. University and governmental based research is the second largest employment group that also slowly expands their workforce because of long running research programs that continues to expand. Labor places related to installations are scarce because of the inconsistent subsidy and the otherwise low installation rate.

Research and development (not including companies)	40
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	550
Distributors of PV products	5
System and installation companies	25
Utilities and government	5
Other	5
Total	630

Table 8: Estimated PV related labor places in 2009

3.7 Business value

Since the installation market is still small in Sweden the business value is dominated by the module production companies. The overall value of 577 MSEK for 2009 is lower than 1102 MSEK for 2008 because of both the reduced installations due to the gap in the subsidy program and due to the falling module prices during 2009 that reduced the profit per produced module.

Sub market	Capacity installed in 2009 [kW_p]	Price [SEK/W_p]	Value [MSEK]
Off-grid domestic	318	80	25
Off-grid non-domestic	20	80	2
Grid-connected	516	60	31
		Totals	58
Export of PV products			3114
Charge in stocks held			n/a
Import of PV products			2595
		Value of PV business	577

Table 9: Value of PV business

4 Framework for deployment (Non technical factors)

4.1 Support measures, new initiatives and market stimulation

As of July 1st 2009 there is a new direct capital subsidy active in Sweden ending a half year long subsidy gap. The new subsidy is valid for any type of PV system, including combined PV and solar thermal systems on any type of estate as long as the installation has a building permit. To reflect the recent increase in interest for PV the refund was turned down from 70 % to 60 % (55 % for larger companies) or to a maximum of 2 MSEK down from 5 MSEK of the total system cost including planning and installation. The funds are split up over a three year period as follows 100 MSEK for 2009, 60 MSEK for 2010 and 50 MSEK for 2011.

Sweden also got its first FiT agreement in 2009, even if it was only local. It is formed between a small PV community in the Sala-Heby municipal area and the local power utility company Sala Heby Energi AB and states that the utility company is obliged to buy PV power from the community's plant at an elevated electricity price for 10 years. Both parts hope for an expansion in the future and that the idea will spread to other municipalities.

	On-going measures	Measures that commenced during 2009
Enhanced feed in tariffs	-	Local (only a few systems)
Direct capital subsidies	-	National (restarted)
Green electricity schemes	-	-
PV specific green electricity schemes	-	-
Renewable portfolio standards (RPS)	National	-
Investment funds for PV	-	-
Tax credits	-	-
Net metering	-	-
Net billing	-	-
Commercial bank activities	-	-
Electricity utility activities	-	-
Sustainable building requirements	-	-

Table 10: PV Support Measures

4.2 Indirect policy issues

4.2.1 Grid-connection legislation

Current laws allows for small roof mounted PV systems to be installed on roof tops, but they do also enforce that hourly metering is required to deliver power to the grid. Since only the local power utility company is allowed to measure the output from the system they charge a significant amount for the service, additionally they also charge a fixed sum for the grid usage. In practice for a 3 kW_p PV system that is submitted to Swedish solar irradiation the fee is as high as 1 SEK/kW_p.

A governmental investigation addressed this problem and suggested that the fees would be dropped for systems with a current that is lower than 63 Ampere and that it was enough to do monthly measurements on these systems. Even with these changes a system that receives the subsidy is barely profitable at the end of its lifetime.

The initial proposal after the government investigation therefore included net billing based on a monthly basis where it was possible for the meter to turn backwards when the system produced power. With net billing it would be possible to achieve system profit since the produced power from the system would be able to cover for the more expensive externally delivered power from the grid. The net billing was unfortunately dropped in the latest proposal by the government, which was not appreciated by the PV community.

4.2.2 Electricity certificates

Sweden's electricity certificates are based on a market incentive scheme and promote the cheapest type of renewable energy. For each produced MWh of renewable energy a certificate is awarded, which the consumers are forced to buy through a part of the electricity price per kWh. To reach the goal of 17 TWh of produced renewable energy in 2016 and to increase the renewable energy production in general the certificate part of the electricity price is increased on a regular basis.

The certificate system does not promote PV systems well, since it requires that the system is fairly large and delivers at least 1 MWh and since the refund calculated per kWh only is 0.2 SEK.

4.2.3 Taxes

Electricity delivered to industry has a tax of 0.005 SEK/kWh while other consumers pay in the range of 0.19 to 0.28 SEK/kWh depending on the volume of consumption. Additionally, value added tax is applied on top of the regular tax.

4.3 Standards and codes

There are no specific guidelines for PV installations in Sweden so the more general electrical guidelines such as the installation standards SS 436 40 00 and ELSÄK-FS 2004:1 need to be followed instead. To simplify the situation the old research program SolEl 03-07 released a compilation of all of the important standards and guidelines for PV system installation and maintenance.

4.3.1 Building permits

General building permits are required for PV systems since they change the appearance of buildings and landscapes. Installation on locations that have architectural, cultural or heritage value can be controversial and it can therefore take a long time to arrive at conclusive decision.

