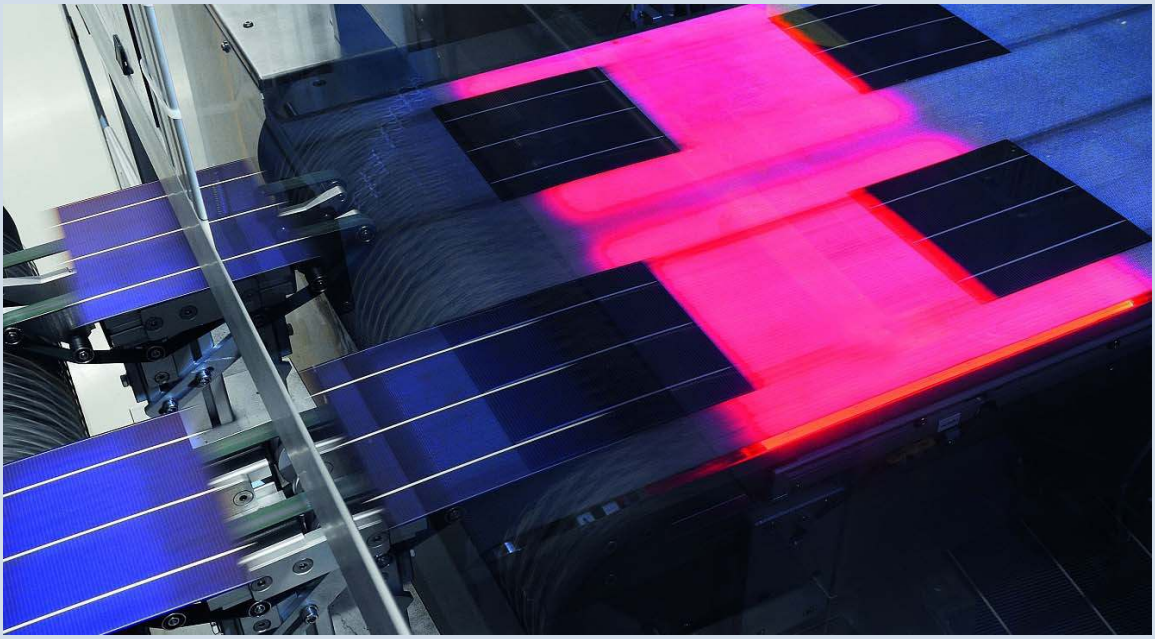
IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in GERMANY 2014



PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Prepared by

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PVPS

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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

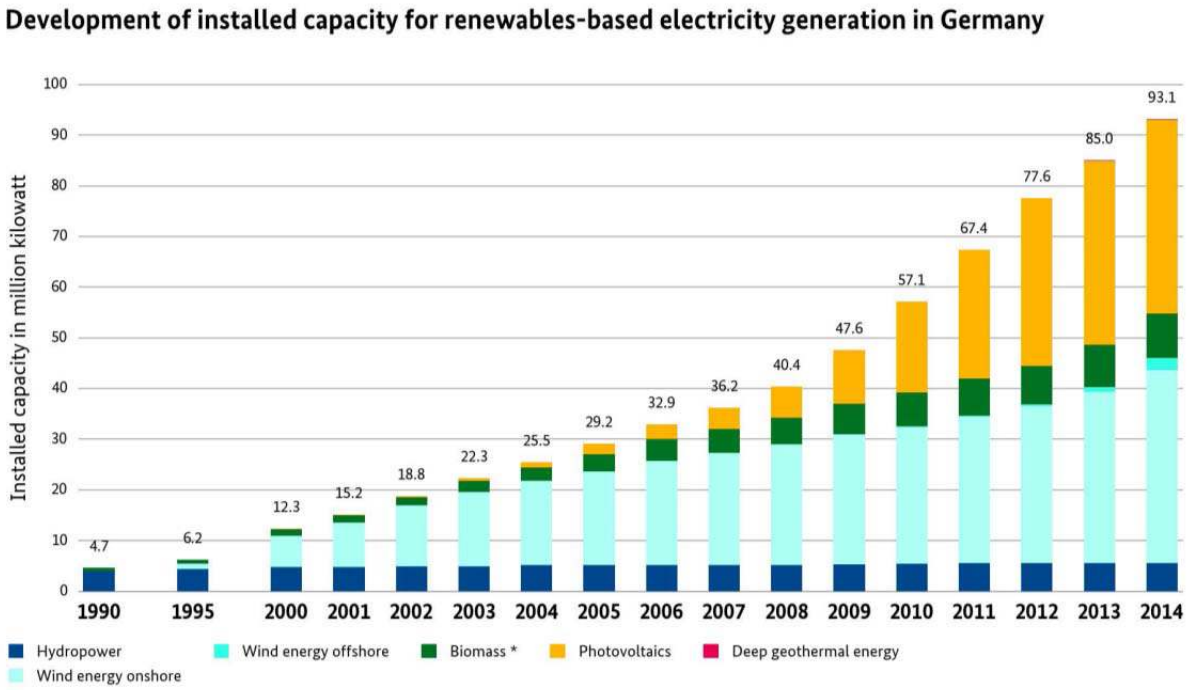
The transformation of the energy system is a core task for Germany's environmental and economic policy. The overall objective is an environmental friendly, reliable and economical feasible energy supply. The German Federal Government paved the way for this target when announcing the German Energy Concept in autumn 2010 [1]. Moreover, it was decided in 2011 to terminate the production of nuclear power until 2022. The goals are to be reached firstly by efficient energy use and secondly by the use of renewable energies. The German Energy Concept states that renewable energies will contribute the major share to the energy mix of the future. The aim of the German Energy Concept is to reach 18 % of the total gross energy consumption in 2020. Beyond that with respect to the electricity supply, the share for renewable energies shall reach 40-45 % in 2025 and 80 % in 2050. At present the share for renewable energies of the gross electricity consumption of Germany has reached 27.8 % ([1], data from 2014). Photovoltaic (PV) is a major part of this development driven by the Renewable Energy Sources Act (EEG 2014) [2] on the one hand and a noticeable decrease of system prices on the other hand. About half of the increase of renewable electricity production can be allocated to PV.

Up to now, the main driving force for the PV market in Germany is the Renewable Energy Sources Act. 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 favourable Feed-in-Tariffs (FiT) for them. However, due to the successful but very fast increase in PV and wind energy generation, the EEG was modified in 2014 to allow a better control of new installations. For PV, the FiT depends on the system size and whether the system is ground mounted or attached to a building. All FiT-rates are guaranteed for an operation period of 20 years. It includes a monthly adapted degression rate of the FiT, which depends on the previously installed PV capacity. This procedure tends to stimulate a yearly installation of 2.4 – 2.6 GW.

Nonetheless, the installation figures fall below this goal in 2014. The new PV installations in 2014 have a capacity of about 1.9 GW. Thus, the trend of decreasing installations continued and in combination with decreasing system prices and margins resulted in severe financial difficulties for German PV companies which often resulted in insolvency.

