International Energy Agency

Implementing Agreement

on

Photovoltaic Power Systems (IEA-PVPS)

Task 1
Exchange and dissemination of information on PV power systems

National Survey Report of PV Power Applications in Denmark in 2006

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i Foreword

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

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

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

The overall programme is headed by an Executive Committee composed of one representative from each participating country, while the management of individual research projects (tasks) is the responsibility of Operating Agents. Ten tasks have been established and currently six are active. Information about these tasks can be found on the public website www.iea-pvps.org. A new task concerning PV environmental safety and health is now being developed.

ii 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. This report gives information on trends in PV power applications in the PVPS member and other countries and is largely based on the information provided in the National Survey Reports which are produced annually by each Task 1 participant.

The present report is the Danish National Survey Report for 2006.

The public PVPS website also plays an important role in disseminating information arising from the programme, including national information: www.iea-pvps.org.

iii Definitions, Symbols and Abbreviations

For the purposes of the 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^2, cell junction temperature of 25^{o}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.

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

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

Off-grid domestic PV power system: System installed 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 systems in a remote area are excluded).

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

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

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

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.

National currency: Danish crown (DKK)

1 Executive summary

Installed PV power
By the end of year 2006 Denmark (including Greenland) had about 2,9 MW installed, an increase of about 250 kW compared to 2005. The SOL 1000 project originally targeting 1 MW, but finally – following budget reductions – targeting about 600 kW was completed end of 2006, leaving Denmark without any incentives for reducing the capital cost of PV systems. Grid-connected distributed systems constitute at about 90 % the majority of PV systems in Denmark.

Costs & prices
The previous Sol-300 project[1] exhibited turn-key system prices for "roof-tops" of almost 40 DKK/W installed. The just completed SOL 1000 project demonstrated a turn-key system price for "roof-tops" of around 34 DKK/W. However, high demand world wide for PV modules during 2005 and 2006 has lead to limited supply of modules and slightly increasing module prices, and system cost figures for 2006 vary widely due inter alia to the time of contracting. The individual PV systems implemented during 2006 exhibit turn-key system prices in the range of 40 to 90 DKK per W installed.

PV production
During 2006 the producer of float-zone silicon Topsil continued its commercial activities to supply international PV industry with high purity, low-cost silicon. Modules (brand: Sunpower) using this feedstock have been tested at NREL in the USA exhibiting efficiencies > 20 %. In 2006 the inverter developer and manufacturer Powerlynx, a company with strong links to the Danfoss[2] group, also reported ongoing and increasing commercial activities in the multi-million € range.
The module production (Gaia Solar) in 2006 is at about 525 kW, an increase of more than 100 % compared to 2005. The main markets for Gaia Solar are Germany and Sweden. There is no production of PV batteries in Denmark. The building industry is showing a limited, but growing interest in developing PV-building integrated components and systems in particular in connection with highly industrialized building processes.

Budgets for PV.
During 2006 the government confirmed its commitment to support renewables, and a new initiative focussing on large scale demonstration of new energy technologies (EUDP) was announced ultimo 2006. Over a 3-5 year period more than 150 mill DKK will be allocated to R&D in renewables; however it is still too early to say to which extend PVs effectively can benefit from these initiatives. In 2006 the Public Service Obligation (PSO) of the Danish transmission system operator, the so called ForskEL programme, funded about 15 mill DKK for applied research projects in PV's, and the Energy Research Programme (EFP) – expected to be replaced by the above EUDP - funded about 3,2 mill DKK for PV activities.

[1] Data collection and data analysis continue until mid 2004
[2] Early 2007 Danfoss announced the full acquisition of the Powerlynx company

Government Policy & Programmes

The Danish government launched a new energy plan in March 2005. The energy plan focus on a fully liberalised energy market supported by a framework, which underpins high consumer and environment protection, energy efficiency, subdued development in energy prices and high security of supply both in the short and long term. The energy plan further focus on the ongoing development of efficient energy technologies both nationally and in the EU, and the government wish to strengthen the research community and the development of new and promising energy solutions. With regard to renewable energy (RE) the plan sets quantifiable targets for the overall contribution from RE, but no technology specific targets. In general the market forces are supposed to promote the most suitable and competitive RE technologies, but the need for special support to emerging RE technologies such as PV appears to be recognized. The energy plan was followed up in late 2006 /early 2007 by "the Visionary Danish Energy Policy 2025", which focus on energy conservation and on increasing the penetration of renewables[3] in the total energy supply to 30 % by 2025. The overall objective is not to let the total energy supply increase and to decrease the use of fossil fuels by 15 %.

