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 Germany

2010

Prepared on behalf of

BMU – German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

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by
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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°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 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 €

PV support measures:

Enhanced feed-in tariff	an explicit monetary reward is provided for producing PV electricity; paid (usually by the electricity utility business) at a rate per kWh somewhat higher than the retail electricity rates being paid by the customer
Capital subsidies	direct financial subsidies aimed at tackling the up-front cost barrier, either for specific equipment or total installed PV system cost
Green electricity schemes	allows customers to purchase green electricity based on renewable energy from the electricity utility business, usually at a premium price
PV-specific green electricity schemes	allows customers to purchase green electricity based on PV electricity from the electricity utility business, usually at a premium price
Renewable portfolio standards (RPS)	a mandated requirement that the electricity utility business (often the electricity retailer) source a portion of their electricity supplies from renewable energies (usually characterized by a broad, least-cost approach favouring hydro, wind and biomass)
PV requirement in RPS	a mandated requirement that a portion of the

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

Foreword

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

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

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

The overall programme is headed by an Executive Committee composed of one representative from each participating country or organization, while the management of individual Tasks (research projects / activity areas) is the responsibility of Operating Agents. Information about the active and completed tasks can be found on the IEA-PVPS website www.iea-pvps.org

Introduction

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

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

1 EXECUTIVE SUMMARY

1.1 Installed PV power

New installed (power) [3]	7.406 MWp
Total installed power [3]	17.320 MWp

1.2 Costs & prices

Turnkey Prices of Typical PV Applications (VAT excluded (19%), net, prices rounded, prices at end of 2010, usually grid connected) [11]

1 – 2	kWp:	3.200 €/kWp
2 – 5	kWp:	2.800 €/kWp
5 - 10	kWp:	2.650 €/kWp
10 - 50	kWp:	2.450 €/kWp
30 -100	kWp:	2.450 €/kWp
> 100	kWp:	2.300 €/kWp

1.3 PV production

Production of cells (Si + thin film) [11]	2.656 MWp
Production of ingots and wafers [2]	1990 MWp
Production of feedstock silicon [2]	31.300 t
PV power generation [3]	12.000 GWh

1.4 Budgets for PV in 2010

R&D budget for PV projects by BMU [7]	39,0 Mio. €
R&D budget for PV projects by BMBF [7]	~ 25,0 Mio. €

2 THE IMPLEMENTATION OF PV SYSTEMS

2.1 Applications for Photovoltaics

Economy and Policy

Energy policy is a prominent topic on the political agenda in Germany for years. Since 2004, Germany is among the countries with the highest annual PV installations worldwide. In 2010 more than 50 % of the worldwide PV installations were carried out in Germany.

In August 2010, the German National Renewable Energy Action Plan was published. The action plan outlines that the binding domestic target of an 18 percent share of renewable energies in gross domestic energy consumption will be reached by 2020 and may even be surpassed and amount to 19,6 percent [12]. In addition to this, the Federal Government submitted an energy concept in autumn 2010 [13] whose outline is broader than that of the national action plan. The concept comprises conventional energy sources as well as renewable energies and takes energy efficiency developments into consideration. The aim was to develop and implement an overall strategy for the period up to 2050. Concerning renewable energies, it states that this energy source will contribute the major share to the energy mix of the future. Photovoltaic (PV) is part of this development. At end of 2010, a PV capacity of around 17,2 GW [1, 14] is connected to the grid; meaning an increase of around 7,4 GW [1] in 2010 alone.

The main driving force for the PV market in Germany is the Renewable Energy Sources Act (EEG) [9]. In terms of achieving expansion targets for renewable energies in the electricity sector, the EEG is the most effective funding instrument at the German government's disposal. It determines the procedure of grid access for renewable energies and guarantees favorable feed-in tariffs for them paid via the utilities.

For PV, the feed-in tariff depends on the system size and whether the system is ground mounted or attached to a building. Since 2009, there is also a tariff for self consumed power. The rates are guaranteed for an operation period of 20 years. For the 2010 and current tariffs see [14].Initially, a steady yearly reduction of the PV tariffs was foreseen. On the background of a constantly rising number of installations, a mechanism was introduced to adapt the EEG tariff to the market growth. Under this scheme, the reductions are increased or decreased if the marked deviates from a predefined corridor.

For 2009 this corridor was defined to be between 1 000 MW and 1 500 MW - which was significantly exceeded as the market reached 3 800 MW. For 2010 to 2012, a new corridor between 2 500 and 3 500 MW was defined. Furthermore, for 2010 two additional reduction steps were agreed to adapt the tariff to the system price level. This resulted in an overall reduction of roughly 1/3 from end of 2009 to early 2011.With around 7 000 MW installed in 2010 the new corridor was surpassed again considerably. Therefore, it is foreseen to implement the reduction foreseen for 2012 already partly in July 2011.

Beside the EEG support for the development of PV installations the decrease of system prices continues which makes PV systems economically more and more attractive. An analysis published by BSW-Solar, the German Solar Industry Association, shows that the average price for PV roof top systems of less than 100 kW arrived at 2 724 EUR/W in the last quarter of 2010 [1]. After a reduction of 25 % from 2008 to 2009 this is another drop of 13 % from 2009 to 2010.

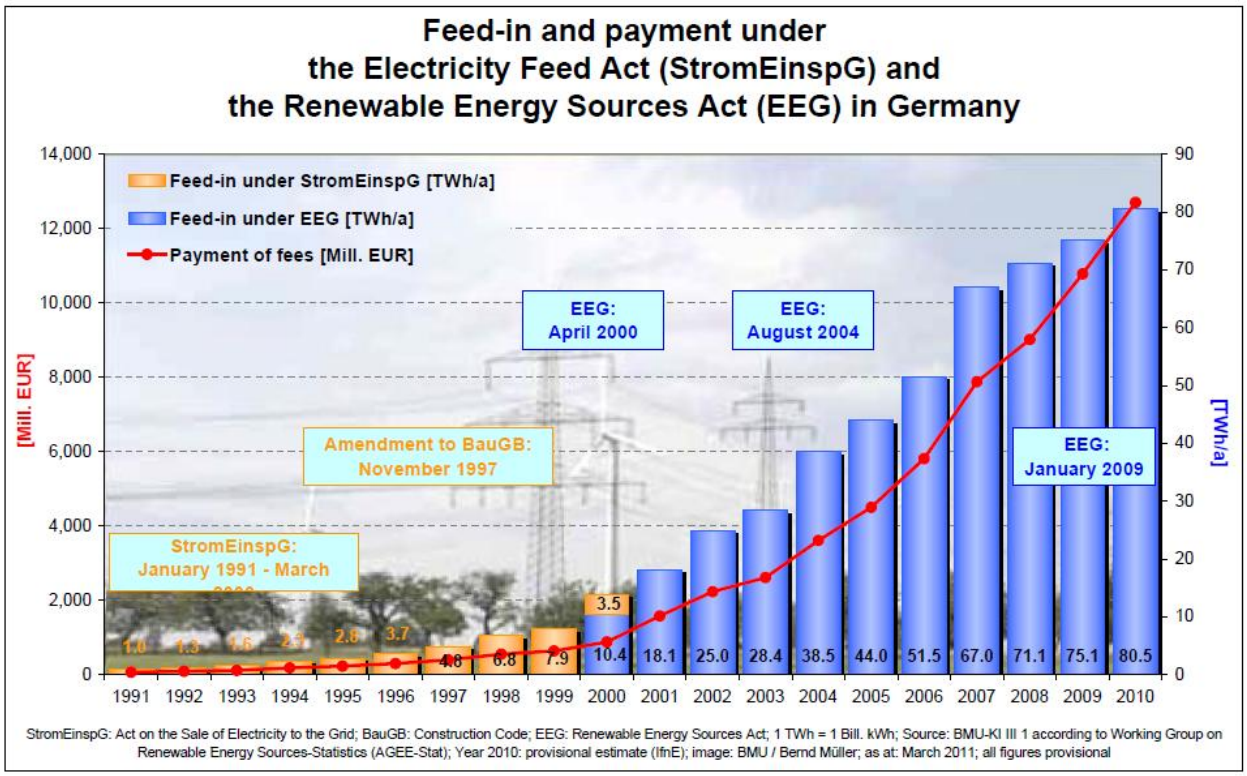
In addition to the EEG, PV receives support from other sources: local fiscal authorities provide tax credits for PV investments; the state owned bank KfW-Bankengruppe provides loans for individuals as well as for local authorities.

Since the beginning of 2009 the owners of new PV systems are legally obliged to register their systems at the German Federal Network Agency. The published statistics of the Federal Network Agency in March 2011 show an additional capacity of 7,4 GW and around 17.3 GW in total connected to the German grid.

As a consequence, Germany produced 12 TWh PV-electricity in 2010, which are roughly 2 % of the domestic consumption [3]. All renewable energies together have a share of 16,8 % of the domestic energy supply [3]. At the same time, the German National Renewable Energy Action Plan includes a target of a 38,6 % share of renewable energies in the electricity sector for 2020. For PV, the scenario assumes a future development of annually 3 500 MW from 2012 to 2020. This leads to an installed capacity of almost 52 GW in 2020 and a resulting electricity production of around 7 % of the overall production [12].In addition to the market of grid connected systems, there is a steady request for standalone systems. It can be estimated that in 2010 around 5 MW were installed additionally in numerous applications, such as the traffic signals, garden lights, etc..

Over the last years, not only the German PV market but also the German PV industry showed a strong and steady growth. The German foreign trade and inward investment agency “Germany Trade & Invest” [5] lists 69 companies involved in PV production creating a turnover of 12,2 billion EUR in 2010. In addition around 100 PV equipment manufacturers supply tools for every step of the PV value chain. Beside this, the development of inverter industry with a production equivalent of 11 GW is another success story. The investment in PV installations amounts to 19,5 billion € [3]. BSW [1] estimates around 860.000 grid connected PV-systems in Germany presently.

At the end of 2010, around 133.000 workers were employed in the PV industry, in handcraft and trade companies [1].