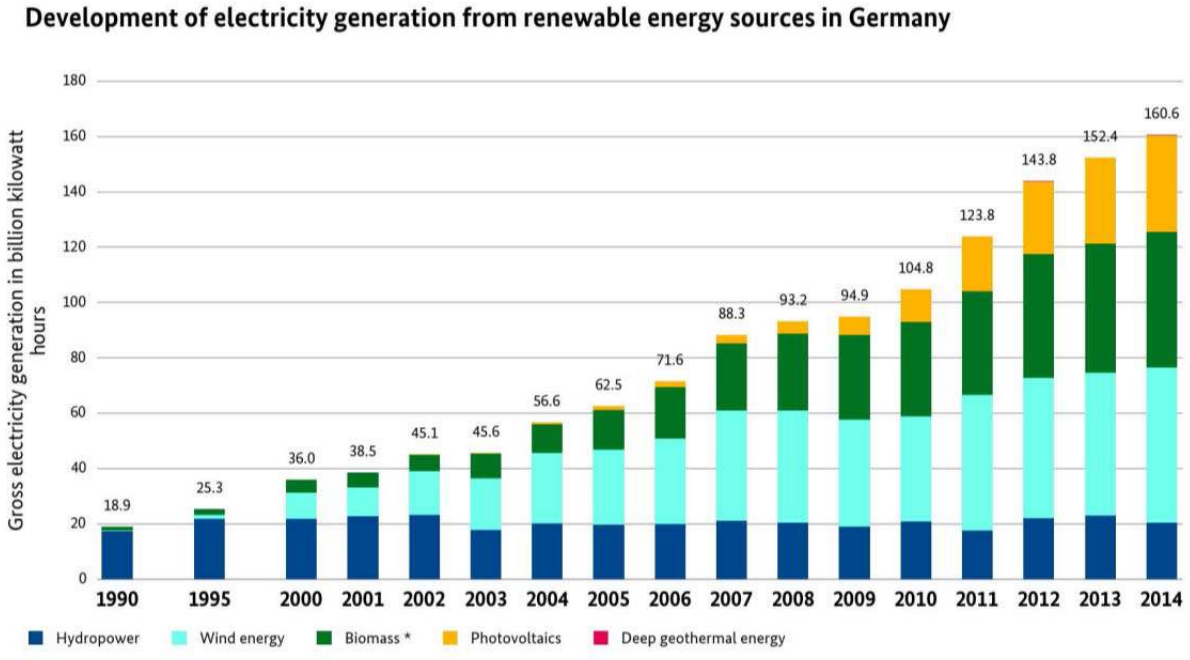
The FiT terminates at a total installed PV capacity of 52 GW. Meanwhile, the EEG contains measures for the integration of PV systems into the grid management.

In order to streamline the German energy policies, the responsibility for all energy related activities are concentrated within the Federal Ministry for Economic Affairs and Energy (BMWi).



* incl. solid and liquid biomass, biogas, biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2013 incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2015; all figures provisional

Figure 1 [1]



* incl. solid and liquid biomass, biogas, biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2013 incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2015; all figures provisional

Figure 2 [1]

1.2 Total photovoltaic power installed

Since the beginning of 2009 owners of new PV systems are legally obliged to register their systems at the German Federal Network Agency [3]. Another official source is the "Working Group on Renewable Energy Statistics" (AGEE-Stat) [1] working on behalf of the BMWi. This group supplies a lot of data for all renewable energies and PV in detail. Furthermore, the German Solar Association (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.

There are nearly no information about off-grid non domestic, grid connected centralized systems or stand-alone 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, estimated less than 1 ‰ of grid connected PV capacities and will not be mentioned in this report anymore.

Due to the official registration procedure by German Federal Network Agency the accuracy of these data can be assumed better than ± 1 %.

Since 2009 AGEE-Stat employs data of the German Federal Network Agency.

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	Residential	1,4 GW		AC
		Commercial			AC
		Industrial			AC
	BIPV (if a specific legislation exists)	Residential			
		Commercial			
		Industrial			
	Ground-mounted	cSi and TF	0,5 GW		AC
		CPV			AC
Off-grid		Residential	N/A	N/A	
		Other	N/A	N/A	
		Hybrid systems		N/A	
		Total	1.9 GW		AC

Development of electricity supply from renewable energy sources in Germany since 1990

Data in million kilowatt hours

	Hydropower[1]	Wind energy onshore	Wind energy offshore	Photovoltaics	Biomass[2]	Geothermal energy	Renewables-based electricity supply	Renewable energy share in gross electricity consumption
1990	17,426	71	0	1	1,435	0	18,933	3.4 %
1995	21,780	1,500	0	7	2,010	0	25,297	4.7 %
2000	21,732	9,513	0	60	4,731	0	36,036	6.2 %
2001	22,733	10,509	0	76	5,214	0	38,532	6.6 %
2002	23,124	15,786	0	162	6,048	0	45,120	7.7 %
2003	17,722	18,713	0	313	8,841	0	45,589	7.6 %
2004	20,095	25,509	0	557	10,471	0	56,632	9.3 %
2005	19,638	27,229	0	1,282	14,354	0	62,503	10.2 %
2006	20,008	30,710	0	2,220	18,700	0	71,638	11.6 %
2007	21,170	39,713	0	3,075	24,363	0	88,321	14.2 %
2008	20,443	40,574	0	4,420	27,792	17	93,247	15.1 %
2009	19,031	38,610	38	6,583	30,578	18	94,859	16.3 %
2010	20,953	37,619	174	11,729	34,307	27	104,810	17.0 %
2011	17,671	48,315	568	19,599	37,603	18	123,775	20.4 %
2012	21,755	49,948	722	26,380	44,633	25	143,463	23.6 %
2013	21,220	52,430	970	30,000	47,900	40	152,560	25.4 %

ZSW according to Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2014; all figures provisional

[1] In the case of pumped storage plants: electricity generation from natural inflow only

[2] Includes biogenic solid fuels and liquid biomass, biogas, sewage gas and landfill gas and the biogenic fraction of waste (biogenic component of waste in waste incineration plants estimated at 50 percent); until 1998 only feed-in to the general supply grid

Figure 3 [1]

Development of installed capacity for renewable-based electricity generation in Germany since 1990

Data in thousand kilowatt

	Hydropower[1]	Wind energy onshore	Wind energy offshore	Photovoltaics	Biomass[2]	Geothermal energy	Installed capacity for renewables-based electricity generation
1990	3,982	55	0	2	679	0	4,718
1995	4,348	1,121	0	18	736	0	6,223
2000	4,831	6,097	0	114	1,288	0	12,330
2001	4,831	8,738	0	176	1,412	0	15,157
2002	4,937	11,976	0	296	1,615	0	18,824
2003	4,953	14,593	0	435	2,330	0	22,311
2004	5,186	16,612	0	1,105	2,630	0	25,533
2005	5,210	18,375	0	2,056	3,526	0	29,167
2006	5,193	20,568	0	2,899	4,283	0	32,943
2007	5,137	22,183	0	4,170	4,723	3	36,216
2008	5,164	23,815	0	6,120	5,256	3	40,358
2009	5,340	25,632	60	10,566	5,995	7	47,601
2010	5,407	27,012	168	17,554	6,599	7	56,748
2011	5,625	28,857	203	25,039	7,148	7	66,880
2012	5,607	30,996	308	32,643	7,537	12	77,103
2013	5,613	33,757	903	35,948	8,086	31	84,338

ZSW according to Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2014; all figures provisional

[1] Inclusion of installed capacity of pump storage power plants with natural inflow

[2] Includes biogenic solid fuels and liquid biomass, biogas, sewage gas and landfill gas and the biogenic fraction of waste (biogenic components of waste in waste incineration plants estimated at 50 percent)

Figure 4 [1]

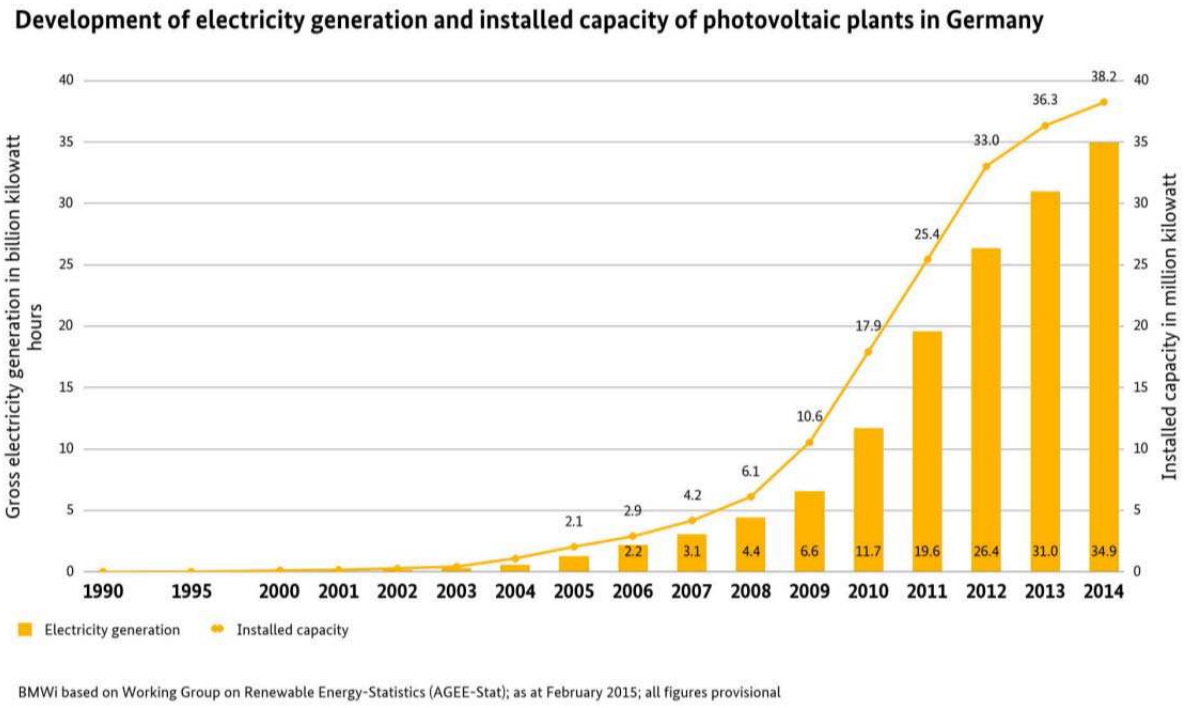


Figure 5 [1]