Photovoltaic technology (PV) is not specifically mentioned in the government's energy plans, but early 2004 the Danish Energy Authority (EA) in collaboration with the electricity sector, the industry and other key stakeholders finalized a national strategy on PV after a public hearing. This PV strategy includes the fields of research, development and demonstration. Deployment activities in support of the PV strategy are expected to be developed in the coming years. Early 2006 a national workshop reviewed the PV strategy and it was consequently revised during 2006 in terms of an addendum to the original strategy. A more comprehensive revision of the PV strategy is expected in 2007.

[3] Only technology specific targets for wind energy and for biofuels.

2 The implementation of PV systems

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

2.1 Applications for photovoltaics

The national electric grid covers practically all of Denmark and leaves little room for stand-alone applications besides the traditional low-power niche applications such as signalling, week-end cottages, garden lights, telemetry & telecommunication and urban furniture such as parking meters and information displays. In Greenland stand-alone PV's play a major role as power source for remote signalling and for the telecommunication network extending more than 2 000 km on the western coast line.

Grid connected PV applications are seen as the largest potential in Denmark, in particular building integrated applications on single family houses, apartment buildings, commercial and office buildings. The public interest for building integrated PVs is increasing, and most efforts are focused on developing and demonstrating PVs in the context of existing buildings. The EU directive[4] on energy consumption in buildings has in 2005 been minted into a revised national building code – moved into force early 2006 – which specifically mentions PV and allocates PV electricity a factor 2,5 in the calculation of the "energy foot print" of a building. However, due to the inertia in the construction sector, it is yet too early to see any real impact on PV deployment.

[4] EU directive: Directive 2002/91/EC of 16.12.02

2.2 Total photovoltaic power installed

The total **cumulative** installed PV power for each sub-market on the 31 December of each year from 1992 onwards is shown in Table 1.

Table 1 The cumulative installed PV power in 4 sub-markets.

Sub-market/ appli-cation	31 Dec 1993 kW	31 Dec 1994 kW	31 Dec 1995 kW	31 Dec 1996 kW	31 Dec 1997 kW	31 Dec 1998 kW	31 Dec 1999 kW	31 Dec 2000 kW	31 Dec 2001 kW	31 Dec 2002 kW	31 Dec 2003 kW	31 Dec 2004 kW	31 Dec 2005 kW	31 Dec 2006 kW
off-grid domestic	10	10	15	20	25	35	40	50	50	50	55	65	70	80
off-grid non-domestic	70	75	85	120	125	140	150	155	160	165	170	190	225	255
grid-conn. distribut.	5	15	40	105	272	330	880	1 255	1 290	1 375	1 675	2 035	2 355	2 565
grid-conn. centraliz.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	85	100	140	245	422	505	1 070	1 460	1 500	1 600	1900	2290	2 650	2 900

2006 was the last year of the SOL 1000 programme, which could provide support of up to 40 % of the capital cost of a PV system. Following this there are no general incentives for PV deployment in Denmark except for the net-metering system[5].

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

As mentioned previously the only general promotion programme for PV deployment in Denmark in 2006 was the now finished SOL 1000 programme. During its course this programme has implemented about 600 kW, but it is not known how many of these were installed in 2006.

At the new headquarters of the national Danish broadcasting system a prestigious 125 kW system has been implemented – at present the biggest system in the country.

[5] Average cost of electricity to consumers in 2006: approx. 1,65 DKK (0,22 €)/kWh

The municipality of Copenhagen received the 2006 PV award for a newly developed PV powered parking ticket machine.

Starting in 2006, Energinet.dk (the Danish transmission system operator) has commenced a monitoring and metering programme to collect insolation and PV production data for selected geographical regions in Denmark. The aim is to gather data for future modelling and prediction of solar electricity production, and potentially to use these data in the control room forecasting of the day-ahead market on the NordPool.

A brief historical overview of major PV initiatives and programmes is given in the following.

Denmark has had no unified national PV programme, but a number of programmes and projects have been and are being supported mainly by the Danish Energy Authority and by the Public Service Obligation (PSO) of the Danish transmission system operator Energinet.dk, the so called ForskEL programme.

