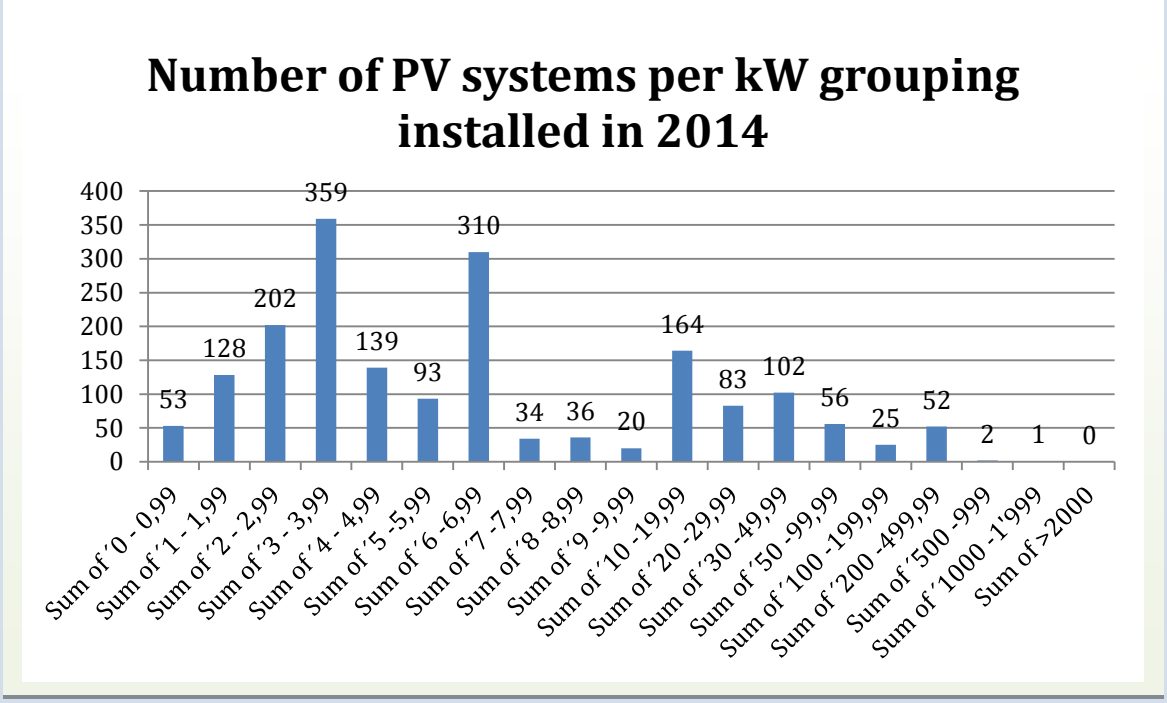
IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in Denmark 2014



PVPS

PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Prepared by: Peter Ahm, PA Energy Ltd.

TABLE OF CONTENTS

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 member countries

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 participating countries and organisations can be found on the www.iea-pvps.org website.

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

Introduction

The objective of Task 1 of the IEA Photovoltaic Power Systems Programme is to promote and facilitate the exchange and dissemination of information on the technical, economic, environmental and social aspects of PV power systems. Task 1 activities support the broader PVPS objectives: to contribute to cost reduction of PV power applications, to increase awareness of the potential and value of PV power systems, to foster the removal of both technical and non-technical barriers and to enhance technology co-operation. 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 country National Survey Report for the year 2014. Information from this document will be used as input to the annual Trends in photovoltaic applications report.

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

1 INSTALLATION DATA

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. Other applications such as small mobile devices are not considered in this report.

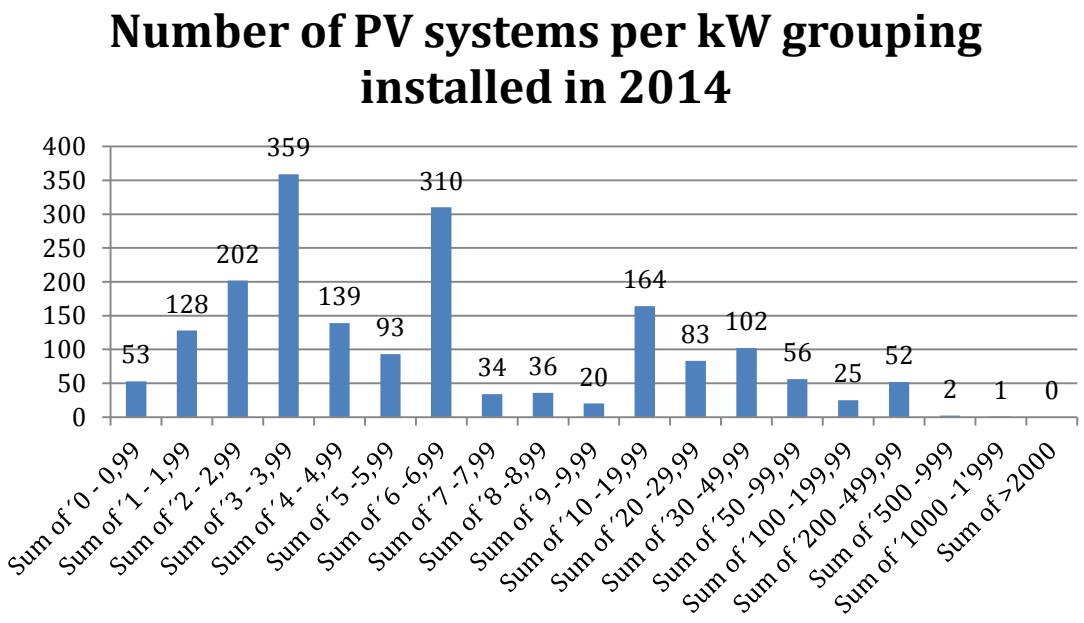
For the purposes of this report, **PV installations are included in the 2014 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2014, although commissioning may have taken place at a later date**.