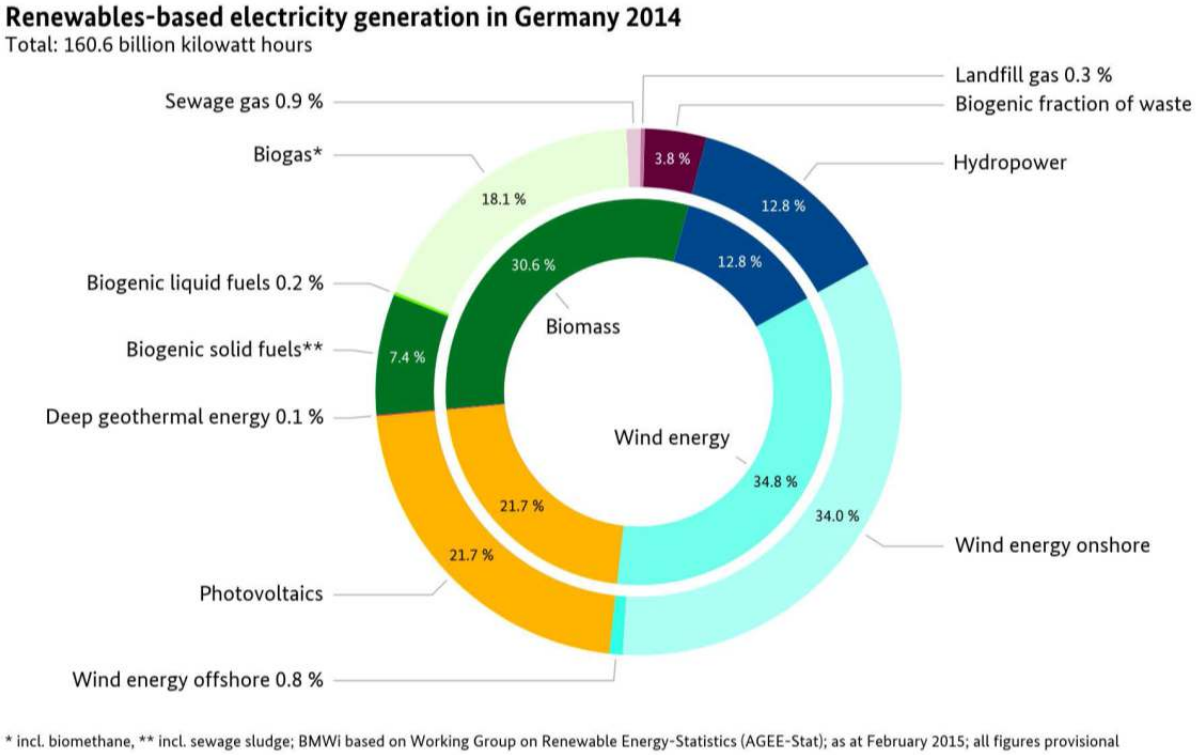


Figure 6 [1]

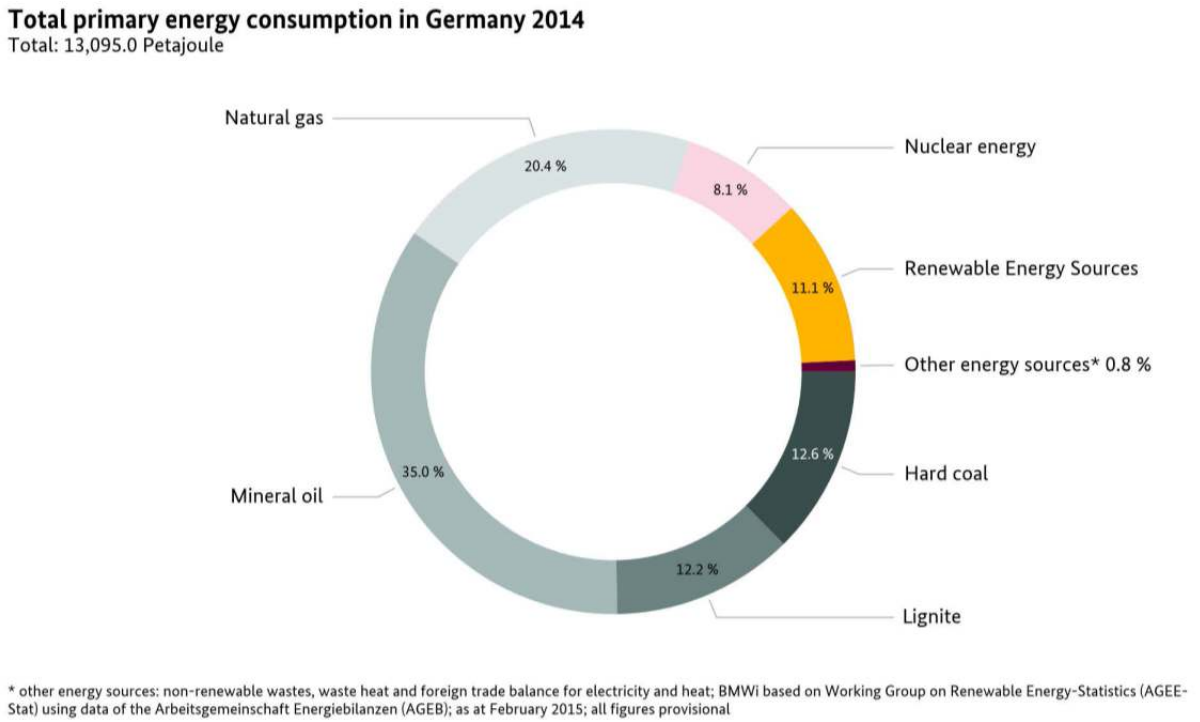


Figure 7 [1]