In Germany, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) takes the responsibility for the renewable energies within the Federal Government.

Research and Development (R&D) is conducted under the 5th Federal Programme on Energy Research and Energy Technology “Innovation and New Energy Technologies”.

Within this framework, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) as well as the Federal Ministry of Education and Research (BMBF) support R&D ranging from basic research to applied research on almost all aspects of PV.

2.2 Total photovoltaic power installed

Due to the fast development of the German PV market it was difficult to trace the numbers of installations. The sources for numbers were mainly the magazine Photon and the BSW (German Solar Industry Association) and data often were different.

But since the beginning of 2009 the owner of new PV systems are legally obliged to register their systems at the German Federal Network Agency (GFNA). Another official source is the "Working Group on Renewable Energy Statistics" (AGEE-Stat) working on behalf of the BMU. This group supplies a lot of data for all renewable energies and in detail. Furthermore BSW supplies data emphasised on the market developments. The fourth source is the "German Trade and Invest (GTI)" collecting data to support foreign investors to enter the German market. Interesting are its list of companies working in the PV market updated quarterly.

One should be aware of that the figures of these institutions may be update and corrected during the year. The figures of AGEE-Stat changed also for the past years due to an improved data collection. Since 2009 AGEE-Stat takes over the data the German Federal Network Agency.

There are nearly no information about off-grid non domestic and grid connected centralized systems in Germany because the electricity supply is completely connected to the public grid. Therefore, there is no need for these systems and regarding the total installed capacity of PV, these systems are negligible.

In addition to the market of grid connected systems, there is a steady request for standalone systems but reliable data are difficult to obtain and only available late in the year. AGEE-Stat has corrected its number of installed capacity for 2009 from 9800 to 9914 including 69 MW of stand-alone systems or own consumption. Thus an estimation for 2010 of about 5 MW is made for stand-alone systems in Germany. That means less than 1 ‰ of grid connected PV capacities.

Due to the official registration procedure the accuracy of these data can be assumed better than ± 1 %.

In spring 2010 these institutions have supplied similar numbers for the installations of PV:

Institution	Newly installed PV-capacity (MW)	Total installed capacity (MW)
GFNA	7.400	17.300
AGEE-Stat	7.406	17.320
BSW	7.400	17.200
GTI	7.400	17.300

For this report the figures of AGEE-Stat will be used. The estimated figure for stand-alone system will be added with 5 MW for 2010 and a total number of 50 MW.

Table 1: PV power installed during calendar year 2010 in 2 sub-markets.

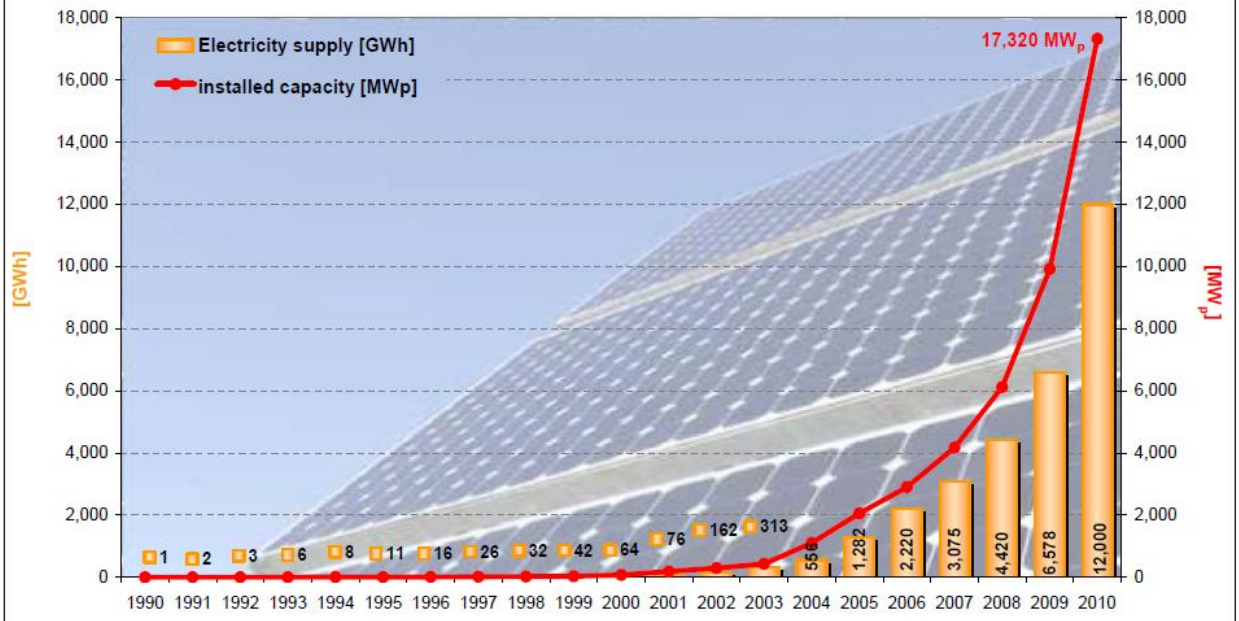
Sub-market/ application	off-grid domestic	off-grid non-domestic	grid-connected distributed	grid-connected centralized	Total
PV power installed in 2009 (kW)	5	-	7406	-	7411

A summary of the cumulative installed PV Power, from 2000-2010, broken down into four sub-markets is shown in table 2.

Table 2: The cumulative installed PV power in 2 sub-markets; updated after [3]

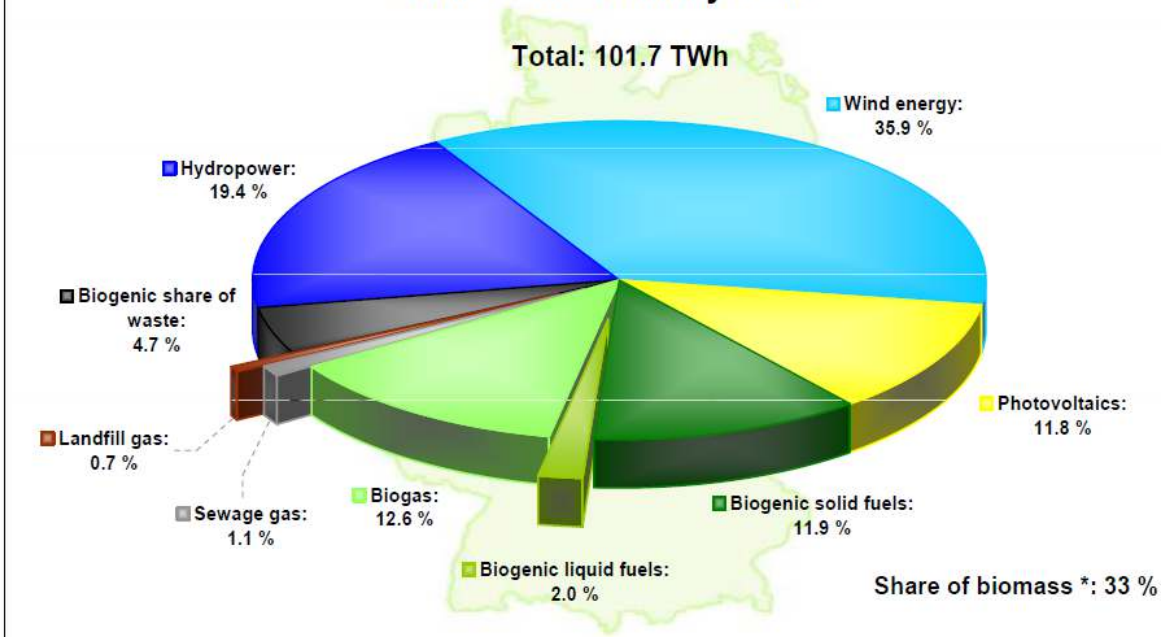
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Off-grid	14	16	20	23	26	29	32	35	40	45	50
Grid-connected	76	186	296	435	1105	2056	2899	4170	6120	9914	17.320
Total	90	202	316	458	1131	2085	2931	4205	6160	9959	17.370

Installed capacity and energy supply from photovoltaic installations in Germany

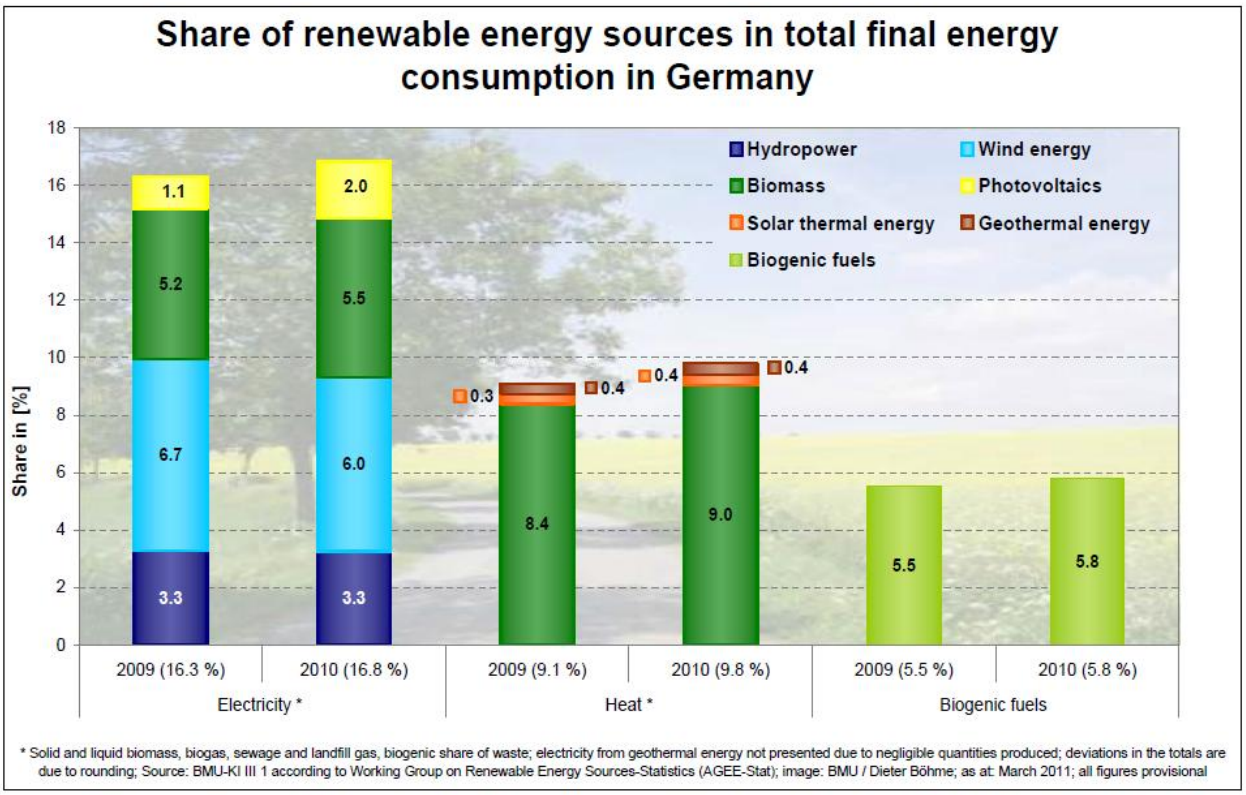


Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat);
1 GWh = 1 Mill. kWh; 1 MW = 1 Mill. Watt; image: BMU / Bernd Müller; as at: March 2011; all figures provisional