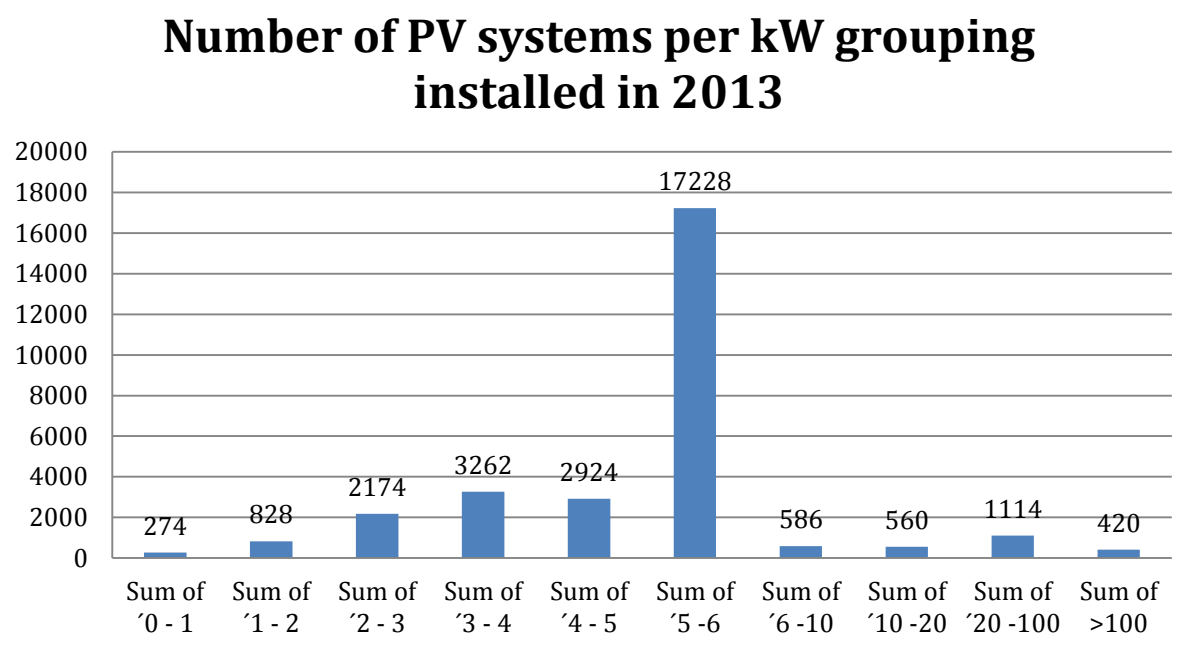
1.1 Applications for Photovoltaics

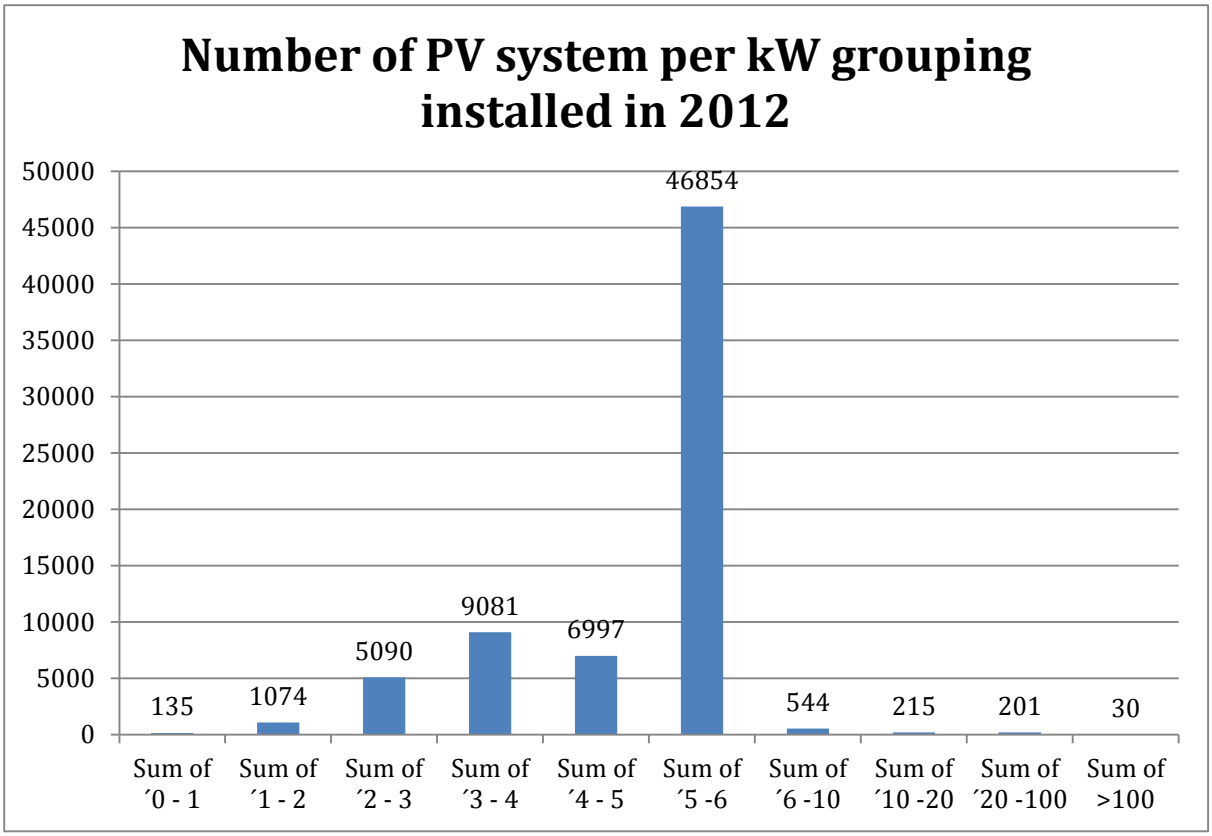
The main PV market in Denmark is BAPV and BIPV. Effective since late 2011 the Danish state owned TSO Energinet.dk (www.energinet.dk) registers all grid-connected PV systems, as it is mandatory for the installer responsible for the grid hook-up to report a number of technical details of each PV system including the time of grid hook-up or start of operation. The basic data in this database (in Danish) is as of early 2014 freely available at the above website.