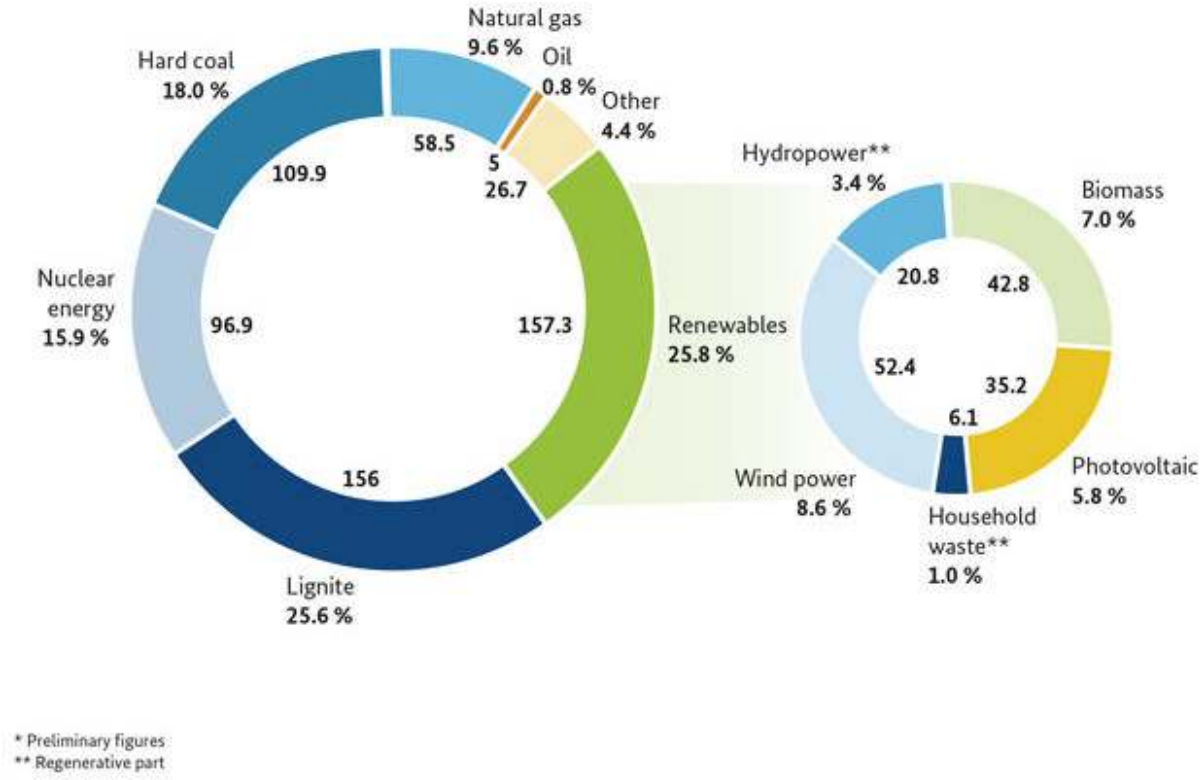


Figure 8: Gross electricity generation in Germany in 2014 (610 TWh (preliminary)) **[4]**

Table 2: PV power and the broader national energy market.

MW-GW for capacities and GWh-TWh for energy	2014 numbers	2013 numbers
Total power generation capacities (all technologies)	194,2 GW (29.10.2014) [4]	188,1 GW [5]
Total power generation capacities (renewables including hydropower)	93,1 GW	85,0 GW
Total electricity demand (= consumption)	578,5 TWh	599,4 TWh
New power generation capacities installed during the year (all technologies)	N/A	N/A
New power generation capacities installed during the year (renewables including hydropower)	8,1 GW	7,4 GW
Total PV electricity production in TWh	35,2 TWh	31,01 TWh
Total PV electricity production as a % of total electricity consumption	6,04%	5,17%

Table 3: Other information

	2014 Numbers
Number of PV systems in operation in your country (a split per market segment is interesting)	**1,5 Mio**

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

PRICE INDEX

December 2014

Module type, Origin	€ / Wp	Trend from November 2014	Trend from January 2014
Crystalline modules			
Germany	0.59	-1.67 % ↘	-14.49 % ↘
Japan, Korea	0.62	0.00 % =	-11.43 % ↘
China	0.53	-1.85 % ↘	-8.62 % ↘
Southeast-Asia, Taiwan	0.45	-2.17 % ↘	-15.09 % ↘

NOTES ON READING THE PV PRICE INDEX

1. Only prices for photovoltaic modules are shown.
2. The prices are not end-customer prices. For an average turnkey solar system in Germany, the quoted figure for modules should be multiplied by a factor of approximately 2 to 3.
3. The prices stated reflect the average prices quoted on the European Spot Market (Chinese goods customs-cleared). All prices are net prices without VAT in Euro per Watt peak.

Figure 9 [6]

2.2 System prices

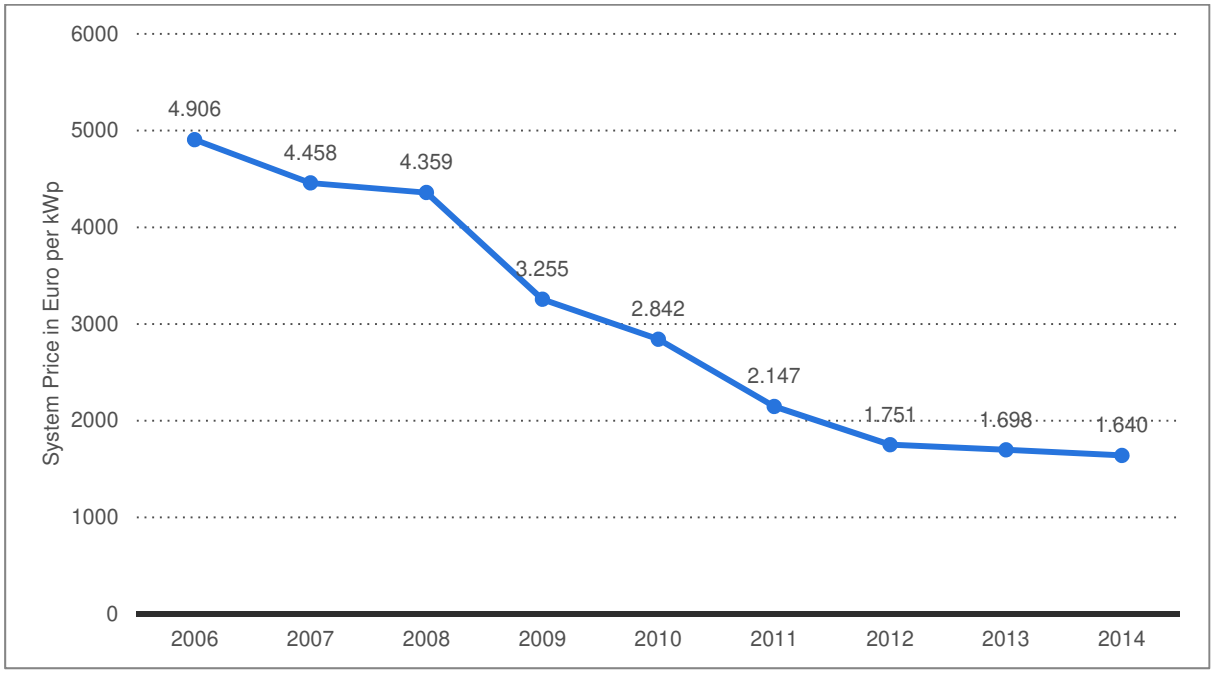


Figure 10 [7]: Net system price of a roof mounted PV system <10 kWp. http://de.statista.com/statistik/daten/studie/156490/umfrage/preis-fuer-eine-fertig-installierte-solaranlage-in-deutschland/

Table 4: **Turnkey Prices of Typical Applications – local currency**

Category/Size	Typical applications and brief details	Current prices per W
Grid-connected Rooftop up to 10 kW (residential)	Typical size: 7 kW	1,6
Grid-connected Rooftop from 10 to 250 kW (commercial)	Typical size: 80 kW	1,24
Grid-connected Ground-mounted above 1 MW	Typical size: 2,865 MW	1,0

2.3 Financial parameters and programs (leasing…)

Due to the developed market for PV installations most of the banks offer loans for private and commercial investments. There is also the option of financing a PV system by a loan from the government-owned development bank KfW (Kreditanstalt für Wiederaufbau).

Several companies offer solar leasing models that usually require a minimum system power of e.g. >30 kWp.

2.4 Additional country information

Table 5: Country information

Retail Electricity Prices for an household (range)	28,3-30,5 ct/kWh (at 3.500 kWh pa) [5]
Population at the end of 2014 (or latest known)	81,1 Mio. (30.09.2014) [8]
Country size (km^2)	357.012
Average PV yield (according to the current PV development in the country) in kWh/kWp	916
Investments in new PV systems (2014)	2,3 Mrd. € [1]
Turnover from operating PV system (2014)	1,4 Mrd. € [1]
Name and market share of major electric utilities. [7]	RWE AG (15,9 %) EnBW AG (12,7 %) E.ON AG (11,0 %) Vattenfall Europe AG (4,4 %)

3 POLICY FRAMEWORK

This chapter describes the support policies aiming directly or indirectly to drive the development of PV. Direct support policies have a direct influence on PV development by incentivizing or simplifying or defining adequate policies. Indirect support policies change the regulatory environment in a way that can push PV development.