Structure of electricity supply from renewable energy sources in Germany 2010



* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; electricity from geothermal energy not presented due to negligible quantities produced; deviations in the totals are due to rounding; 1 TWh = 1 Bill. kWh; Source: BMU-KI III 1 according to Working Group on Renewable Energy Sources-Statistics (AGEE-Stat); as at: March 2011; all figures provisional



Germany has a wide range of policy and promotional initiatives. First of all is the mentioned EEG with the feed-in tariff. Additionally there are tax credits for investments in PV and loans by KfW for measures to reduce energy consumption and the application of renewable energies in buildings. Some states award grants for PV plants.

A lot of journals offer information about PV, some only specific for PV, others under the theme “Renewable Energy”.

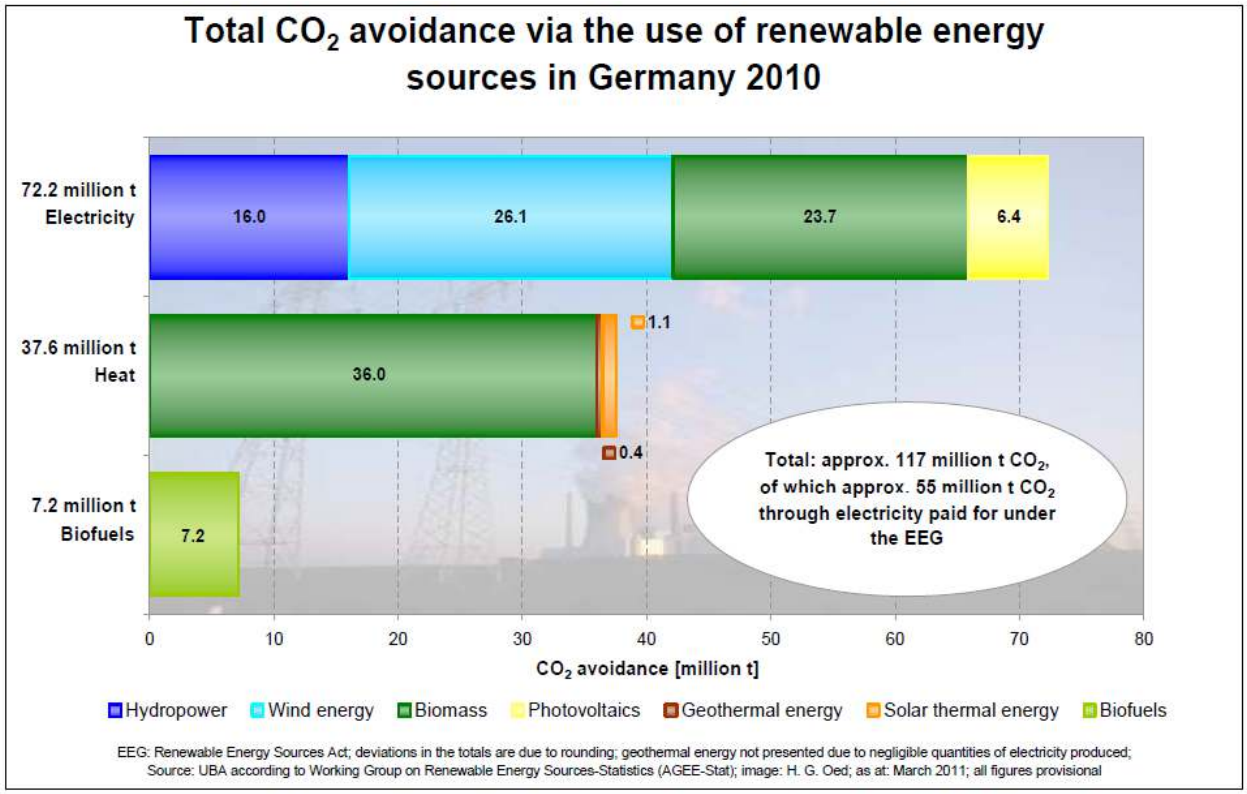
The internet provides several websites, dedicated to PV and renewable energies like:
http://www.bmu.de/english/aktuell/4152.php
http://www.erneuerbare-energien.de/inhalt/39831/39882/
http://en.solarwirtschaft.de
http://www.solarserver.com
http://www.dgs-solar.org/
http://www.solarcontact.de/
http://www.solarfoerderung.de
http://www.eurosolar.de/en/
http://www.top50-solar.de/en
http://www.bine.info/
http://www.dena.de/
http://www.german-renewable-energy.com
http://www.renewables-made-in-germany.com/en/photovoltaics/
http://www.renewablesb2b.com
http://www.gtai.com

BSW represents the German PV and solar thermal industry and supply a lot of market data (http://www.solarwirtschaft.de). The Germany Trade & Invest [5] has the task to acquire

foreign enterprises for investments in Germany. This organisation supplies a lot of commercial information and supports investors individually (http://www.gtai.com).

As the result of these long term initiatives, there is a broad awareness and acceptance for renewable energy and PV by the public. In consequence, a constant demand exists for PV products.

Beside these promotion activities, PV industry is an important branch in the technology sector and gains more and more attention in the public.



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

Due to the mature PV market in Germany, technical orientated demonstration and large field test activities are not in the centre of interest anymore. The proof that PV works in different kind of applications is done. Therefore, the industry focuses their activities in process optimization to reduce the production cost and to increase the quality of their products. Also recycling is becoming more interesting.

2.4 Highlights of R&D

will follow

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

In Germany, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) takes the responsibility for the renewable energies within the Federal Government.

Research and Development (R&D) is conducted under the 5th Programme on Energy Research and Energy Technology “Innovation and New Energy Technologies” [10]. The Programme was originally designed to be valid for the period from 2006 to 2008. It was now extended until 2010. Within this framework, the BMU as well as the BMBF (Federal Ministry of Education and Research) support R&D on different aspects of PV. Both parts of the programme are administrated by the Project Management Organisation PtJ in Jülich.

Funding Activities of the BMU

Every two years BMU invites renowned experts to a photovoltaics strategy meeting in Glottertal to discuss research priorities and draw up guidelines. The 11th Glottertal Strategy Meeting was held in November 2009. As a result of the discussions, the following areas of research currently funded had a greater structural focus in 2010:

- silicon wafer technology,
- thin-film technologies,
- systems engineering and grid integration, and
- concentrating photovoltaics.

The structural focus will mean that:

- BMU funding will still primarily target precompetitive research and virtually all German companies will be able to access the findings.
- Consequently, the aim is to achieve an allocation of funds, which, as in the past, places greater emphasis on medium- and long-term research. The time horizon for implementing the findings of the research funded is usually five years.

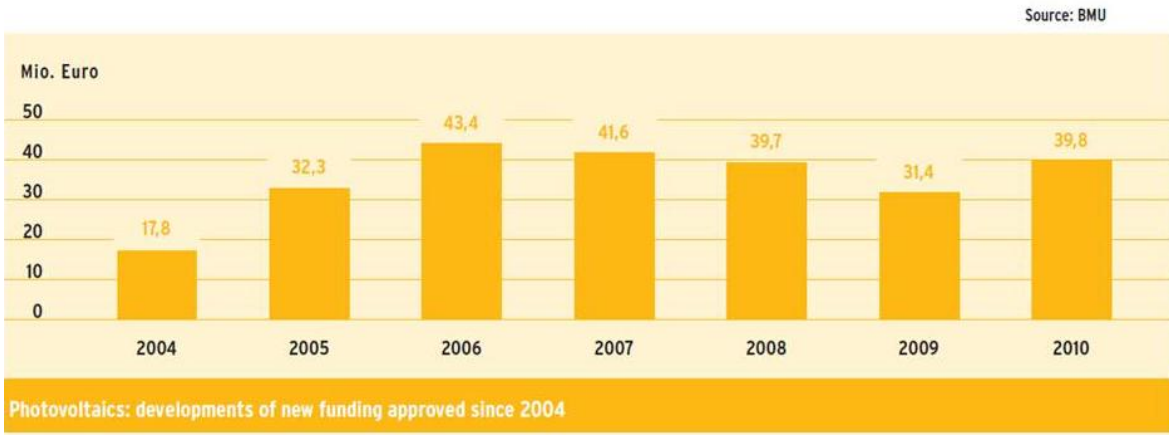
Criteria for selecting projects are:

- industry participation and a networking structure; preference is given to collaborative projects;
- development risk and time horizon for implementation;
- possibility of broad dissemination of the research findings, while taking into account the need to protect the findings through patents.