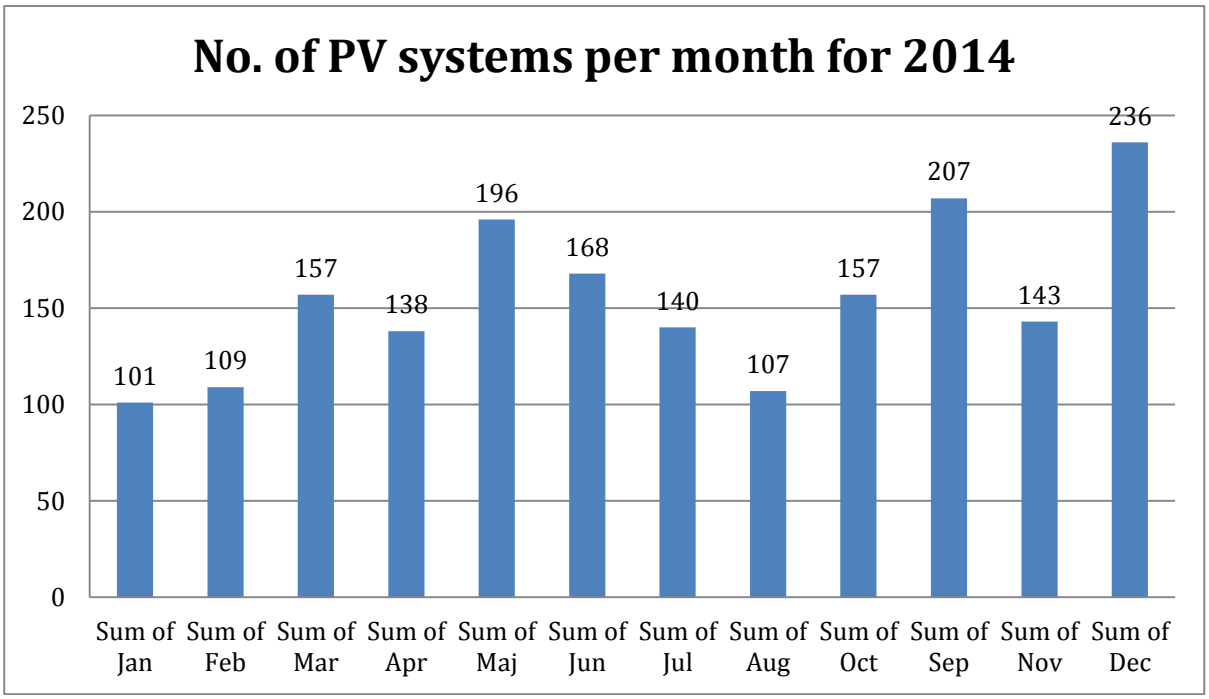
Using this database as source it can be stated with a quite high degree of accuracy, that in 2012, the Danish PV boom year, 70.221 PV systems corresponding to 406,661 MW were put in operation. The similar figures for 2013 are 29.370 PV systems corresponding to 155,439 MW, and for 2014 only about 1.860 PV systems corresponding to 42,019 MW.