3.1 Direct support policies

Table 6: PV support measures (summary table)

	On-going measures	Measures that commenced during 2014
Feed-in tariffs (gross / net?)	Renewable Energy Sources Act (EEG)	
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 depreciation by commercial investments	
Prosumers' incentives (self-consumption, net-metering, net-billing…)	No	
Commercial bank activities e.g. green mortgages promoting PV	Yes	
Activities of electricity utility businesses	Yes	
Sustainable building requirements	Yes, by law for new buildings, there are provisions for energy efficiency	

3.2 Direct support measures

3.2.1 Support measures existing in 2014

3.2.1.1 Description of support measures excluding prosumers, BIPV, and rural electrification

In terms of achieving expansion targets for renewable energies in the electricity sector, the Renewable Energy Sources Act 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 favourable Feed-in-Tariffs (FiT) for them. For PV, the FiT depends on the system size and whether the system is ground mounted or attached to a building. All FiT-rates are guaranteed for an operation period of 20 years. It includes a monthly adapted degression rate of the FiT, which depends on the previously installed PV capacity. This procedure tends to stimulate a yearly installation of 2,4 – 2,6 GW.

The FiT terminates at a total installed PV capacity of 52 GW. Meanwhile, the EEG contains measures for the integration of PV systems into the grid management.

3.2.1.2 Prosumers' development measures

Since August 2014, owners of a newly installed system > 10 kWp have to pay a reduced rate of 30 % of the EEG-surcharge (see 3.2.5) for every self-consumed kWh. In 2017 the rate will increase to 40%. Owners of systems below 10 kWp are not affected.

3.2.1.3 BIPV development measures

There were no special measures favouring the development of PV as building element in Germany in 2014.

3.2.1.4 Rural electrification measures

N/A

3.2.1.5 Other measures including decentralized storage and demand response measures

A 25 MEUR market stimulation program has been introduced to boost the installation of local stationary storage systems in conjunction with small PV systems < 30 kWp.

3.2.2 Support measures phased out in 2014

N/A

3.2.3 New support measures implemented in 2014

To lead the commercialisation of electricity from renewable sources from governmental measures to the free market, Germany will implement a system of calls for bids. In the first phase, investors can place their bids for ground mounted PV systems. The call defines the total volume of the measure (150 MW) and a maximum funding level (11,29 ct/kWh). The investors with the lowest funding level will be awarded the funding until the maximum volume is reached.

3.2.4 Measures currently discussed but not implemented yet

The coalition leaders were in agreement that the introduction of mandatory direct marketing should come about quicker than has so far been planned: Already as of 2016, all systems with an output of 100 kWp and more will be required to market electricity directly (until now this was not planned until 2017). [9]

3.2.5 Financing and cost of support measures

Electricity consumers have to pay the so called EEG-surcharge for financing of renewable energy sources. In 2014 the EEG-surcharge amounted to 6,24 ct/kWh. There are special treatments for energy intensive industries. [2]

4 HIGHLIGHTS OF R&D

Research and Development (R&D) is conducted under the 6th Programme on Energy Research "Research for an Environmental Friendly, Reliable and Economical Feasible Energy Supply" [10], which came into force in August 2011. Within this framework, the Federal Ministry for Economic Affairs and Energy (BMWi) as well as the BMBF (Federal Ministry of Education and Research) support R&D on different aspects of PV. The main parts of the programme are administrated by the Project Management Organisation (PtJ) in Jülich.

4.1 Funding activities of the BMWi

In December 2014, the BMWi released a new call for tender, which reflects the targets of the 6th energy research program. Concerning PV, the call addresses six focal points which are all connected to applied research:

- Silicon wafer technology,
- Thin-film technologies, especially based on chalcopyrites (CIS/CIGS),
- Quality control and lifetimes
- System technology for both, decentralised grid-connection and island systems,
- Concentrated Solar Power and other alternative concepts and
- Cross-cutting issues like Building Integrated PV (BIPV), recycling or research on the ecological impact of PV systems.

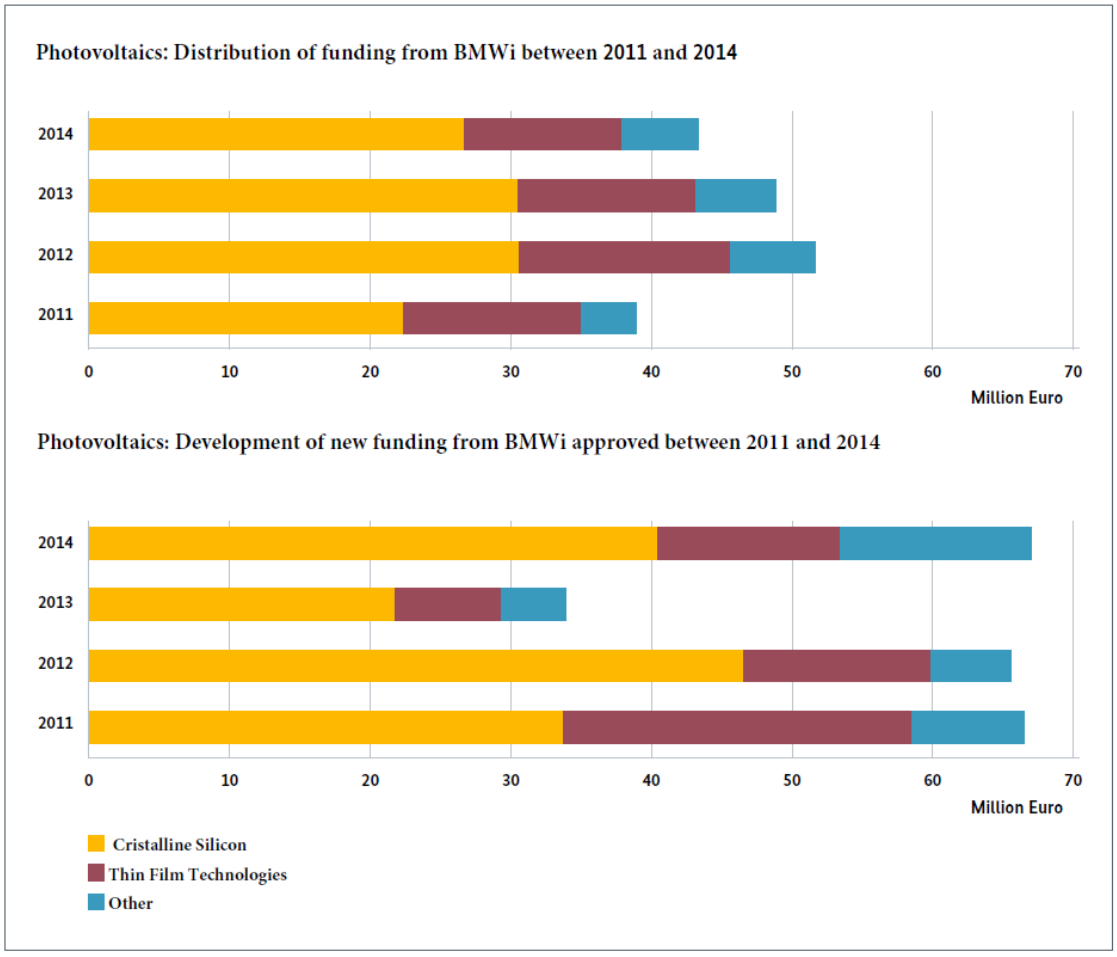


Figure 11: Development of the volume of R&D funding from the Federal Ministry for Economic Affairs and Energy (BMWi) **[11]**

In 2014, the BMWi support for R&D projects on PV amounted to about 43,3 MEUR shared by 259 projects in total. That year, 90 (2013: 43: 2012: 85) new grants were contracted. The funding for these projects amounts to 66.9 (2013: 34.0; 2012 68.3) MEUR in total. The temporary budget reduction in 2013 is explained by the fact that the phase of granting new projects under the "Innovation Alliance PV", was terminated in 2012, while funding period of the subsequent programme "R&D for Photovoltaics" (see 4.3) started in 2014. Details on running R&D projects can be found in the BMWi "Annual Report on Research Funding in the Renewable Energies Sector" [11] or via a web-based database of the Federal Ministries.