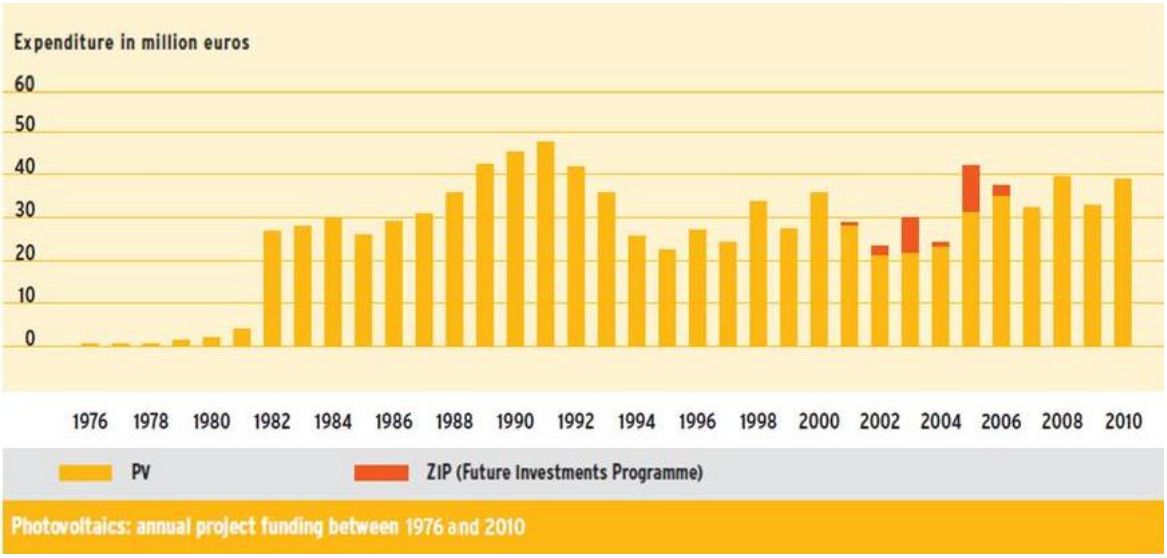
As well as technology-specific topics, cross-cutting issues such as increasing the lifetime of plant and equipment, reducing the energy used in the production process, and recycling are also funded.

In 2010 the BMU support for R&D projects on PV amounted to about 39,1 MEUR shared by 152 projects in total. The focal point is still on silicon wafer technology. The second centre of attention lies on thin-film technologies especially on silicon and CIS thin-film technologies. Furthermore, the German contributions to the PVPS Tasks 1, 11, 12, 13 and 14 are part of the programme. During 2010, 45 new grants were contracted. The funding for these

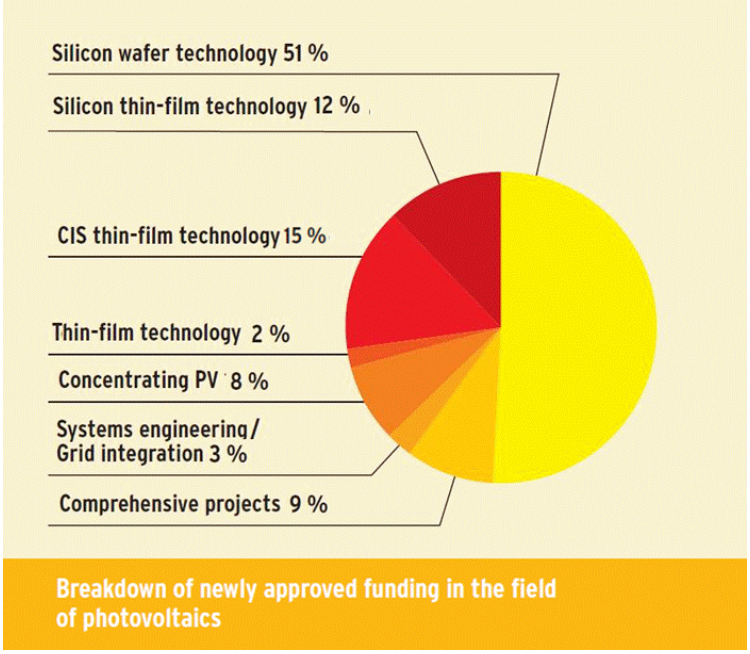
projects amounts to 39,8 MEUR in total. Details on running R&D projects can be found in the BMU “Annual Report on Research Funding in the Renewable Energies Sector” [7] or via a web-based database www.forschungsjahrbuch.de owned by PtJ [15].



Photovoltaics: developments of new funding approved since 2004



Photovoltaics: annual project funding between 1976 and 2010



Breakdown of newly approved funding in the field of photovoltaics

In 2010, BMU approved 45 new projects on photovoltaics (2009: 36), corresponding to a funding volume of 39.8 million Euros (2009: 31.4 million Euros). At the same time 39 million Euros were allocated to ongoing projects [7].

Funding Activities of the BMBF

In 2008, the BMBF published its concept paper ”Basic Energy Research2020+” aiming for the support of long-term R&D on renewable energies which is complementary to the BMU funding. Concerning PV, currently there are three focal points of engagement: A joint initiative of BMBF and industry addresses the development of organic solar cells. A call for networks aiming for the development of thin-film solar cells was initiated in 2008. First projects started in 2009, putting emphasis on topics like material sciences including nanotechnology, new experimental or analytical methods and the usage of synergies with other fields of research like microelectronics or bionics. Additionally, the BMBF funds the development of the cluster “Solarvalley Mitteldeutschland” as part of the Federal High-Tech Strategy. This cluster comprises most of Germany's PV industry and received federal grants of 40 MEUR for a period of four years.

Innovation Alliance PV - a Joint Initiative of BMU and BMBF

In summer 2010, BMU and BMBF initiated the Innovation Alliance PV. Under this scheme R&D projects will be funded which support a significant reduction of PV production costs in order to enhance the competitiveness of Germany's industry. Therefore, projects under industrial leadership integrating different steps of the PV value chain are sought. In particular, cooperation between PV industry and PV equipment suppliers is of importance.

Together, BMU and BMBF will support this initiative with 100 MEUR. The German PV industry agreed to raise additional 500 MEUR to accompany the Innovation Alliance. First R&D projects will start at the beginning of 2011.

Table 3: Public budgets for R&D, demonstration/field test programmes and market incentives in Germany 2009.

R&D budget for PV projects by BMU [7]	39,0 Mio. €
R&D budget for PV projects by BMBF [7]	> 25,0 Mio. €
Industrial R&D investments (2008) [1]	163,0 Mio. €

PV feed-in tariff of the EEG from 2010

Date of commissioning	< 30 kWp	up to 100 kWp	up to 1 MWp	> 1MWp
01.01.2010 - 30.06.2010	39,14	37,23	35,23	29,37
01.07.2010 - 31.09.2010	34,05	32,39	30,65	25,55
01.10.2010 - 31.12.2010	33,03	31,42	29,73	24,79
01.01.2011 - 30.06.2011	28,74	27,33	25,86	21,56
01.07.2011 - 31.12.2011	24,43	23,23	21,98	18,33
2012 (- 9%)	22,23	21,14	20,00	16,68
2013 (- 9%)	20,23	19,24	18,20	15,18

No feed-in tariff anymore for ground mounted systems on agricultural used fields from 1st of July 2010!

3 INDUSTRY AND GROWTH

Due to the rapid growth of the German PV market with 90 % in 2010 it is a challenge to track the numbers for production and production capacities of the PV companies. For this report the numbers are taken from the magazine Photon [2, 11], edition 1/11 and 4/11, the press release of BSW [1] in 3/11 and the tables of “Germany Trade and Invest” in 3/11 [5].

During the year 2010 a lot of companies opened new production facilities or expanded their production or even closed. In consequence it is not always possible to calculate the degree of capacity utilization due to differing operation and commissioning.

One must pay attention to the figures for modules and cells. Some sources are counting modules as the sum of modules based on silicon cells and thin-film-cells together. In other sources “thin-film modules” are regarded as thin-film cells.

Another obstacle is that the statistics often called “preliminary” or “first estimate” and get updated during the year. Additionally you can find tables with a mixture of data supplied by the enterprises and estimates by the publisher.

Some enterprises are producing Si-cells as well as thin-film cells or Si-modules and thin-film modules. Sometimes only the overall production or production capacity is stated without any distinction of the production type.

Numbers for production capacities are available only by Photon and German Trade & Invest.

By using of the here presented data take this circumstances into account.

For all the above mentioned reasons the figures are rounded for clarity’s sake based on the used sources. Nevertheless the accuracy of the data should be around ± 5%.

3.1 Production of feedstocks, ingots and wafers

Table 3: Production information for the year for silicon feedstock, ingot and wafer producers in 2010, Germany [2]

Producers	Process & technology	Total Production	Maximum production capacity	Product destination
Silicon feedstock		*t/year*	*t/year*	
Wacker-Chemie	Silicon feedstock	30.000	32.000	market
Joint Solar Silicon GmbH & Co. KG	Silicon feedstock	100	200	subsidiary
Total		**30.100**	**32.200**	
Ingots		*t/year*	*t/year*	
PV Crystalox Silicon GmbH	sc-Si ingots.	**1200**	***1800***	market
Wafer		*MW/year*	*MW/year*	
Bosch Solar Wafers	sc/mc-Si wafers	250	450	market
Conergy	mc-Si wafers	210	250	subsidiary, market
Deutsche Solar AG (Solarworld)	mc-Si wafers	750	750	subsidiary, market
Sovello AG (ex- EverQ)	mc-Si wafers	150	170	subsidiary
PV Silicon AG	sc-Si wafers	350	350	market
Schott Solar Wafer GmbH	mc-Si wafers	280	300	subsidiary
Total		**1990**	**2270**	

3.2 Production of photovoltaic cells and modules

Table 4: Production and production capacity in Germany for 2010 (Data based on [2]

Technology Type	Production MW	Capacity MW
Si-cells	1950	2300
amorphous Si cells	260	400
CIS cells	150	320
CdTl cells	240	240
CPV cells	10	20
Si-Module	1800	2300