PVs have been included in the action plan of the Danish Energy Authority (EA) since 1992 and have received increasing attention in the consecutive three-year Solar Energy Action Plans. Since 1992 the Renewable Energy Development Programme of the EA has supported about 125 PV projects. Since 2001 the three-year plan has not been produced due to cancellation of the Renewable Energy Development Programme, however the Danish Energy Authority in collaboration with the electricity sector, the industry and other key stakeholders have early 2004 finalised a national PV strategy following a public hearing; the strategy includes research, development and demonstration, but not deployment. Early 2006 a national workshop reviewed the PV strategy and it has been revised during 2006 in the form of an addendum to the strategy.

A 300 roof-top's project including 750 kWp was launched early 1998 and was completed by end of 2001 although the monitoring continued up till mid 2004. The project received its main support from the PSO facility of the Danish electric network operators. A 1000 roof-top programme was launched late 2001 as a follow up; this programme targeted a mix of general cost reductions, increase in end-user payment and promotion of small roof-tops. Only a few weeks after the announcement of the programme, the SOL 1000, more than 3000 house owners had registered their interest. However, uncertainty about the programme due to change of government and increased demand for end-user payment have introduced a delay of almost a year in the programme implementation. By the end of 2002 the programme reported a portfolio of some 1300 house owners expressing firm interest in the programme and by end 2006 about 600 kW have been implemented stimulated by net-metering and an investment subsidy of 40 % of the turnkey system cost; average turnkey system cost is € 4,50/W. The SOL 1000 programme was finished by end of 2006.

A special support programme for PV applications in the commercial sector, funded by the CO_2 tax on electricity, was set up early 1998. The support includes a subsidy of up to 36 % for the turn-key costs and the calculation of the actual subsidy will be in favour of high yield installations. However, little use has been made of this subsidy scheme so far as the commercial sector to some extent obtains refunding of the taxes on electricity, and the value of the solar electricity (substitution principle) is consequently low.

Net-metering for privately owned PV systems was established mid 1998 for the present for a pilot-period of four years. Late 2002 this scheme was extended until end of 2006. Late 2005

the net-metering scheme for PV's was made permanent by law. Analysis of ownership issues and tariffs for apartments sharing one common PV installation has been finalised in 2004, however certain legal issues still have to be solved in particular related to taxation.

A new utility initiative has been launched in 2003 by the utility Copenhagen Electric: the sale of certified PV produced electricity without any subsidies or other external support. The utility contracts to buy all electricity from new PV systems for the next 20 years at commercial terms, and tries to sell same electricity to the consumers in small standard packages including a certificate. Even though the end-user cost of the certified PV electricity is 3-4 times that of standard electricity – ironically partly because of the present tax and duty structure – the scheme reports a small but slowly growing success.

Preparations have been continued for a multi-megawatt project intended to bridge the gap from the SOL 1000 incentive of 40 % towards a market situation with no investment subsidy. Due to a present lack of public funding for large scale demonstration projects this initiative is in a waiting position.

Denmark participated in the former EU network of excellence in the fields of PVs: PV-EC-NET, and is also active in its continuation PV-ERA-NET. Denmark participates in the first joint call in the framework of the PV-ERA-NET.

2.4 Highlights of R&D

As part of the so called Three Year Programme R&D activities into PEC cells (Grätzel type cells) was initiated in 1999 at the Danish Institute of Technology in collaboration with Risoe National Laboratory and the Roskilde University Center. This initiative has in 2006 received ongoing support under the Elforsk programme. During 2004 the project attracted commercial finance and a separate business entity has been set up under the umbrella of the Institute of Technology; during 2006 a separate business entity has been created. It is attempted to develop PEC cells/modules and at the same time have control over the transparency of the module – which, if successful, should constitute a unique building element. The basic research into PEC technology continues at the Institute of Technology and efficiencies of +5 % has been reached. At present the R&D focus is on reaching an acceptable lifetime of PEC modules, e.g. module edge sealing.

R&D efforts into polymer based PV cells have in 2006 been continued at the Risoe National Laboratory with progress being reported both as to efficiency and life time. The R&D project has also during 2006 strengthened its European links. The project manager received in 2005 a reward for scientific excellence.

R&D efforts are beginning to exhibit commercial results in terms of export as mentioned above. A commercial break through was announced in 2003 by the company Topsil. It is now seeing commercial results of its R&D into low-cost float-zone processing and is on a commercial base supplying float-zone Si for high efficiency (> 20%) PV cells. Commercial progress during 2006 is reported.