The German contributions to the PVPS Tasks 1, 9, 11, 12, 13 and 14 are part of the programme.

4.2 Funding activities of the BMBF

In 2008, the BMBF published its concept paper "Basic Energy Research 2020+" aiming for the support of long-term R&D on renewable energies which is complementary to the BMU funding. Concerning PV, currently there are two focal points of engagement:

- A joint initiative of BMBF and industry addresses the development of organic solar cells.
- 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 from 2009 until 2013.

4.3 Joint initiatives of BMWi and BMBF: "Innovation Alliance PV" and "R&D for Photovoltaics"

In summer 2010, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and BMBF initiated the "Innovation Alliance PV". Under this scheme in total 19 R&D projects are 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 were selected. In particular, cooperation between PV industry and PV equipment suppliers is of importance. Together, BMU and BMBF allocated 100 MEUR to support this initiative. The German PV industry agreed to raise an additional 500 MEUR to accompany the Innovation Alliance.

To support the momentum stimulated by the "Innovation Alliance PV", a new joint initiative of BMU and BMBF has been launched in 2013. The aim of this program "R&D for Photovoltaics" (German Title: "FuE für Photovoltaik") is to support R&D activities especially with participation of the German PV industry in the fields of:

- Economical operation of grid-connected and off-grid PV system solutions including energy management and storage systems,
- Efficient and cost effective production concepts including the introduction of new materials and production monitoring systems, and
- Introduction of new PV module concepts with a special focus on quality, reliability and life time.

A sum of 50 MEUR is allocated by the ministries to be increased by an equivalent sum expected as contribution from industry. 10 joint projects were approved and started in 2014 [12].

5 INDUSTRY

Like in the years before, in 2014 the worldwide production capacity significantly exceeded the market, resulting to an oversupply with low-price modules. Due to this situation, only the most economical and efficient productions can produce without losses. Many companies worldwide had therefore to deal with serious economic problems.

This again lead to changes also for the German market leaders: SolarWorld AG took over the production lines from Bosch Solar Energy GmbH in Arnstadt (who stopped production end of 2013) and thus could increase the production capacity to above 1GW for Wafers and Modules. SolarWorld AG could sell 849 MW of modules in 2014 which is an increase by 55 % with respect to 2013. Still the EBIT is negative. The other market leader Hanwha Q.Cells, which was taken over by the Hanwha Group in 2013, announced in January 2015 to stop the production in Germany

5.1 Production of feedstock, ingots and wafers (crystalline silicon industry)

The main suppliers of silicon feedstock (Wacker Chemie, PV Crystalox Solar Silicon, Schmid Polysilicon Production) kept their production capacity constant during 2014, there are no numbers available on the actual production. SolarWorld AG announced to restart silicon feedstock production during 2015 in the former Bosch Solar line in Arnstadt that closed down end of 2013.

5.2 Production of photovoltaic cells and modules (including Thin Films - TF and Concentrator Photovoltaics - CPV)

Figure 12 gives an overview of the Solar Cell and Module manufacturers with production capacity and number of employees. Data of the actually produced number of modules is not available for 2014.

5.3 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 the “Fact Sheet” of “Germany Trade and Invest” [13]:

- Fact Sheet - CSP Industry in Germany [PDF, 420 KB]
- Fact Sheet - Photovoltaic BOS Components [PDF, 397 KB]
- Fact Sheet - Photovoltaic Equipment [PDF, 508 KB]
- Fact Sheet - Photovoltaic Manufacturers [PDF, 357 KB]
- Fact Sheet - Photovoltaic Module Materials [PDF, 346 KB]
- Fact Sheet - Photovoltaic R&D [PDF, 413 KB]
- Fact Sheet - Solar Thermal Industry in Germany [PDF, 155 KB]
- Germany: Lead Market for Energy Storage & Fuel Cell Systems [PDF, 4668 KB]

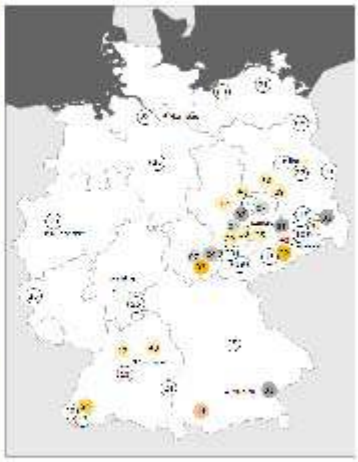
For details see the website of the companies.

Photovoltaics — made in Germany

Leading PV Manufacturers in Germany

January 2015

Value Chain	No.	Company	Locations	Production Capacity [MWp]	Empl.[1]
Silicon	1	Wacker Chemie	Burghausen, Nünchritz	52,000t	700
	2	PV Crystalox Solar Silicon	Bitterfeld-Wolfen	1,800t	125
	3	Schmid Polysilicon Production	Schwarze Pumpe	180t	85
Wafer	4	PV Crystalox - PV Silicon	Erfurt	350	145*
Cell	5	Hanwha Q-Cells	Bitterfeld-Wolfen	200	799
	6	ITS Innotech Solar	Halle	100	54
	7	Bluecell GmbH	Arnstadt	100	40
Module	8	SCP Solar	Prenzlau	280	664*
	9	Solar-Fabrik AG[2]	Wismar	350	350
	10	SOLARWATT	Dresden	200	250
	11	Aabronergy	Frankfurt (Oder)	300	280
	12	Solar-Fabrik AG[2]	Freiburg	210	240
	13	Axitec GmbH	Böblingen	120	15
	14	axsis Technologies (TUSAI Holding)	Erfurt	40	10
	15	Heckert Solar	Chemnitz	170	195
	16	Hanwha Q-Cells	Bitterfeld-Wolfen	120	1231*
	17	Solar Direct Group	Königswartha	25	n/a
	18	ALGATEC Solar	Prösen, Großräschen	25	23
	19	Sunset Solar	Löbichau	40	40
	20	Alfasolar GmbH	Hannover	40	30
	21	MLS S Man. GmbH	Greifswald	40	500
	22	Solarnova GmbH	Wedel	30	20
	23	GSS	Korbußen	20	36
	24	AuSun Solar	Laupheim-Baustetten	20	60
	25	JuraWatt	Neumarkt	20	25
	26	Mage Sunovation	Eisenfeld	5	12
	27	Q-mo solar	Teltow	<1	6
	28	Sunware	Duisburg	n/a	n/a
	29	Soluxtec	Bitburg	n/a	55
	30	SI Module	Freiburg	25	25
	31	No-vo GmbH	Laubusch	10	15
Fully Integrated	32	SolarWorld	Freiberg	750/330/530	1046
	33	Solarworld	Arnstadt	0/700/200	751
CPV	34	Soitec	Freiburg	70	175
a-Si	35	AVANCIS (CNBM International)	Torgau	120*	240
CIS	36	Smartenergy Renewables Deutschland	Luckenwalde	120*	41
	37	Solibro (Hanergy)	Bitterfeld-Wolfen	110	400
CIGSSe	38	Solarion	Leipzig, Zwenkau	20	120
CIGS	39	Bosch Solar CIS Tech	Brandenburg	15	150
	40	Manz CIGS Technology GmbH	Schwäbisch Hall	6	120
CdTe	41	Calyxo (Solar Fields LLC)	Bitterfeld-Wolfen	85	150
GaAs	42	Azur Space Solar Power	Heilbronn	300*	150*
OPV	43	Heliatek	Dresden	2	63
PV & Thermal	44	Solarzentrum Allgäu	Altdorf-Biesenhofen	25	60



The Industry and Market

Germany is home to around 44 manufacturers of silicon, wafers, cells, and modules. In addition, there are over 200 PV material and equipment suppliers, more than 100 balance-of-system (BOS) component manufacturers, more than 50 PV research institutes and hundreds of project development, system integration and installation companies. The German PV industry currently employs a workforce of around 100 thousand people.

With the own-consumption model growing successfully in Germany, the German PV sector is about to develop a customer base independent of feed-in tariff-based subsidy schemes. Independence from subsidies will help make the PV market even more stable in the future. New PV sales strategies, system configurations, and integration processes required in the future grid-parity environment are intrinsic components of the specialist expertise currently being developed in Germany.