Other published figures:

Cells (Si-cells + thin-film): 2.700 MW [11]

Modules: (Si-modules + thin-film): 3.200 MW [1]

Modules: (Si-modules + thin-film): 2.600 MW [2]

Table 5a (1)**: Production capacity and number of employees in Germany for 2010 after [4]**

Value Chain	No.	Company	Locations	Capacity 2011 [MWp]	Empl.*
Silicon	01	Wacker Chemie	Burghausen, Nünchritz	33,000t	1766
	02	PV Crystalox Solar Silicon	Bitterfeld-Wolfen	1,800t	115
	03	JSSi	Rheinfelden	850t	n/a
	04	Schmid Pilot Production	Spreewitz[1]	150t	90
Wafer	05	SCHOTT Solar Wafer	Jena	500	400
	06	PV Crystalox	Erfurt	400	145
Cell	07	Q-Cells	Bitterfeld-Wolfen	500	1300
	08	SCHOTT Solar	Alzenau	305[2]	520[2]
	09	ITS Innotech Solar	Halle[1]	135	36
	10	Sunways	Konstanz, Arnstadt	116	350
	11	Solland Solar Cells	Aachen	110	275
	12	ARISE Technologies	Bischofswerda, Gelsenkirchen	85	160
	13	Systaic	Heilbronn	-	40
Module	14	CENTROSOLAR	Wismar	350	700
	15	aleo solar (Bosch)	Prenzlau	280	801
	16	SOLON	Berlin, Greifswald	251	470
	17	SOLARWATT	Dresden	240	470
	18	Solar-Fabrik	Freiburg	210	350
	19	Scheuten Solar Technology	Gelsenkirchen	200	270
	20	Heckert Solar	Chemnitz	180	205
	21	ALGATEC Solar	Prösen, Großräschen	130	233
	22	asola	Erfurt	45	120
	23	Antaris JuraWatt	Neumarkt	40	45
	24	solarnova	Wedel	25	40
	25	alfasolar	Hannover	20	85
	26	arinna	Berlin	20	50
	27	GSS	Korbußen	20	44
	28	Webasto Solar	Landsberg/Lech	20	40
	29	Solarbau Süd	Großbettlingen	15	43
	30	Sunware	Duisburg	< 1	20
	31	Sunovation	Klingenberg	< 1	5
	32	Q-mo solar	Teltow	< 1	5
	33	Wulfmeier Solar	Bielefeld	< 1	5
	34	Q-Cells	Bitterfeld-Wolfen[1]	-	1300
Fully Integrated	35	SolarWorld	Freiberg	1000/250/550	990
	36	Bosch Solar Energy	Arnstadt	400/550/150	2500
(Wafer/Cell/ Module)	37	Conergy	Frankfurt (Oder)	200/250/250	750
	38	Sovello	Bitterfeld-Wolfen	180/180/180	1250

1) Planned/Under construction
2) Numbers from 2010 only
*) Total number of employees at respective locations

Source: Germany Trade & Invest,
Information provided by the respective company,

Table 6a (2): Production capacity and number of employees in Germany for 2010 [4]

Value Chain	No.	Company	Locations	Capacity 2011 [MWp]	Empl.*
CPV	39	Concentrix Solar	Freiburg	25	80
Thin Film					
	40	Schüco TF	Großröhrsdorf	110	150
	41	Masdar PV	Ichtershausen	75	270
	42	Malibu (Schüco)	Osterweddingen	45	120
a-Si	43	Inventux	Berlin	40	200
a-Si/µc-Si	44	Bosch Thin Film	Erfurt	40	195
	45	SCHOTT Solar Thin Film	Jena	35[2]	200[2]
	46	EPV SOLAR	Senftenberg	30	110
	47	Wilms Gruppe	Bitterfeld-Wolfen	25	79
	48	CENTROSOLAR	Paderborn	6.5	10
	49	Solibro (Q-Cells)	Bitterfeld-Wolfen	135	500
	50	AVANCIS	Torgau	120	223
	51	Nanosolar	Luckenwalde	120	77
	52	Sulfurcell	Berlin	35	250
CIS	53	Global Solar	Berlin	35	100
CIGS	54	Würth Solar	Schwäbisch Hall	30	280
CIGSSe	55	Bosch Solar CIS Tech	Brandenburg	30	150
	56	Odersun	Frankfurt (Oder), Fürstenwalde	25	330
	57	Solarion	Leipzig	Pilot	50
	58	CIS Solartechnik	Bremerhaven	Pilot	25
	59	PVflex Solar	Fürstenwalde	Pilot	20
	60	First Solar	Frankfurt (Oder)	447	600
CdTe	61	Calyxo (Q-Cells)	Bitterfeld-Wolfen	25	140
	62	ANTEC Solar	Arnstadt[1]	n/a	n/a
Poly-Si	63	CSG Solar	Bitterfeld-Wolfen	-	44
GaAs	64	Azur Space Solar Power	Heilbronn	250	135
OPV	65	heliatek	Dresden[1]	-	55
PV & Thermal	66	Solarzentrum Allgäu	Altdorf-Biessenhofen	2	100
	67	solarhybrid	Markranstädt	n/a	50
	68	Grammer Solar	Amberg	n/a	45
	69	Heli Solar	Blankenburg[1]	n/a	5

3.3 Module prices

The installation of PV systems in Germany was boosted again in 20110 driven by the Renewable Energy Sources Act (EEG) on the one hand, and on the other hand there was a decrease of system prices and modules. In 2010 the feed-in tariff was reduced and the prices of the systems were following.

Regarding the development of module prices a distinction must be made between end costumer price and wholesale prices.

Table 7: Typical module prices for a number of years (end costumer, VAT excl.)

Year	1992	2000	2001	2002	2003	2004.	2005	2006	2007	2008	2009	2010
Module price(s): Typical	5,98	3,58	3,53	3,5 -4,3	3,1-3,9	3,0- 9,6	3,0 -6,0	3,0- 5,3	3,0- 4,8	3,0- 4,3	1,5 -2,5	2,2-3,6
Best price								4,0	3,0	2,0	2,0	2,0

For wholesale prices the “www.solarserver.de” [6] publishes every month the spot price for modules which corresponds more or less to the wholesale prices.

Table 8a: Typical spot market module prices (wholesale, VAT excl.) after [6]

Type of Module, origin	January ‘10	December‘10	Trend since 01/10	Trend since 01/09	April ‘11
	€ / Wp	€ / Wp			€ / Wp
Crystalline Europe	2,03	1,75	- 13,8 %	- 36,4 %	1,32
Crystalline China	1,55	1,55	0,0 %	- 47,5 %	1,54
Crystalline Japan	1,91	1,71	- 10,5 %	- 39,6 %	1,09
Thin-film CdS/CdTe	1,61	1,38	- 14,3 %	- 23,3 %	0,94
Thin-film a-Si/µ-Si	1,38	1,22	- 11,6 %	- 37,6 %	1,19

3.4 Manufacturers and suppliers of other components

Due to the well developed PV industry all components for an entire PV system are available in Germany. An excellent overview is given by [4] (see following tables). For details see the website of the companies.

Leading PV Equipment Suppliers Produce in Germany

Equipment	No.	Company[1]	Locations	Empl.[2]
Silicon	01	centrotherm SiTec	Blaubeuren	150
- Equipment	02	Decker	Berching	50
	03	G+R GreenTech	Regenstauf	200
	04	PVA TePla	Wettenberg, Jena	300
	05	STANGL Semiconductor Equipment	Fürstenfeldbruck	170
Ingot/Wafer	06	ALD Vacuum Technologies	Hanau	365
- Equipment	07	Centrotherm SiTec	Blaubeuren	150
	08	Elma	Singen	190
	09	G&N	Erlangen	33
	10	Herbert Arnold	Weilburg	190
	11	HK Präzisionstechnik	Obernburg	40
	12	KUKA Systems	Augsburg	1200
	13	LOG-O-MATIC	Mainaschaff	20
	14	PVA TePla	Wettenberg, Jena	300
	15	RENA	Gütenbach, Berg, Herrenberg	1150
	16	Schmid	Freudenstadt, Niedereschach	750
	17	STANGL Semiconductor Equipment	Fürstenfeldbruck	170
Cell	18	centrotherm photovoltaics group	Blaubeuren	1500
- Turnkey Lines	19	Roth & Rau	Hohenstein-Ernstthal	500
	20	Schmid	Freudenstadt, Niedereschach	750
	21	SINGULUS TECHNOLOGIES	Kahl	270
Cell	22	centrotherm thermal solutions	Blaubeuren	470
- Thermal Equipment	23	ATV TECHNOLOGIE	Vaterstetten	24
	24	Rehm Thermal Systems	Blaubeuren	170
Cell	25	Decker	Berching	50
- Wet Chemistry	26	LOTUS Systems	Gutmadingen	90
	27	Ramgraber	Hofolding b. Brunnthal	45
	28	RENA	Gütenbach, Berg, Herrenberg	1150
	29	Schmid	Freudenstadt	550
	30	STANGL Semiconductor Equipment	Fürstenfeldbruck	170
Cell	31	Applied Materials	Alzenau	540
- Anti-reflective Coating	32	centrotherm photovoltaics group	Blaubeuren	1500
	33	Roth & Rau	Hohenstein-Ernstthal	500
	34	Schmid	Freudenstadt	550
	35	SINGULUS TECHNOLOGIES	Kahl	270
	36	VON ARDENNE Anlagentechnik	Dresden	570
Cell	37	ASYS Automatisierungssysteme	Dornstadt	400
- Screen Printers	38	JRT Photovoltaics	Malterdingen	80
	39	Manz Automation	Reutlingen	400
	40	THIEME	Teningen	350