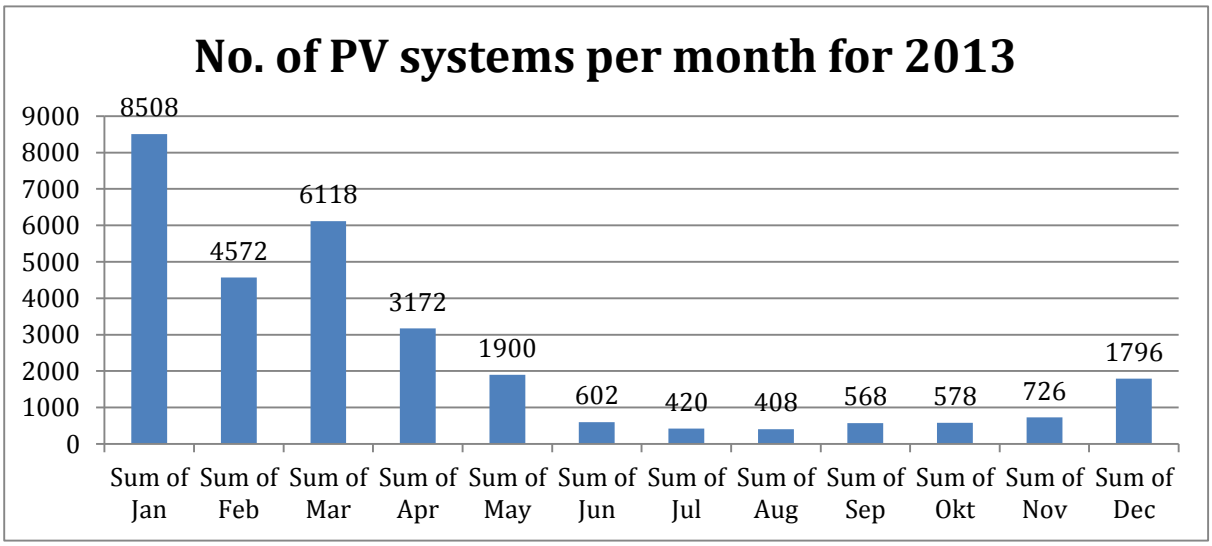
In order to try to analyze the market development the data for 2012 and 2014 have been sorted in number of PV systems per size, e.g. 0-1 kW, 1-2 kW, 2-3 kW etc. and in number of PV systems connected to the grid per month. The results are shown in the following six charts.

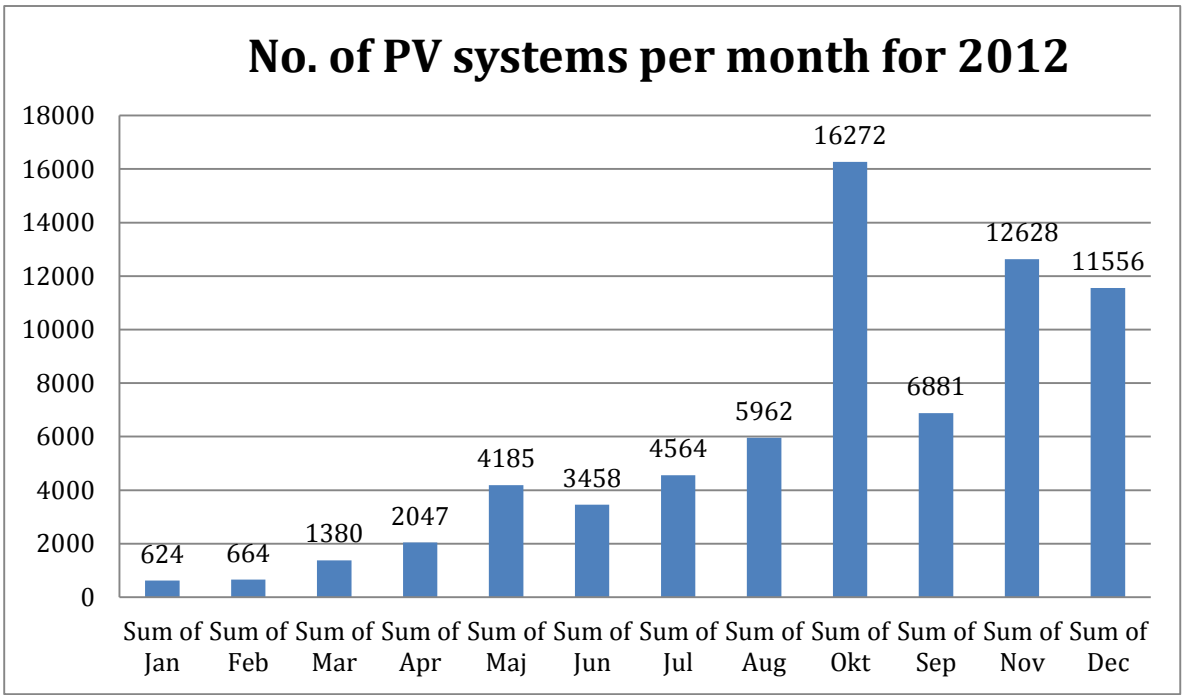



Number of PV systems per kW grouping installed in 2013
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
274
828
2174
3262
2924
17228
586
560
1114
420
Sum of ´0 - 1
Sum of ´1 - 2
Sum of ´2 - 3
Sum of ´3 - 4
Sum of ´4 - 5
Sum of ´5 -6
Sum of ´6 -10
Sum of ´10 -20
Sum of ´20 -100
Sum of >100


Number of PV system per kW grouping installed in 2012
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
135
1074
5090
9081
6997
46854
544
215
201
30
Sum of ´0 - 1
Sum of ´1 - 2
Sum of ´2 - 3
Sum of ´3 - 4
Sum of ´4 - 5
Sum of ´5 -6
Sum of ´6 -10
Sum of ´10 -20
Sum of ´20 -100
Sum of >100


No. of PV systems per month for 2014
250
200
150
100
50
0
101
109
157
138
196
168
140
107
157
207
143
236
Sum of Jan
Sum of Feb
Sum of Mar
Sum of Apr
Sum of Maj
Sum of Jun
Sum of Jul
Sum of Aug
Sum of Oct
Sum of Sep
Sum of Nov
Sum of Dec