1) Current total number of employees at respective locations
2) Company entered voluntary bankruptcy

*) 2013

Source: Germany Trade & Invest, Information provided by the respective company, January 2015

GERMANY
TRADE & INVEST

Figure 12 [14]: Overview on the leading producers of silicon, wafers, cells and modules in Germany.

6 PV IN THE ECONOMY

6.1 Labour places

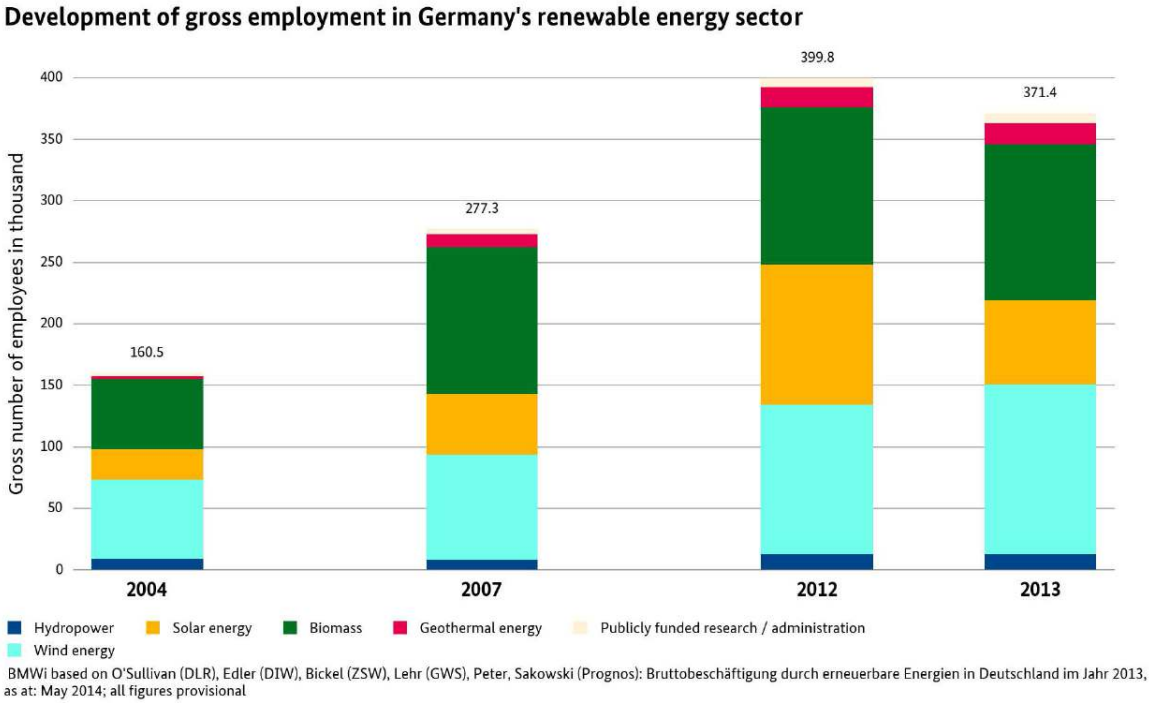


Figure 13 [1]

6.2 Business value

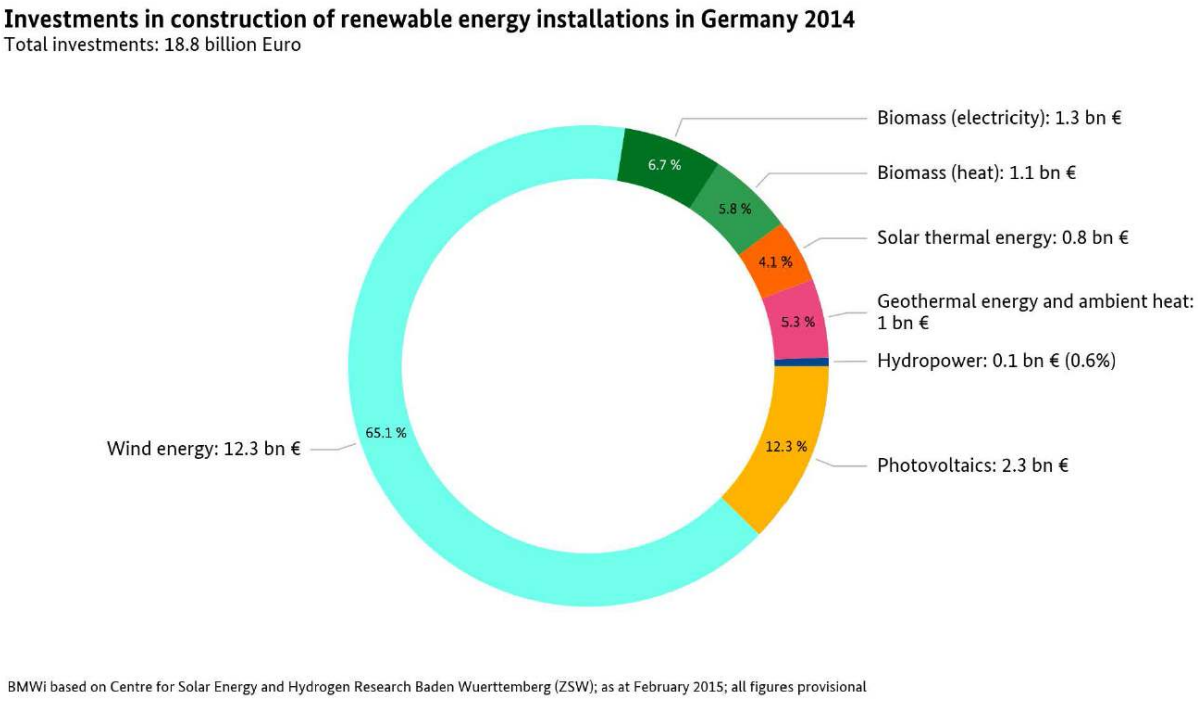


Figure 14 [1]

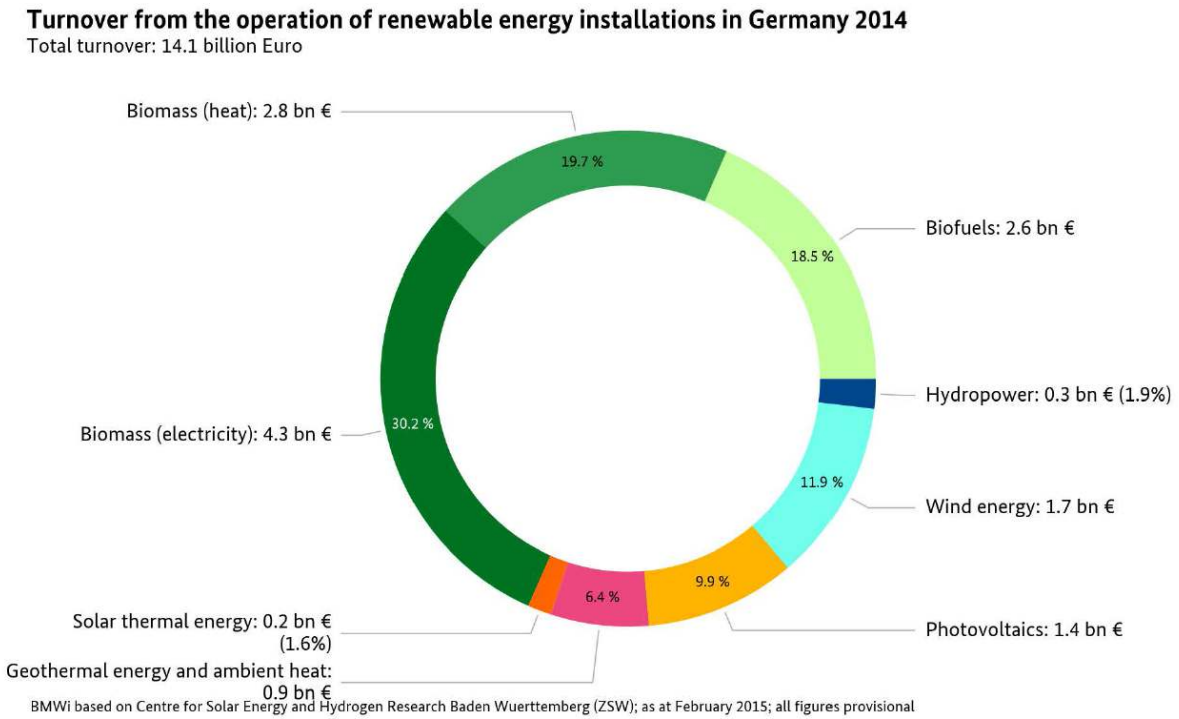


Figure 15 [1]

Photovoltaic (solar power) industry in Germany — Profile in brief, as of end of 2014 (approx.)