4.3.2 Public procurement act

The stakeholder of a proposed subsidized system is required to use a public tender system in order to decide the system supplier because of the public procurement act. This is problematic since the stakeholder cannot ask a specific supplier for advice when he is working on the in depth details of the system proposition, which in the end results in worse propositions being made.

5 Highlights and prospects

Most of the key events in Sweden during 2009 were related to subsidy politics. As the year started there was no subsidy since the old direct capital subsidy ended 2008. A new similar subsidy started around mid year, but had a slow start due to paperwork and rules. Meanwhile, a small PV community signed a FiT agreement with their local power utility company for the upcoming 10 years.

5.1 Highlights

Because of the gap in the subsidy for grid-connected systems, the overall installation rate dropped from 1.7 MW_p in 2008 to 0.85 MW_p in 2009 generating an 11 % increase in the total cumulative power. Despite of the financial crisis the off-grid installations continued to be around 300 kW_p per year, possibly because of an increased media exposure for renewable energy.

As almost all of the production is exported the Swedish module producers were strongly affected by the ups and downs of the international PV market. In the end the overall module production remained almost unchanged from 185 MW_p in 2008 to 173 MW_p in 2009.

A new direct capital subsidy started July 1st 2009, which grants a refund of 60 % of the total system cost and which has a 210 MSEK budget split over three years. The initial interest for the subsidy was higher than expected and the applications therefore totaled a sum that was several times larger than the budget.

Sweden got its first local FiT as a small PV community in the Sala-Heby municipal signed an agreement with the local power utility company Sala Heby Energi AB to buy electricity produced from the communities power plants at an elevated price compared to the market price for the upcoming ten years.

5.2 Prospects

There is an optimistic outlook for 2010 because of the new subsidy for grid-connected systems that will increase the number of systems and create work for the installers. Even if there have been some initial delays in delivering the subsidy funds for 2009 the systems should be completed or close to completion in the beginning of 2010. The intention is to speed up the process to avoid delays in future calls. Additionally, it will be interesting to follow if the local FiT idea will spread to more areas in the near future.

The final verdict on the connection of small scale power plants and the proposed net billing law that would be very influential for the Swedish PV development is also expected to come in 2010.

Looking further ahead there is already an interest in the PV community to start planning for the years following 2011 when the current subsidy has ended.

While most of the Swedish module production has a good supply of cells either through long term contracts or through a good market supply, they are facing a challenge to both expand and to survive on the global market where the demand is currently high, but where the prices keeps on falling and where the outcome of the cuts in the European FiT is still uncertain.

Annex

Country information

i) For a household with electric heating and an average consumption of 20000 kWh per year the electricity price was 1.40 SEK/kWh including energy taxes, electric energy price, distribution fees, electricity certificates and value added tax, while a household without electric heating and an average consumption of 5000 kWh per year paid 1.60 SEK/kWh.

The industrial electricity price which consists of energy taxes, distribution fees, electrical energy price and certificates is determined by the consumption and is in the range of 0.52 to 1.21 SEK/kWh. Industry prices are thus substantially smaller compared to households and this is mainly due to lower energy taxes and distribution fees.

ii) The average electricity consumption per capita is 16500 kWh in Sweden, because of the electricity demanding industry, the cold climate and the large share of electric heating. As an example the average yearly consumption for a flat is 2000 kWh while the yearly consumption for an electrically heated house is 20000 kWh.

iii) During the first half of 2009 the consumer electricity bill was determined by a prognosis based on the yearly consumption for previous years. However, the law was changed and since July 1st 2009 the consumer pays for the actual consumption during the previous month instead.

Energy taxes, distribution fees, electricity certificates, value added tax and electricity price are the posts of a Swedish electricity bill. Additionally, a post for time of use is added for industry.

iv) A Swedish household has a median income of 249000 SEK/year.

v) Because of the financial crisis at the end of 2008 the interest rate started out at a low level of around 4.1 %, but continued to drop rapidly until it reached a level just below 2 % where it stabilized and only experienced minor fluctuations for the remaining part of 2009.

vi) The back bone of the Swedish electrical grid operates at either 200 or 400 kV depending on the location. Down conversion of the voltage is done regionally to be in the range of 20 to 130 kV and locally to 10 kV. Nominal power in the power outlet for the end users is 230 V at 50 Hz.

vii) Svenska kraftnät owns and manages the back bone of the electrical grid whereas power utility companies own the regional and local grids. Companies compete for customers on the electricity retailing market, Nord Pool, which in theory lowers the electricity price. Although, the system back fires and increases the prices if there is a shortage of electrical power on the market, something that occurred during the cold end of Dec 2009 when for a short time the electricity price 10 folded.

Vattenfall AB, Fortum and E.ON are active in all of the three sub markets generation, retailing and transmission and therefore have a strong influence on Swedish electricity and an advantage compared to their competitors.

viii) During 2009 the price of diesel was fairly stable at a value of 12 SEK/l.

ix) Recent data shows that the energy production per installed power unit is greater than 900 kWh/kW for a typical PV installation in Sweden.