Continuation

Module - Turnkey Lines	41	ACI-ecotech	Zimmern ob Rottweil	100
	42	ATS Automation Tooling Systems	Munich	80
	43	Böhm-Solar Equipment Technology	Zella-Mehlis	200
	44	Bürkle	Freudenstadt, Rietberg	140
	45	centrotherm photovoltaics group	Blaubeuren	1500
	46	JVG Thoma	Freystadt	40
	47	KUKA Systems	Augsburg	1200
	48	MAG	Göppingen	320
	49	Maschinenbau GEROLD	Nettetal	50
	50	REIS ROBOTICS	Obernburg	830
	51	Schmid	Freudenstadt, Niedereschach	750
	52	Teamtechnik	Freiberg am Neckar	350
Module - Stringers, Laminators	53	Böhm-Solar Equipment Technology	Zella-Mehlis	200
	54	Bürkle	Freudenstadt, Rietberg	140
	55	IMA Automation Berlin	Berlin	56
	56	JVG Thoma	Freystadt	40
	57	Meier Solar Solutions	Bocholt, Roßla	140
	58	REIS ROBOTICS	Obernburg	830
	59	Robust	Remscheid	80
	60	Schmid	Niedereschach	200
	61	SOMONT	Umkirch	100
	62	Spaleck/ SPALECK-STEVENS InnoTech	Bocholt	240
	63	Teamtechnik	Freiberg am Neckar	350
	64	USK Karl Utz Sondermaschinen	Limbach-Oberfrohna	230
Thin Film - Turnkey Lines	65	Bürkle	Freudenstadt, Rietberg-Mastholte	140
	66	centrotherm photovoltaics group	Blaubeuren, Dresden	1370
	67	LEYBOLD OPTICS	Alzenau, Dresden	380
	68	Manz Automation	Reutlingen	400
	69	Roth & Rau	Hohenstein-Ernstthal	500
Thin Film - Vacuum Deposition	70	Aixtron	Herzogenrath	450
	71	Applied Materials	Alzenau	540
	72	FHR Anlagenbau	Ottendorf-Okrilla	170
	73	LEYBOLD OPTICS	Alzenau, Dresden	380
	74	VON ARDENNE Anlagentechnik	Dresden	570

Continuation

Automation	75	ACI-ecotec	Zimmern ob Rottweil	100
	76	AMB Automation	Langweid	50
	77	ASYS Automatisierungssysteme	Dornstadt	400
	78	ATMsse	Singen	50
	79	ATS Automation Tooling Systems	Munich	80
	80	Baumann	Amberg	210
	81	Bürkle	Freudenstadt, Rietberg-Mastholte	140
	82	Grenzebach	Hamlar	1500
	83	IMA Automation Berlin	Berlin	56
	84	Jonas & Redmann Photovoltaics	Berlin	650
	85	JRT Photovoltaics	Malterdingen	80
	86	KUKA Systems	Augsburg	1200
	87	MAG	Göppingen	320
	88	Manz Automation	Reutlingen	400
	89	Maschinenbau GEROLD	Nettetal	50
	90	MiniTec Maschinenbau	Waldmohr	170
	91	Mondragon Assembly	Stockach	20
	92	Olbricht	Hamminkeln-Brünen	30
	93	REIS ROBOTICS	Obernburg	800
	94	RENA	Gütenbach, Gutmadingen, Berg	1150
	95	Rommel	Ehingen	100
	96	Schiller Automation	Sonnenbühl-Genkingen	264
	97	Schmalz	Glatten	420
	98	Schmid	Niedereschach	200
	99	SLS Solar Line Saxony	Limbach-Oberfrohna	20^{3}
Laser Processing	100	3D-Micromac	Chemnitz	70
	101	4JET	Ahlsdorf	30
	102	ASYS Automatisierungssysteme	Dornstadt	400
	103	InnoLas	Krailling	80
	104	Jenoptik Automatisierungstechnik	Jena	200
	105	LPKF SolarQuipment	Suhl-Friedberg	50
	106	MAG	Göppingen	320
	107	Manz Automation	Reutlingen	400
	108	Rofin	Starnberg, Hamburg, Günding	1600
	109	Schmid	Schwetzingen	60

Leading Manufacturers of Materials for PV Modules Produce in Germany

Material	No.	Company	Locations	Empl.*
Wires	01	BRUKER-SPALECK GmbH	Schramberg	50
	02	Heraeus Holding GmbH	Hanau	25
	03	Schlenk Metallfolien GmbH	Roth	100
Frontsheets	04	Jura Plast GmbH	Reichenschwand	50
	05	Kuraray Europe GmbH Trosifol	Troisdorf	600
	06	Solutia GmbH	Dietenheim	70
	07	Wacker Chemie AG	Burghausen	10000
Backsheets	08	Krempel GMBH	Kuppenheim	850
Glass	09	EUROGLAS GmbH	Haldensleben	580
	10	f | glass GmbH	Osterweddingen	265
	11	GMB Glasmanufaktur Brandenburg GmbH	Tschernitz	210
	12	GVB Solutions in Glass	Aachen	15
	13	Hecker Glastechnik GmbH	Dortmund	100
	14	Pilkington Deutschland AG	Weiherhammer	480
	15	Saint Gobain Deutsche Glas GmbH	Bremen, Deggendorf, Mannheim, Wilsdruff, Torgau	640
	16	Scholl Glastechnik GmbH	Nossen-Heynitz	250
Glass Processing	17	CENTROSOLAR GLAS GmbH & Co. KG	Fürth	300
	18	GBT Bischoff Glastechnik AG	Bretten	220
	19	Glaswerke Arnold GmbH & Co. KG	Remshalden	370
	20	Hecker Glastechnik GmbH & Co. KG	Dortmund	100
	21	Schott Technical Glas Solutions GmbH	Jena	150
	22	Vetro Solar GmbH	Thalheim	65
Tapes/ Adhesives/ Sealants	23	3M Deutschland GmbH	Hilden	910
	24	DELO Industrie Klebstoffe GmbH & Co. KG	Windach	190
	25	Dow Corning GmbH	Wiesbaden	350
	26	Hermann Otto GmbH	Fridolfing	300
	27	KÖMMERLING Chemische Fabrik GmbH	Pirmasens	360
	28	Lohmann GmbH & Co. KG	Neuwied	400
	29	Schreiner ProTech	Oberschleißheim	700
	30	tesa SE	Hamburg	415
	31	Wacker Chemie AG	Burghausen	10000
Frames	32	Alcan Aluminium-Presswerke GmbH	Landau	330
	33	Benz Alusysteme GmbH	Ingersheim	14
	34	Cziotec GmbH	Greifswald	105
	35	Gutmann AG	Weißenburg	650
	36	heroal - Johann Henkenjohann GmbH & Co.KG	Verl	330
	37	Hydro Aluminium Extrusion Deutschland GmbH	Uphusen, Rackwitz	410
	38	RBB Aluminium Profiltechnik AG	Wallscheid	165
	39	Sapa Aluminium Profile GmbH	Offenburg	150
	40	Wuppermann Metalltechnik GmbH	Burgbernheim	115
Sputter Targets	41	5N PV GmbH	Eisenhüttenstadt	50
	42	GfE Gesellschaft für Elektrometallurgie mbH	Nürnberg, Freiberg	350
	43	H.C. Starck GmbH	Goslar	100
	44	Robeko	Münchweiler	6
	45	Sindlhauser Materials GmbH	Kempten	20
	46	W. C. Heraeus GmbH	Hanau	160
Junction Boxes	47	Citel Electronics GmbH	Bochum	130
	48	EnWi-Etec GmbH	Wurmannsquick	30
	49	Hensel GmbH & Co. KG	Lennestadt	800
	50	KOSTAL Industrie Elektrik GmbH	Freiburg	190
	51	Lumberg Connect GmbH	Schalksmühle, Cloppenburg	800
	52	Multi-Contact Deutschland GmbH	Weil am Rhein	120
	53	Phoenix Contact Deutschland GmbH	Blomberg	8400
	54	SKS Kontakttechnik GmbH	Niederdorf	90
	55	Spelsberg GmbH & Co. KG	Schalksmühle, Buttstädt	400
	56	Tyco Electronics GmbH	Bensheim	1950
	57	UK LORT GmbH	Rottendorf	20
	58	Weidmüller Interface GmbH & Co. KG	Detmold, Wutha-Farnroda, Eisleben	1800
	59	Yamaichi Electronics Deutschland GmbH	Frankfurt (Oder)	70

Leading Manufacturers of PV System Components Produce in Germany

Component	No.	Company	Locations	Capacity 2010 [MWp]	Empl.*
Inverters	01	AEG Power Solutions	Warstein-Belecke	n/a	300
	02	Aixcon Powersystems	Stolberg	n/a	20
	03	Bonfiglio Vectron	Krefeld	n/a	80
	04	Converteam	Berlin	n/a	700
	05	Diehl AKO	Wangen	700	140
	06	Dorfmüller Solaranlagen	Reutlingen	5	5
	07	FEG	Sömmerda	<1	12
	08	KACO new energy	Neckarsulm	1200	350
	09	KOSTAL Industrie Elektrik	Hagen	n/a	190
	10	LTi REEnergy	Unna	100	250
	11	Oelmaier Technology	Ochsenhausen	100	100
	12	PADCON	Helmstadt	50	60
	13	PAIRAN Elektronik	Göttingen	n/a	90
	14	REFU Elektronik	Metzingen	n/a	170
	15	Siemens Industry Automation	Fürth	950	n/a
	16	SMA Solar Technology	Niestetal, Kassel	10000	4000
	17	Solutronic	Großbettlingen	250	30
	18	Steca Elektronik	Memmingen	40	510
	19	Sunways	Konstanz	n/a	180
	20	voltwerk electronics	Hamburg	250	100
Cables	21	bedea	Aßlar, Herborn		325
	22	Draka Industrial Cable	Wuppertal		300
	23	HELUKABEL	Windsbach		450
	24	HEW-KABEL	Wipperfürth		320
	25	HI Kabelkonfektionierung	Beerfelden		120
	26	HUBER+SUHNER	Taufkirchen		200
	27	KBE Elektrotechnik	Berlin		220
	28	Klasing Kabel	Denkendorf		170
	29	KWV Kabelwerke VS	Villingen-Schwenningen		90
	30	Lumberg Connect	Schalksmühle, Cloppenburg		1000
	31	Multi-Contact	Weil am Rhein		120
	32	Nexans	Hannover		400
	33	PRYSMIAN	Eschweiler, Schwerin		110
	34	Sykonec	Neustadt bei Coburg		42
	35	Tyco Electronics	Bensheim		1950
	36	U.I. Lapp	Stuttgart		800
	37	UK LORT	Ochsenfurt		20
	38	VOKA	Plauen, Falkenstein		500
	39	XBK-Kabel	Rottweil		200
	40	Yamaichi Electronics	Frankfurt (Oder)		70
Connectors	41	Amphenol-Tuchel	Heilbronn		350
	42	Büschel	Jungingen		30
	43	Citel	Bochum		130
	44	HI Kabelkonfektionierung	Beerfelden		120
	45	Hirschmann	Neckartenzlingen, Ettlingen		350
	46	Huber + Suhner	Taufkirchen		200
	47	Huonker	Villingen-Schwenningen		100
	48	Lumberg Connect	Schalksmühle, Cloppenburg		800
	49	Molex	Bretten		70
	50	Multi-Contact	Weil am Rhein		120
	51	Pöppelmann Kunststoff-Technik	Lohne		350
	52	U.I.Lapp GmbH	Stuttgart		800
	53	Wieland Electric	Bamberg		1000
	54	Yamaichi Electronics	Frankfurt (Oder)		70