New photovoltaic (PV) capacity installed in Germany 2014[1]	1,900 MWp
New PV systems installed in Germany 2014[1]	75,500
Total PV capacity installed in Germany 2014[1]	38,200 MWp
Power generation through PV systems 2014[2]	34,900 GWh
Total number of installed PV systems at the end of 2014[1]	1.5 million
PV share in German gross power consumption 2014 / 2020[3]	6% / 8 - 10%
Total number of installed storage systems at the end of 2014[4]	>20,000
Total number of KfW-supported PV storage systems between 5/2013 and 5/2015[5]	10,700
CO_2 savings in 2014[6]	approx. 25 million t
Number of full-time jobs by photovoltaic technology 2014[7]	approx. 45,000 - 50,000
Export quota 2004 / 2014[7] / 2020[3]	14% / >65% / 80%

[1] Source: Bundesnetzagentur
[2] Sources: EEX, AGEB
[3] BSW-Solar, according to PV-Roadmap 2020
[4] Source: estimation by BSW-Solar
[5] Source: KfW
[6] internal calculations according BMU
[7] BSW-Solar, internal calculations

BSW SOLAR

Figure 16 [9]

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

The electricity market and production is dominated by the 4 large enterprises EON, RWE, Vattenfall and EnBW. Additionally there are city owned companies and industrial producers for their own facilities [Figure 18].

The grid belongs to Tennet, Amprion, 50hertz and Transnet BW [Figure 17].

The Bundesnetzagentur (Federal Network Agency) is Germany's regulatory authority for the electricity, gas, telecommunications, postal and rail markets. Since 2011, it has also taken on responsibility for implementing the Grid Expansion Acceleration Act (NABEG) [13] [15].

Figure 18

Figure 17

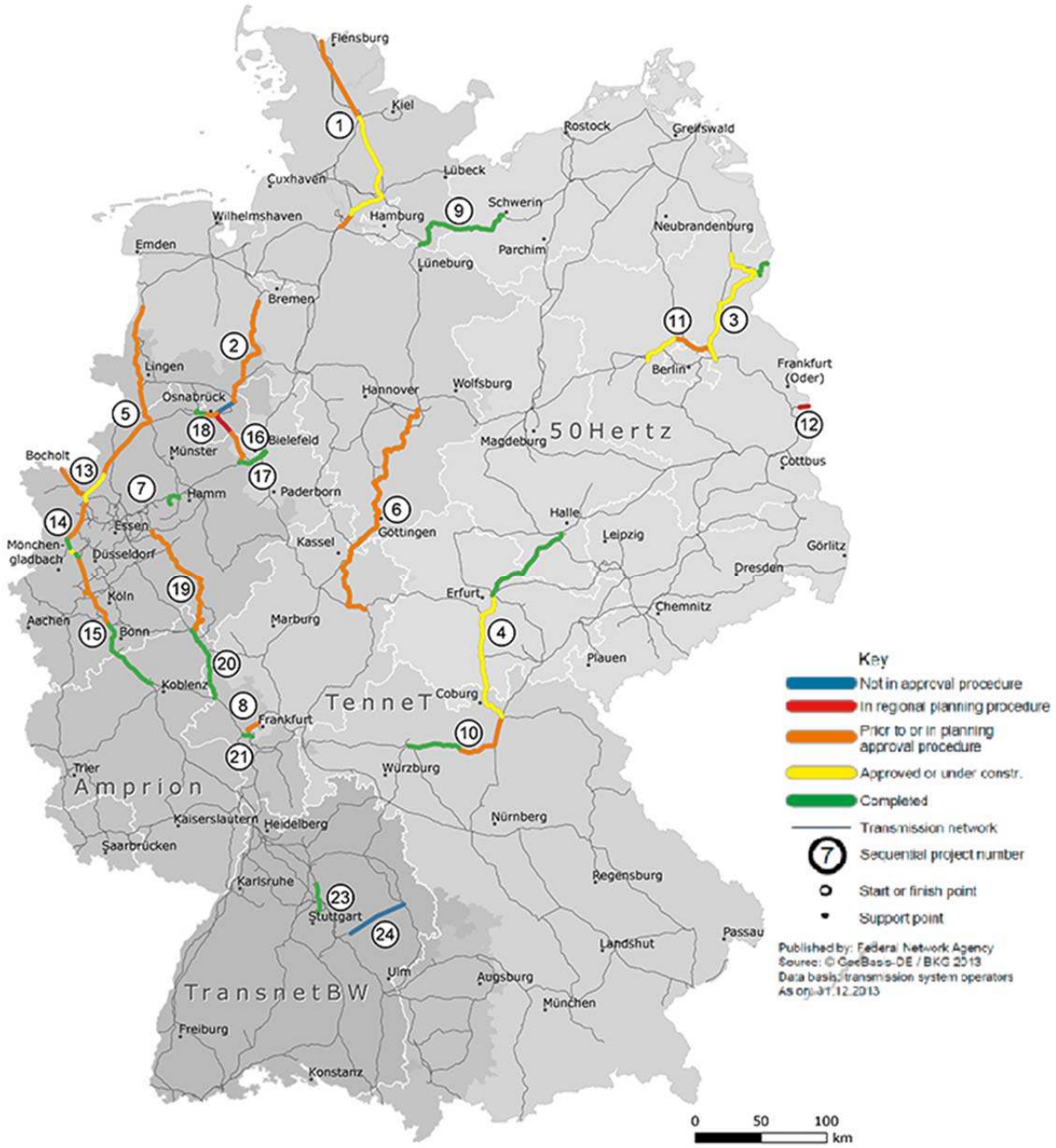


Figure 19: Status of the expansion of energy lines pursuant to the Energy Line Extension Act (EnLAG) **[3]**

7.2 Interest from electricity utility businesses

The interest of the 4 large enterprises EON, RWE, Vattenfall and EnBW for the installation of PV power plants is low. They are more engaged in the wind sector.

Some city owned companies are operating their own systems. The market is dominated by the private sector for roof-top systems and by project developers for ground mounted systems.

8 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.

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 dc current of the modules into ac 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 €

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

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[16] „Renewable Energy Sources Act (EEG),“ [Online]. Available: http://www.bmwi.de/EN/Topics/Energy/Renewable-Energy/2014-renewable-energy-sources-act,did=693154.html.

9.1 Useful sources of information

http://www.bmwi.de/EN/Service/publications.html

http://www.bmwi.de/DE/Themen/Energie/energiedaten-und-analysen,did=589204.html

http://www.ag-energiebilanzen.de/EN/home/home.html

http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/arbeitsgruppe-erneuerbare-energien-statistik.html

http://www.bundesnetzagentur.de/cln_1431/DE/Home/home_node.html

http://www.gtai.de/GTAI/Navigation/EN/invest.html

http://www.bdew.de/internet.nsf/id/strom-de

https://www.destatis.de/EN/Homepage.html;jsessionid=11F6267FF228ED501A4CE35814E04D37.cae4

http://www.dena.de/en.html

http://www.bmub.bund.de/en/topics/climate-energy/

http://www.fvee.de/en/

http://www.bine.info/en/topics/

http://www.forschungsjahrbuch.erneuerbare-energien.de/home

http://www.solarwirtschaft.de/en/start/english-news.html

http://www.photovoltaiksolarstrom.de/einspeiseverguetung#dachanlage

http://www.sma.de/unternehmen/pv-leistung-in-deutschland.html

http://www.solarserver.com/

http://www.ise.fraunhofer.de/en/publications

Cover Photo: SolarWorld AG