No. of PV systems per month for 2013
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
8508
4572
6118
3172
1900
602
420
408
568
578
726
1796
Sum of Jan
Sum of Feb
Sum of Mar
Sum of Apr
Sum of May
Sum of Jun
Sum of Jul
Sum of Aug
Sum of Sep
Sum of Okt
Sum of Nov
Sum of Dec



Looking at only three years interpretation of trends will be quite uncertain, but the writer believes the following observations to be pertinent:

- The Danish PV market has been disrupted in 2013 and 2014 as indicated above by the uncertainties of the actual feed-in-tariffs due to the dispute between Denmark and the European Commission (EC) on the current Public Obligation Service (PSO) system, which is base for most Danish support to electricity producing renewable energy technologies. This problem reached an interim solution early 2015, but needs to find a more permanent solution before end of 2016.
- The number of PV systems grouped by system size are grouped according to the PV panel maximum output (DC). The systems at 6-7 kW and below are typically BAPV installations on residential housing (roof-tops) with a concentration of systems at 6-7kW, and includes for 2012 almost 70.000 systems and for 2103 almost 27.000 systems. For 2014 this trend has almost disappeared to be replaced by small (3 kW) systems indicating an increased focus on self-consumption for residential roof-tops. Self-consumption appears also to have driven the PV systems from >7 to 100 kW typically being BAPV and BIPV installations on commercial buildings; systems >100 kW are mostly BAPV installations again on large commercial buildings but a few large scale ground mounted installations as well, e.g. in 2014 a couple of PV farms < 2 MW were commissioned.
- The dramatic reduction in number of systems from 2013 to 2014, in particular concerning residential roof-tops, is a clear consequence of a very political influenced market – both by domestic policies and the above mentioned dispute with the EC.
- The overall result of the rather panicky series of political changes in the support scheme for PV as mentioned above appears to be an increasing focus on PV system designed for a high degree of self-consumption both for the residential and the commercial market sectors. For the residential sector a self-consumption ratio of 20-30 % appears possible, for the commercial sector a ratio of up to 40 % seems realistic. There is an increased interest in “behind-the-meter” storage to increase the self consumption rate. The increasing focus on self-consumption, and thus loss of revenue for the government (green taxes) and loss of revenue for the DSO’s have lead to considerations of both a tax

on the self-consumed electricity and a fee for the grid access of PV system owners, but no final decisions on these issues have been taken.

1.2 Total photovoltaic power installed

Table 1: PV power installed during calendar year 2014

AC			**MW installed in 2014 (mandatory)**	**MW installed in 2014 (optional)**	**AC or DC**
Grid-connected	BAPV/BIPV	Residential	39		
		Commercial			DC
		Industrial			
	Ground-mounted	cSi and TF	3		DC
		CPV			
Off-grid		Residential	0,1		DC
		Other	0,2		DC
		Hybrid systems			
		Total	42,3		DC

Table 2: Data collection process:

If data are reported in AC, please mention a conversion coefficient to estimate DC installations.	
Is the collection process done by an official body or a private company/Association?	The state owned TSO
Link to official statistics (if this exists)	www.energinet.dk
	All grid connected PV systems must be registered at the TSO; off-grid is authors estimate

Table 5: The cumulative installed PV power in 4 sub-markets.

Sub-market	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Stand-alone domestic	0	0	0,1	0,1	0,1	0,1	0,1	0,2	0,2	0,3	0,5	0,6	0,7
Stand-alone non-domestic	0,2	0,2	0,2	0,2	0,2	0,3	0,3	0,4	0,5	0,5	0,5	0.9	1,1
Grid-connected distributed	1,4	1,7	2	2,4	2,6	2,7	2,8	4	6,4	15,9	406,7	556,8	595,8
Grid-connected centralized	0	0	0	0	0	0	0	0	0	0	0	5	8
TOTAL (MW)	1,6	1,9	2,2	2,6	2,9	3,1	3,2	4,6	7,1	16,7	407,8	563,3	605,6

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Table 6: Typical module prices for a number of years (DKK/W)

Year	2008	2009	2010	2011	2012	2013	2014
Standard module price(s): Typical	25-45	15-25	10-15	8-12	6-10	5-10	4-9

2.2 System prices

Table 7: **Turnkey Prices of Typical Applications (DKK/W)**

Category/Size	Typical applications and brief details	Current prices per W
OFF-GRID Up to 1 kW	Telemetry, navigational aids, information displays, etc.	15-30
OFF-GRID >1 kW	Professional remote, telecommunication, etc.	25-50
Grid-connected Rooftop up to 10 kW (residential)	Residential roof-tops	10-18
Grid-connected Rooftop from 10 to 250 kW (commercial)	BAPV/BIPV	10-20
Grid-connected Rooftop above 250kW (industrial)	BAPV/BIPV	10-15
Grid-connected Ground-mounted above 1 MW	Only 3 plants	8-10

Table 8: National trends in system prices (current) for roof-tops (DKK/W)

Price/Wp	2007	2008	2009	2010	2011	2012	2013	2014
Residential PV systems < 10 KW	33-40	35-45	25-40	20-30	18-25	15-25	12-20	10-18

2.3 Additional Country information

Table 12: Country information

Retail Electricity Prices for an household (range)	2,25 DKK/kW
Retail Electricity Prices for a commercial company (range)	1,75 DKK/kW
Retail Electricity Prices for an industrial company (range)	0,80 – 1,25 DKK/kW
Population at the end of 2014	5,6 mio
Country size (km^2)	44.000
Average PV yield (according to the current PV development in the country) in kWh/kWp *)	900-950 kWh/kW
Name and market share of major electric utilities.	http://www.danishenergyassociation.com/

*) most systems are South oriented. However, with the increased focus on self consumption more East-West oriented systems are coming up reducing the average PV yield; statistics not yet available.