Inverter technologies has been R&D' for some years for both fuel cell and PV applications. For the latter a commercial break through was also announced in 2003 by the Danfoss related company Powerlynx, which reports to have received multi-million € orders. During

2006 the company has reported strong commercial progress and consolidation. Early 2007 the company was fully acquired by Danfoss.

The company Grundfos, which among other things produce PV power water pumping systems, continues R&D efforts in this special niche.

Some medium to large scale industrial corporations long established in the building industry, such as Velux Industries, continue their R&D into how to integrate PVs in their main stream products. The products are currently being marketed in Southern Europe and to a small extent in Denmark. Up-start companies are also exhibiting interest in this field.

The Aarhus Academy of Architects has in 2006 continued including PV's in the curricula for architects.

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

Table 2 Public budgets for R&D, demonstration/field test programmes and market incentives.

	*) R & D	Demo/Field test	Market
National/federal	50 mill DKK	5 mill DKK	-
State/regional	-	-	-
Total	50 mill DKK	5 mill DKK	-

*) including estimates of potential PV share of R&D and PSO funds for renewable energy

3 Industry and growth

3.1 Production of feedstocks, ingots and wafers

Table 3: Production and production capacity information for the year for silicon feedstock, ingot and wafer producers

Producers	Process & technology	Total Production	Maximum production capacity	Product destination?	Price??
	Silicon feedstock	*tonnes*	*tonnes/year*		
Topsil	sc-Si ingots (float zone)	10 *tonnes*	10 *tonnes/year*	Exports	No data
	mc-Si ingots	*tonnes*	*tonnes/year*		
	sc-Si wafers	*MW*	*MW/year*		
	mc-Si wafers	*MW*	*MW/year*		

3.2 Production of photovoltaic cells and modules

Module manufacturing is defined as the industry where in the process of the production of PV modules the encapsulation is done. A company may also be involved in the production of ingots, wafers or the processing of cells, in addition to fabricating the modules with frames, junction boxes etc. The manufacturing of modules may only be counted to a country if the encapsulation takes place in that country.

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

Cell/Module manufacturer	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)			Maximum production capacity (MW/yr/shift)		
		Cell	Module	Concentrators	Cell	Module	Concentrators
Gaia Solar	mc-Si & sc-Si	_	0,525	-	-	0,45	-
Thin film manufacturers	-	-	-	-	-	-	-
Concentrators	-	-	-	-	-	-	-
TOTALS		-	0,525	-	-	0,45	-

Gaia Solar produces modules (laminates) based on imported cells. Modules are of the standard glas-EVA-Tedlar design. Product range is 27-150 Wp with 55-110 W modules being most typical. Normal warranty: 5 years. The company is open to custom design modules. Certification to IEC 61215.
Typical PV module cost range between DKK 40 – 50/W.

Most modules are exported to Germany and Sweden.

A few other companies have shown interest in manufacturing window-integrated PVs, but so far the throughput is estimated as negligible.

Table 4a: Typical module prices for a number of years

Year (only data since 2000)	2000	2001	2002	2003	2004	2005	2006
Module price(s): Typical	30-50	30-50	21-45	21-45	30-50	30-50	40-60
Best price	-	-	-	-	-	-	-

In 2005 and 2006 the price of PV modules has increased slightly as in many other countries reflecting the global “sellers market” situation for PV modules.

3.3 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain. For 2006 the situation in Denmark is briefly described below.

The company Powerlynx has reported +20 million € commercial orders for its recently developed inverter system specially designed for large scale OEM customers. However, no detailed information is publicly available on technology, performance, volume and prices.

The company Grundfos produces its special variable frequency inverter system for its water pumping systems. However, no detailed information is publicly available on technology, performance, volume and prices.

No battery producers in Denmark with PV related products.

Three companies produce (on a small scale) charge controllers and PV related electronics for stand-alone PV systems.

One company is looking into development and manufacturing of support structures.

The company Velux Industries has developed and marketed a roof-integration package. However, no detailed information is publicly available on technology, performance, volume and prices.