Leading Manufacturers of PV Mounting & Tracking Systems in Germany

System	No.	Company	Locations	Empl.*
Tracking Systems - own manufacturing	55	DEGERenergie	Horb	30
	56	Eggert	Oberstadion	25
	57	EGIS-Equipment	Offenbach	5
	58	EQ-SYS	Treuenbrietzen	21
	59	Galaxy Energy	Heroldstatt	10
	60	Green Factory	Heidenheim	12
	61	GSM Solar	Mamming	90
	62	Hanse Solar	Wismar	10
	63	Kemper	Vreden	100
	64	mp-tec	Eberswalde	60
	65	PV-Eiwa	Plattling	100
	66	Soemtron	Sömmerda	70
	67	Solarpark Rödenäs	Rodenäs	50
	68	sonnen_systeme	Alheim-Heinebach	100
Tracking Systems - OEM production in Germany	69	Energiebau Solarstromsysteme	Köln	190
	70	IDEEMATEC	Wallerfing	20
	71	RWenergy	Schwandorf	30
	72	S+S Energietechnik	Lüchow-Grabow	5
	73	Solar-Trak	Lübeck	10
	74	Sundustry	Leipzig	5
	75	voltwerk electronics	Hamburg	100
Mounting Systems - own manufacturing	76	ALTEC Solartechnik	Crispendorf, Sömmerda	210
	77	Benz Alusysteme	Ingersheim	15
	78	CEKO	Neresheim	15
	79	EQ-SYS	Treuenbrietzen	21
	80	Fath Solar	Spalt	100
	81	Grammer Solar	Amberg	45
	82	Metall Josten	Düsseldorf	25
	83	Mounting Systems (Conergy)	Rangsdorf	140
	84	mp-tec	Eberswalde	60
	85	MÜPRO**	Hofheim-Wallau	n/a
	86	Niemetz Metall	Königsfeld	50
	87	PV-Eiwa	Plattling	100
	88	RegTec	Rottenburg an der Laaber	20
	89	Schletter	Kirchdorf	400
	90	Soemtron	Sömmerda	70
	91	Solarpark Rödenäs	Rodenäs	50
	92	Solarstep	Königstein	6
	93	Soltech**	Bielefeld	15
	94	TS-Aluminium	Großefehn, Burgsstädt	85
	95	VM Edelstahltechnik	Plettenberg	20
	96	Wagener & Simon	Wuppertal	180
	97	Wagner & Co. Solartechnik	Cölbe	400
	98	Wilhelm Flender	Netphen	75
	99	Zambelli	Grafenau	650
	100	Zentralsolar	Rheine	25
	101	Zinco	Unterensingen	70
Mounting Systems - OEM production in Germany	102	alfasolar	Hannover	40
	103	E.u.r.o Tec**	Hagen	30
	104	ECOSOLAR	Duisburg	10
	105	Energiebau Solarstromsysteme	Köln	230
	106	HABDANK PV-Montagesysteme	Göppingen	40
	107	HELTRON**	Breisach	15
	108	IDEEMATEC	Wallerfing	20
	109	K2 Systems	Weil der Stadt	45
	110	Renusol**	Köln	50
	111	RWenergy	Schwandorf	30

3.5 System prices

Table 7: Turnkey Prices of Typical PV Applications (19% VAT excluded, net prices rounded, prices at end of 2010, usually grid connected) [11]

1 – 2 kWp: 3.214 €/kWp

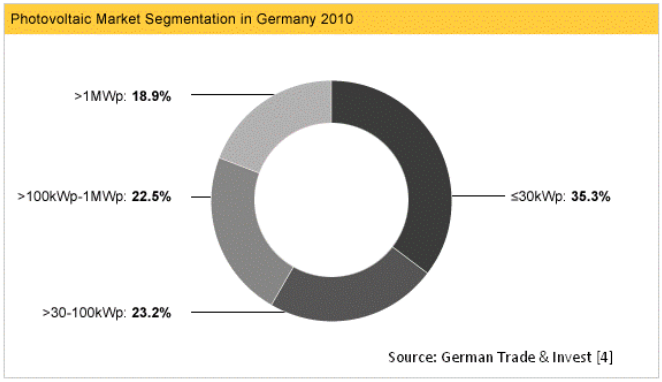
2 – 5 kWp: 2.771 €/kWp

5 - 10 kWp: 2.642 €/kWp

10 - 50 kWp: 2.449 €/kWp

30 -100 kWp 2.455 €/kWp

> 100 kWp 2.300 €/kWp



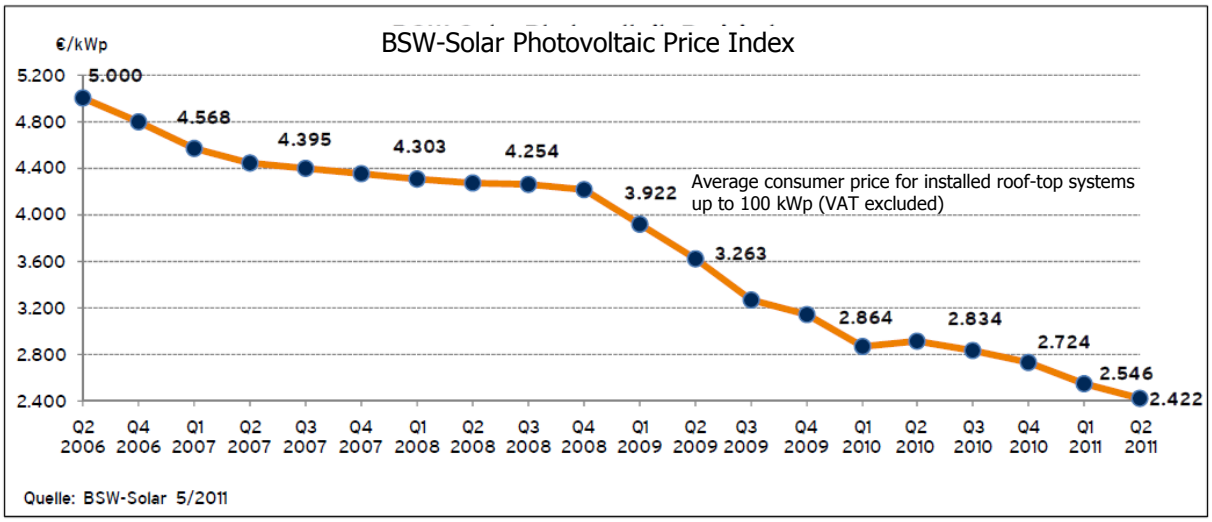


Table 7a: National trends in system prices (< 10MWp, VAT excl.)

Year	1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Price €/kW	8 390	6540	6400	5600	5080	5300	5600	5400	5500	4200	3200	2700

The prices are related to roof-top installations and usually the systems are grid-connected in Germany. Less than 10 % of installations are in other categories with specific prices.

3.6 Labour places

The BSW estimates that meanwhile around 10.000 companies with133.000 employees are active in the PV business. More than 200 companies are producer of cells, modules and components. The turnover in 2010 amounted to 10 billion EUR [1].

Table 8: PV-related labour places in 2010 [1]