3 POLICY FRAMEWORK

Renewable energy is not only a future option, but very much a present and considerable element in the Danish energy supply: by end of 2013 more than 30 % of the national electricity consumption was generated by renewable energy sources including incineration of waste. Ongoing research, development and demonstration of new energy solutions including renewable energy sources have high priority in the proposed energy plan, the main objectives being the development of a future environmental benign energy system completely free of fossil fuels. Denmark has no unified national PV programme, but a number of projects supported mainly by the Danish Energy Authority's EUDP programme and via the Public Service Obligation (PSO) of Danish transmission system operator, Energinet.dk, a fully government owned body; Energinet.dk administers two programs of relevance for PV, e.g. ForskVE (mainly demonstration) and ForskEL (mainly R&D); the ForskVE programme will expire by end of 2014.

A couple of public funds also support PV related projects, mainly supporting market entrance.

Net-metering for privately owned and institutional PV systems was established mid 1998 for a pilot-period of four years. Late 2002 the net-metering scheme was extended another four years up to end of 2006. Net-metering has proved to be a cheap, easy to administrate and effective way of stimulating the deployment of PV in Denmark; however the relative short time widow of the arrangement was found to prevent it from reaching its full potential. During the political negotiations in the fall of 2005 the net-metering for privately owned PV systems was consequently made permanent, and net-metering - during 2012 at a level of approx. € 0,30/kWh primarily because of various taxes – combined with dropping PV system prices proved during 2012 to be able to stimulate PV deployment seriously, as the installed grid connected capacity during 2012 grew from about 13 MW to approx. 390 MW, a growth rate of about 30 times. For PV systems qualifying to the net-metering scheme grid-parity was reached in 2012.

This dramatic grow gave rise to political debate towards the end of 2012, and the government announced a revision of the net-metering scheme inter alia reducing the net-metering time window from one year to one hour. During the first half of 2013 a series of new regulations were agreed politically; this because the consequences of the new regulations were not fully clear at time of decision and follow up measures were found to be necessary. By June 2013 the new regulations were finally in place including transitory regulations, effectively putting a cap on future PV installations under the net-metering scheme in terms of an overall max. installed capacity of 800 MW by 2020; for municipal PV installations the cap was set at an additional 20 MW by 2020.

The above mentioned uncertainties as to net-metering regulations increased during 2014 and the general reduction in benefits of the revised net-metering scheme almost killed the market as mentioned previously. The number of PV installations not applying for the net-metering scheme but operating in the "self consumption mode" appears to be growing, but not firm data is available yet – only indications as discussed previously.

3.1 Direct support policies

Table 13: PV support measures (summary table)

	On-going measures	Measures that commenced during 2014
Feed-in tariffs (gross / net?)	DKK 0,60/kWh for 10 Y, 0,40 DKK the next 10 Y; no limitations. Transitory net-metering (time window 1 hour) scheme until 2017; FIT in 2014 1,15 DKK/kWh dropping in yearly steps to 0,60 DKK by end of2017	Transitory net-metering scheme suspended during 2014 due to the discussion with the EC on the Danish PSO scheme
Capital subsidies for equipment or total cost		
Green electricity schemes		
PV-specific green electricity schemes		
Renewable portfolio standards (RPS)		
PV requirement in RPS		
Investment funds for PV		
Income tax credits		
Prosumers' incentives (self-consumption, net-metering, net-billing…)	Self-consumption possible for all. Net metering as a transitory measure until end of 2017 (see above)	
Commercial bank activities e.g. green mortgages promoting PV		
Activities of electricity utility businesses		Fee for grid access under consideration
Sustainable building requirements	BAPV/BIPV enters favourably into calculation of energy foot print of buildings (factored by 2,5)	

Direct Support measures

See above under 3 and 3.1

3.2 Indirect policy issues

There is an ongoing and increasing conflict between climate and energy policy and the resulting loss of revenue for the government due to both conservation and green generation. DSO's face a similar conflict providing grid access to customers buying less and less electricity.

Discussions at the political level continues, but no clear cut solutions can be seen.

4 HIGHLIGHTS OF R&D

4.1 Highlights of R&D

During 2014 R&D efforts in the fields of organic dye sentisized PV cells (PEC), polymer cells and "PV cells-architecture-lights" continued with steady progress primarily for the polymer cells, and efforts to commercialize the R&D results in the field of polymer cells initiated in 2010 were quite successful continued in 2014 involving the screen printing company Mekoprint. R&D efforts into nano-structured PV cells were continued as well.

Basic research into PV cells based on mono-X Si is ongoing at the University of Aarhus in a partnership with industry, however no firm data on this is available.

A new small R&D&D programme of 20 mio DKK targeting BIPV was agreed by end of 2012, and was minted out in the first half of 2013. About 10 R&D&D projects have received support. In early 2004 and again in early 2005 this programme received and additional about 5 mio DKK for new projects.