3.4 System prices

Category/Size	Typical applications and brief details	Current prices per W in DKK
OFF-GRID Up to 1 kW	Telemetry, navigational aids, emergency phones, etc.	70-90
OFF-GRID >1 kW	Professional remote: Greenland tele-communication links, etc.	150-200
GRID-CONNECTED Specific case	1-4 kW roof-mounted system (roof-tops)	35-45
GRID-CONNECTED Up to 10 kW	Facades and gables	50-85
GRID-CONNECTED >10 kW	Roofs (typically single projects with high visibility)	50-100

Table 5a: National trends in system prices (current) for …… (*specify application, for example from table 5 above*)

YEAR	1997	1998	1999	2000	2001*)	2002	2003	2004	2005	2006
Price /W:	50	50	40	40	40-80	33-36	33-36	33-36 #)	33-36 #)	35-45 #)

*) in between programmes Sol 300 and SOL 1000

#) only for system on long term contract, e.g. SOL 1000. Other (few) systems exhibit price increases, which vary widely.

3.5 Labour places

a) Research and development (not including companies): 15
b) Manufacturing of PV system components, including company R&D: 150
c) All other, including within electricity companies, installation companies etc. 20

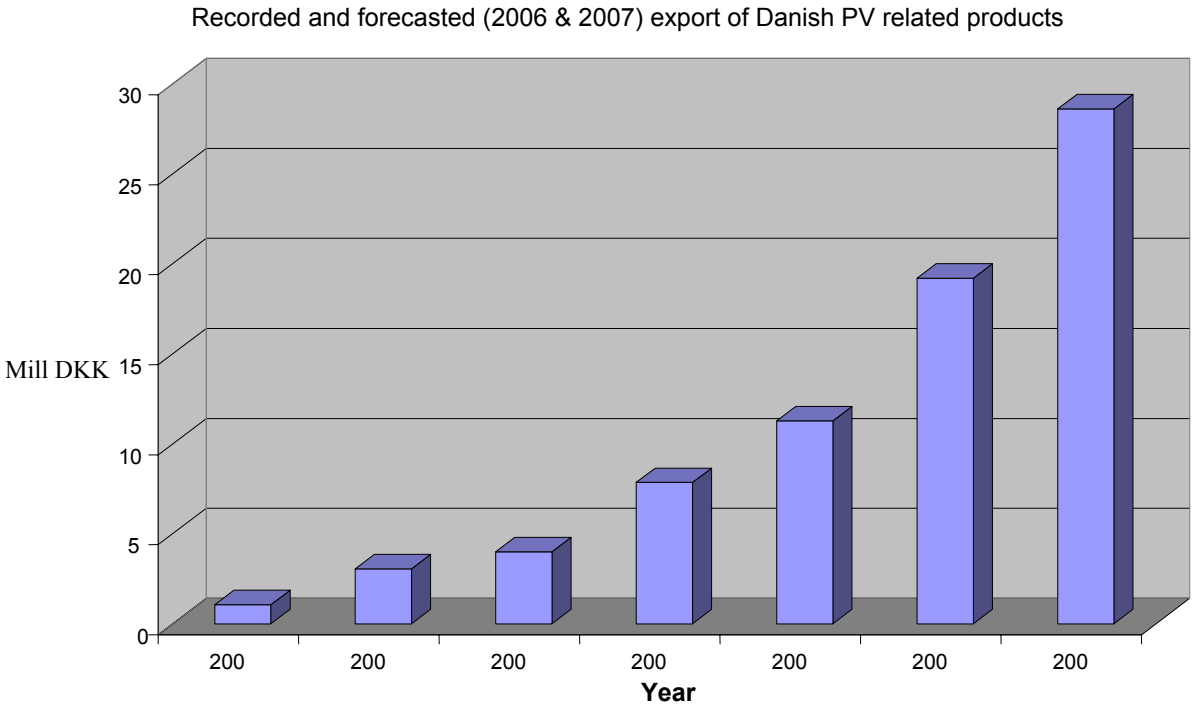
Information on labour places is based on the author's best estimate – no official statistics available.

3.6 Business value

Table 6: Value of PV business
(Table 6 cannot be completed due to lack of data)

Total business value is estimated (author's estimate – no way of getting solid data) to about 250-275 million DKK.

Estimate by the Danish Federation of Industries (DI) on PV related export for 2006 points at approx. 200 mill DKK. The trend in PV related exports is illustrated below[6].



4 Framework for deployment (Non-technical factors)

[6] Source: The Energy Industry, Danish Federation of Industries.