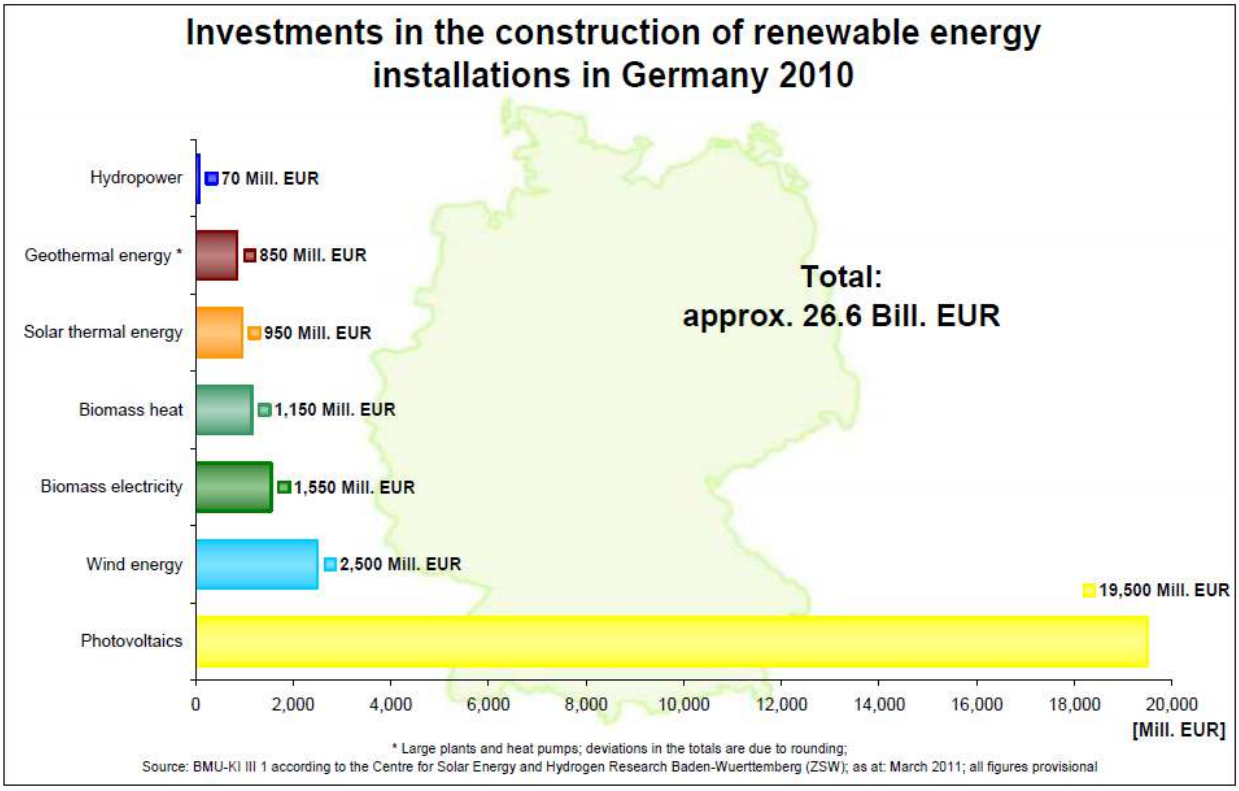
Labour places in total:	133.000
• PV production industry:	18.000
• Component supplier:	43.000
• Machine building Industry:	12.000
• Handicraft:	39.000
• Others:	21.000

Figures for employees in PV institutes are not available. Employment in institutes and administration for all renewable energies is 7.500 working places [3].

3.7 Business value

Over the last years, not only the German PV market but also the German PV industry showed a strong and steady growth. The German foreign trade and inward investment agency “Germany Trade & Invest” [5] lists 69 companies involved in PV production creating a turnover of 12,2 billion EUR in 2010. In addition around 100 PV equipment manufacturers supply tools for every step of the PV value chain. Beside this, the development of inverter industry with a production equivalent of 12 GW is another success story. The investment in PV installations amounts to19,5 billion € [3]. BSW [1] estimates around 860.000 grid connected PV-systems in Germany presently.

The export quota is around 50 % [1].



3.8 Framework for deployment (Non-technical factors)

Table 9: PV support measures

	On-going measures	Measures that commenced during 2010
Enhanced feed-in tariffs	Renewable Energy Sources Act (EEG)	Reduction of feed-in tariffs
Capital subsidies for equipment or total cost	Yes, in some states	
Green electricity schemes	Yes, some utilities offer „green electricity“	
PV-specific green electricity schemes	no	
Renewable portfolio standards (RPS)	No obligations for utilities to obtain a minimum percentage of their power from renewable energy resources	
PV requirement in RPS	none	
Investment funds for PV	On commercial basis by banks or investment funds dedicated to renewable energies, particularly large solar power plants	
Income tax credits	None specific for PV, but the regular depreciations by commercial investments	
Net metering	yes	
Net billing	yes	
Commercial bank activities e.g. green mortgages promoting PV	yes	
Electricity utility activities	yes	
Sustainable building requirements	Yes, by law for new buildings, there are provisions for energy efficiency	

3.9 Indirect policy issues

If the dynamic market development continues grid parity may be reached as early as 2013. This means that solar power will then be generated at costs corresponding to those of regular consumer electricity tariffs. The **EEG amendment** prepares the way for such a development as it will promote consumers' own consumption to a higher degree: private households that do not feed in solar electricity but consume it themselves will gain up to 8 euro cent per kWh. Businesses will also profit from the amendment as the stipulation will apply to installations with a capacity of up to 500 kW, one hundred times the capacity of a typical single-family home roof installation. This provision on own-consumption will trigger further important technological progress, e.g. in the field of storage technology. Consumption of grid electricity will be reduced, thus easing the burden on the grid. This in turn will advance the integration of electricity generated from renewable energies into the grid.

In contrast to previous EEG stipulations, open space installations will continue to be promoted beyond 1 January 2015. Conversion areas allowing for tariffs pursuant to the EEG will also comprise land converted from residential building or transport use in addition to land converted from agricultural or military use. Open space installations can now also be promoted in a 100 m wide strip along the kerbside of motorways or rail tracks. The category arable land will not apply beyond 1 July 2010. There will be transitional stipulations for open space installations which have already reached an advanced planning stage. [16]

Since the beginning of 2008, additional funding from the auction of emission allowances has been available to the BMU for the implementation of the **Climate Initiative**. The Climate Initiative aims to cost-effectively tap existing potential for emission reductions and advance innovative model projects for climate protection. Trade and industry, local authorities, educational institutions and consumers directly benefit from the numerous actions and support measures. The latest information on the Federal Environment Ministry's Climate Initiative can be found on the BMU website at www.international-climate-initiative.com. The website contains details of the projects and support programmes of the national and international Climate Initiative.

In February 2011 the Federal Cabinet adopted a draft amendment to the **Greenhouse Gas Emissions Trading Act** (TEHG). The amendment to the TEHG transposes comprehensive amendments to the EU Emissions Trading Directive into national law. From 2013 there will be no more free allowances for electricity generation. Power plant operators will have to pay for the emission allowances they need. This does not justify a rise in electricity prices as plant operators have been passing on the price of emission allowances to their customers in full since 2005, even though they received free allowances. From 2013 about five times as many emission allowances will be auctioned in Germany compared to the current trading period (2008-2012). More than 90 percent of the revenues from auctioning will be used for national and international climate protection and measures implementing the energy concept.

The harmonization of EU emissions trading from 2013 reduces the need for national rules. The amended Greenhouse Gas Emissions Trading Act serves the purpose of incorporating the rules of EU emissions trading into the German legal system and regulating the enforcement of the Act. The competences of the federal and Länder governments regarding the enforcement are defined more clearly than before. For example, in future emissions monitoring will be a responsibility of the German Emissions Trading Authority (DEHSt) at the Federal Environment Agency. This nationwide uniform monitoring of reporting ensures that with regard to emissions trading the same conditions for competition apply to all companies in Germany. [17]

The BMU brochure "**Electricity from Renewable Energy Sources: What does it cost us**" provides the components of the electricity price in Germany, especially for private households and what share do renewable energies cover (http://erneuerbare-energien.de/inhalt/36865/42456/).

Another information about RE-cost is the study "**Cost and benefit effects of renewable energy expansion in the German power and heat market**" (http://www.erneuerbare-energien.de/inhalt/46120/40870/).

Furthermore the website http://www.unendlich-viel-energie.de/en/sun.html supplies a lot of background information about the impact of PV and other RE installations in the German electricity market. Also interesting is the "Brief Analysis on the Current Debate about Costs and Benefits of Expanding the Use of Renewable Energies in Electricity Generation" http://www.unendlich-viel-energie.de/uploads/media/WI_Gutachten_eng_01.pdf.

Germany is member of International Renewable Energy Agency (**IRENA**) and several **IEA** implementing agreements and can promote the use of PV via these institutions. Additionally there are numerous bilateral projects for PV throughout the world.

In 2011 16,8 % or 102 billion kWh of the electricity was produced by renewable energy sources and problems arise with volatile feed-in into the existing grid, especially wind energy (36,5 billion kWh) and PV (12 billion kWh). Therefore grid management, expansion of the grid, load prediction and power storage are currently important issues in Germany.

All in all - politicians, the industry, research and the population have widely accepted the way to more renewable energies in Germany. Therefore a wide range of initiatives, regulations and financial support schemes are existing.

3.10 Interest from electricity utility businesses

Due to the regulations of the EEG there are no real barriers for the development of renewable energy production in general. PV is predominately situated in the private sector and utilities are engaged subordinate.

3.11 Standards and codes

The elaboration of standards and codes for PV is performed on the European level (CENELEC) and international level (IEC). The actual list of international standards and codes can be found on the web site: www.iec.ch.

4 HIGHLIGHTS AND PROSPECTS

Please highlight key aspects of PV deployment or production in your country during 2010.

Please give one paragraph maximum on forward looking issues within your country such as:

- Details from industry of planned increases in PV module production capacity
- Any significant developments in technologies

Please specify any long-term targets for installed PV power capacity that exist, or future energy scenarios that are being discussed, within your country.

ANNEX A: COUNTRY INFORMATION

1) Electricity prices: 0,21 – 0,26 €/kWh + basic fee for households. As an average 0,24 €/kWh is adequate. For industrial supply, the prices are lower depending on consumption. The production cost of conventional power plants are in the range of 8 – 11 €ct/KWh. Tendency to increasing prices in 2010 and 2011. Strong influence by price level of oil and gas.
2) Typical household consumption: 4000 kW/yr.
3) Typical metering and tariff structure: The metering systems are installed in the household. The measurement takes place once a year and a payment in a one or two month period with an invoiced at the end of the year.
4) Average household income: 42 535 €/yr (gross, 2010) (household income can vary by different private status).
5) Typical mortgage interest rate: around 3,5 %/yr
6) Voltage: 230 V / 380 V
7) Electricity Structure: There are parallel structure of large enterprises (E-on, RWE, Vattenfall, EnBW), city owned companies and industrial producers for their own facilities. The grid belongs mostly to the producers.
8) Price of diesel fuel: 1,20 – 1,40 €/l.
9) Typical values for PV system of household: 1- 5 kWp.

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[13] German Government's Energy Concept, http://www.bmu.de/english/energy_efficiency/doc/46516.php

[14] Bundesnetzagentur, http://www.bundesnetzagentur.de

[15] PtJ database, see http://www.forschungsjahrbuch.de

[16] BMU Press Release No.063/10

[17] BMU Press Release No.028/11