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

Table 14: Public budgets for R&D, demonstration/field test programmes and market incentives.

	R & D	Demo/Field test
National/federal	Approx. 30 mio DKK	Approx. 25 mio DKK
State/regional	-	-

As mentioned previously there is no unified PV programme in Denmark. With the above exception R&D funding for PV is in combination with other competing RE technologies; only indicative figures can thus be given.

4.3 Production of feedstocks, ingots and wafers (crystalline silicon industry)

Table 15: Production information for the year for silicon feedstock, ingot and wafer producers

Manufacturers (or total national production)	Process & technology	Total Production	Product destination (if known)	Price (if known)
	Silicon feedstock	tonnes		
	sc-Si ingots.	tonnes		
	mc-Si ingots	tonnes		
	sc-Si wafers	MW		
	mc-Si wafers	MW		

Describe briefly the overseas activities of any key companies also operating in other countries.

No information available on the above. The company Topsil produces manufacturing equipment for float zone Si ingots. The company Photonic Energy owns large scale PV manufacturing facilities in China, but no details are available. Several investors have announced interest in PV farms in and outside Denmark, but no details are available.

4.4 Production of photovoltaic cells and modules (including TF and CPV)

Module manufacturing is defined as the industry where 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.

Total PV cell and module manufacture together with production capacity information is summarised in Table 9 below.

Table 16: Production and production capacity information for 2014

Cell/Module manufacturer (or total national production)	Technology (sc-Si, mc-Si, a-Si, CdTe)	Total Production (MW)		Maximum production capacity (MW/yr)	
		Cell	Module	Cell	Module
Wafer-based PV manufactures					
Gaia Solar	mc-Si, sc-Si	-	2	-	2,5
¤)					
Total		-	2	-	2
Thin film manufacturers none					
Cells for concentration none					
TOTALS		**-**	**2**	**-**	**2**

¤) Company Dansk Solenergi was confirmed bankrupt. No information on company Racell.

Gaia Solar produces modules (laminates) based on imported cells. Modules are of the standard glas-EVA-Tedlar design. Product range is 50-250 Wp with 75-200 W modules being most typical. Normal warranty: 5 years. The companies are open to custom design modules. Certification to IEC 61215.

Typical PV module cost range between DKK 6 – 9/W. Modules are exported, although in limited numbers – mostly custom designed modules.

Company Racell develops and has limited production of large-scale (7-8 m^2) PV-T modules.

Some companies have announced plans to establish more large scale PV module production, and a few other companies have shown interest in manufacturing window-integrated PVs, but so far the throughput is estimated as commercially negligible.

The company Photonics Energy acts as a holding company inter alia with PV manufacturing facilities in China (Jumao); no details of manufacturing capacities and technologies are available.

4.5 Manufacturers and suppliers of other components

Balance of system component manufacture and supply is an important part of the PV system value chain. For 2014 the situation in Denmark is briefly described below.

The company Danfoss Solar Inverters has up till 2013 reported multi million € commercial orders for its recently developed modular inverter system. For 2013 a reduced production volume in relation to 2012 has been reported, but no detailed information is publicly available on technology, performance, volume and prices. Danfoss has entered into formal collaboration with the German based inverter manufacturer SMA and most sales and services of Danfoss products are carried out by SMA .

The company Grundfos produces its special variable frequency inverter system for its RE powered range of water pumping systems. However, no detailed information is publicly available on technology, performance, volume and prices except for general information on the company website.

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 (Linak) is looking into development and manufacturing of support structures and trackers.

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

5 PV IN THE ECONOMY

5.1 Labour places

a) Public research and development (not including private companies): 30

b) Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D: 300

c) All other, including within electricity companies, installation companies etc.: 500

Information on labour places is based on the author's best estimate - no official statistics available. Table 17 on labour places cannot be completed due to lack of data.

Table 17: Estimated PV-related labour places in 2014

Research and development (not including companies)	
Manufacturing of products throughout the PV value chain from feedstock to systems, including company R&D	
Distributors of PV products	
System and installation companies	
Electricity utility businesses and government	
Other	
Total	

5.2 Business value

Total business value for 2014 is estimated by the author, no solid data available, to about half a billion DKK.

Table 18 on business value cannot be completed due to lack of data.

Table 18: Value of PV business

Sub-market	**Capacity installed *in 2014* (MW)**	**Price per W** *(from table 7)*	**Value**	**Totals**
Off-grid domestic	*X*	*Y*	*a = X x Y x 1 000 000*	
Off-grid non-domestic			*b*	
Grid-connected distributed			*c*	
Grid-connected centralized			*d*	
				a+b+c+d
Export of PV products				*e*
Change in stocks held				*f*
Import of PV products				*g*
Value of PV business				***a+b+c+d+e+f-g***

6 INTEREST FROM ELECTRICITY STAKEHOLDERS

6.1 Structure of the electricity system

The transmission systems for power and gas are operated by the state owned TSO, Energinet.dk, see http://www.energinet.dk/EN/Sider/default.aspx .

The DSO's are mostly owned by the consumers as cooperatives, but a few commercial DSO's can also be found. The DSO's are organized in an association, see http://www.danishenergyassociation.com/.

The government regulator controls the pricing of electricity and the margins and accumulated wealth of the DSO's. The DSO's are by law obliged to contribute to energy conservation and has at present a target of 3 % energy conservation per year; if the target is not met the DSO's are fined. From 2014 the energy conservation target may be increased again. The DSO's have full (commercial) freedom how to implement the conservation targets.