Table 7: PV support measures

	National / Regional (State) / Local
Enhanced feed-in tariffs	-
Direct capital subsidies	Under the Sol 1000 programme incentives up to 40 %.[7]
Green electricity schemes	-
PV-specific green electricity schemes	-
Renewable portfolio standards (RPS)	-
PV requirement in RPS	-
Investment funds for PV	-
Tax credits	-
Net metering	National scheme for net-metering
Net billing	-
Commercial bank activities	-
Electricity utility activities	EnergiMidt regional support model Energinet.dk monitoring and metering programme
Sustainable building requirements	-

4.1 New initiatives

In the framework of the previously mentioned EU supported PV-ERA-NET Denmark has decided to join the first joint call named Polymol targeting R&D into organic PV cells. This joint call includes 7 European countries or regions with Denmark as secretariat.

4.2 Indirect policy issues

The European Commission has early 2007 established binding targets for RE implementation in the EU as such. However, no targets for countries nor technology specific targets have yet been set.

The Danish government has as previously mentioned – also early 2007 – set binding RE targets for the country for 2025. However, few technology specific targets have been set and none for PV.

The extent to which these overall RE targets may stimulate the deployment of PV's in Denmark is very uncertain.

The EU Directive on energy in buildings has lead to obligatory building codes in the EU member states including Denmark. The new Danish building codes were introduced in 2006, and may in the future promote PV's as PV's enter favorably into the calculation of a buildings energy "foot print". This is expected - with time - to stimulate the use of BIPV in Denmark.

[7] The Sol 1000 programme ended ultimo 2006

4.3 Standards and codes

Certification scheme for PV components and systems are established; certification of installers are established and ongoing.

The aforementioned EU Directive on energy consumption in buildings has lead to national building codes in favour of BIPV. The revised Danish building codes has move into force early 2006 and includes a factor of 2,5 for BIPV when calculating the energy “foot print” of a building, see also section 4.2.

5 Highlights and prospects

Efforts are ongoing to establish relative large scale deployment/demonstration programmes, which over a 7-8 year period can bridge the gap from the present need of a capital incentive of approx. 30 % to 0 %. The need of a capital incentive is based on consumer polls indicating, that many owners of residential houses can accept a pay-back time for a PV roof-top system of 20-25 years, but not higher.
Such a programme would have an overall budget of approx. 200 mill DKK and require a public support amounting to approx. 50 mill DKK. However, it has not yet been possible to establish the required public support.

The national Danish PV strategy is expected to be revised during 2007.

Annex A Method and accuracy of data

The PV scene in Denmark is of limited size, and most information is available via either the Danish PV Advisory Group to the Energy Authority (the Government), the associated “PV Dialog Group” broadly representing Danish PV stakeholders, the Danish Solar Energy Group (part of the Federation of Engineers) including some 50 professionals involved in PV technology and the SolarEnergyCenter Denmark (Institute of Technology).

No official statistics deal with PV technology. In general terms the Danish PV data given in this report is based on personal knowledge of the local PV scene and on information sought and received from professionals working in the PV field and collected through the above four fora.

Annex B Country information

The following brief description of the Danish scene in which PV activities take place is based on the author's estimates and opinion.

The national electric grid covers practically all of Denmark and leaves little room for stand-alone applications besides the traditional low-power niche applications such as signalling, week-end cottages, garden lights, telemetry & telecommunication and urban furniture such as parking meters and information displays. In Greenland stand-alone PV's play a major role as power source for the telecommunication network extending more than 2 000 km along the west coast.

Grid connected PV applications are seen as the largest potential in Denmark, in particular building integrated applications on single family houses, apartment buildings, commercial and office buildings.

For private households the retail price of electricity is constituted by a number of elements, one example seen from the point of view of a distribution utility is given in table B.1.

Table B.1: Elements of a typical Electricity Retail Price

Category:	Name:	DKK/100
Production	Market price at high voltage level	26,31
Grid, System and Public Service Obligation (PSO)	Distribution grid	14,08
	Medium voltage grid	2,37
	System	3,12
	PSO	12,60
Taxes (to the state)	Electricity tax	53,60
	CO2 tax	9,00
	Distribution tax	4,00
Sub-total		125,08
VAT	25 % VAT	31,27
Price /kWH	Retail price	156,35

Certain industries and commercial operations can get certain taxes refunded.

Average household electricity consumption is estimated to 4 400 kWH/year, and for private households electricity is typically metered at a constant flat rate. Net-metering (allowing the meter to run "back-wards") is permanently set by law for PV systems up to 6 kW and under certain conditions to prevent misuse.

For single family houses PV roof-top systems are seen as an integrated part of the house with regard to taxing, insurance, mortgage etc.

Typical mortgage interest is in the range of 2-5 % depending on type of loan.