6.2 Interest from electricity utility businesses

The Danish TSO Energinet.dk has for several years expressed interest in PV as a potential contributor to the electricity supply and in support of the electric grid. This interest has also been minted out via support channelled through the various relevant PSO support programmes. One example is the EU EcoGrid project encompassing many smart grid activities including up to 7 MW of PV providing a local PV penetration of around 17 % in the grid of the island of Bornholm.

The distribution utilities, notably EnergiMidt, have also promoted the use of PV, and in particular since 2009 several distribution utilities have included PV technology in their portfolio of products. EnergiMidt made for a couple of years use of a capital incentive to customers inside its service area, but is now marketing PV technology without any special support. Most distribution utilities simply regard PV as a relevant standard product and some offer finance packets and payment via the electricity bill.

Through its national federation Dansk Energi the Danish utilities in 2010 announced, that they will not charge PV system owners for access to the grid (related to the use of the net-metering scheme), and several distribution utilities will not charge for the metering system needed to benefit from the net-metering scheme. However, these free services of the utilities can soon be expected to change to a fee-for-service scheme as the Danish regulator has found this free service in principle illegal; Dansk Energi is now reported to be working on recommendations to its members on such a fee and issued a first proposal early 2015; this proposal was however quickly withdrawn following a lot of criticism from a wide range of stakeholders.

6.3 Interest from municipalities and local governments

Municipalities and regions in Denmark have demonstrated a fast growing interest in PV technology. The main driver here is the climate plans and targets formulated by most municipalities, e.g. to aim for a CO_2 neutral community by a certain year. Municipalities then follow up with lighthouse demonstration of the PV technology by installing PV on the many municipal buildings such as schools, hospitals, kindergartens, homes for the elderly, etc. Many municipalities combine the PV demonstration systems with information campaigns both targeting the citizens using the municipal buildings and the general public. The current net-metering scheme also includes PV on municipal buildings with some constraints as to ownership, size and application. These constraints are seen as serious barriers for PV deployment by several municipalities, and proposals to lift same barriers have been submitted to the government – so far with uncertain result.

The deployment of PV in a municipal context has been capped at an additional 20 MW up to 2020, if the involved municipalities want to benefit from the special regulations in force for municipal PV systems. If not municipalities are forced to created one administrative operational unit per PV

system making municipal PV systems an administrative nightmare, and many municipalities have had to cancel otherwise planed PV installations on schools, kindergartens and administrative facilities.

7 STANDARDS AND CODES

Certification scheme for PV components and systems are established but in practice dormant; however revival of the scheme is expected to be imminent. Certification of installers is established and ongoing stimulated by EU requirements.

The 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 BAPV/BIPV when calculating the energy “foot print” of a building.

Grid codes are under revision in preparation of a high penetration of decentralized grid connected generators including PV. These grid codes are expected to a large extend to reflect the existing German grid codes for the low respectively medium voltage networks, and are part of a holistic approach towards a smart grid system with 50% RE in the electricity supply by 2030 and 100% by 2050. ENTSOE-E codes will be introduced in Denmark as well in a step-by-step process.

8 HIGHLIGHTS AND PROSPECTS

The former net-metering scheme was getting more and more attractive driving the market for PV systems qualifying for the scheme; explosive growth in roof-tops during 2012 was seen. The market impact of the revised net-metering scheme and its associated transitory measures are not known yet. However, although the market is reported to suffer severely from the uncertainties and lack of European Commission notification (approval) following the net-metering changes effected November 20 2012 up to June 2013, in practice the market has been almost frozen at about 43 MW in 2014. Following the settlement of the aforementioned dispute between Denmark and the EC on the PSO scheme the Danish Energy Agency early 2015 opened up for additional FIT at the level of DKK 1,03/kWh for a total window of 60 MW distributed on 4 main areas of applications and with a rather complicated range of constraints. This new approach has been found overly complicated by many potential end users.

A revised national PV Strategy was published primo 2009, and a revision has in spring 2015 been decided by the Danish Energy Agency to proper reflect the very fast technical and economic development of PV. Furthermore the Danish minister of Climate. Energy and Buildings announced in the parliament during spring 2015, that “PV electricity now was cheaper than electricity from off-shore wind”. This political recognition of the competitiveness of PV may lead to a new era for PV in Denmark, however several key politicians want to wait until the present energy agreement expires by 2020.

Definitions, Symbols and Abbreviations

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^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.

CPV: Concentrating PV

Hybrid system: A system combining PV generation with another generation source, such as diesel, hydro, wind.

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 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 DKK.

PV support measures:

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 that may be higher or lower 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
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

Compensation schemes (self-consumption, net-metering, net-billing…)	These schemes allow consumers to reduce their electricity bill thanks to PV production valuation. The schemes must be detailed in order to better understand if we are facing self-consumption schemes (electricity consumed in real-time is not accounted and not invoiced) or net-billing schemes (the electricity taken from the grid and the electricity fed into the grid are tracked separately, and the electricity account is reconciled over a billing cycle). The compensation for both the electricity self-consumed and injected into the grid should be detailed. Net-metering schemes are specific since they allows PV customers to incur a zero charge when their electricity consumption is exactly balanced by their PV generation, while being charged the applicable retail tariff when their consumption exceeds generation and receiving some remuneration for excess electricity exported to the grid
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