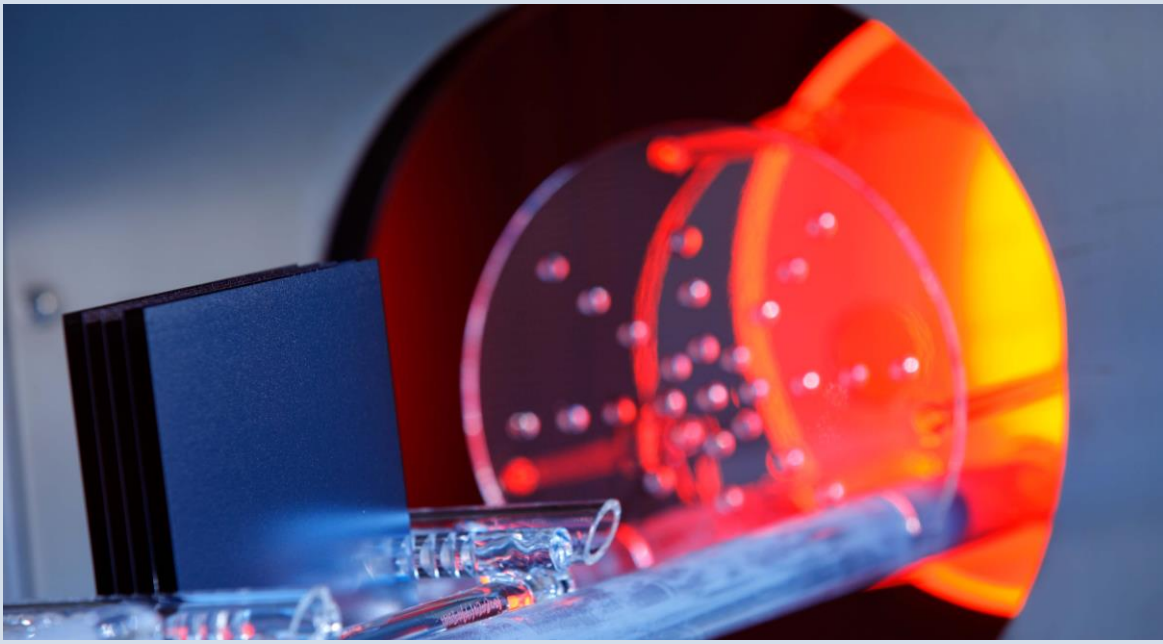
IEA INTERNATIONAL ENERGY AGENCY

National Survey Report of PV Power Applications in GERMANY 2013



PHOTOVOLTAIC POWER SYSTEMS PROGRAMME

Prepared by

Dr. Lothar Wissing

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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 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 24 participating countries are Australia (AUS), Austria (AUT), Belgium (BEL), 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), Thailand (THA), Turkey (TUR), the United Kingdom (GBR) and the United States of America (USA). The European Commission (EC), the European Photovoltaic Industry Association (EPIA), the US Solar Electric Power Association (SEPA), the US Solar Energy Industries Association (SEIA) and the Copper Alliance 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 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 2013. 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 2013 statistics if the PV modules were installed and connected to the grid between 1 January and 31 December 2013, 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. With respect to the electricity supply, the share for renewable energies has reached approx. 25 % of the gross consumption of Germany in 2013. The aim of the German Energy Concept is to reach 35 % in 2020 and 80 % in 2050. Photovoltaic (PV) is a major part of this development driven by the Renewable Energy Sources Act (EEG 2012) [2] on the one hand and a noticeable decrease of system prices on the other hand. More than half of the increase of renewable electricity production can be allocated to PV.

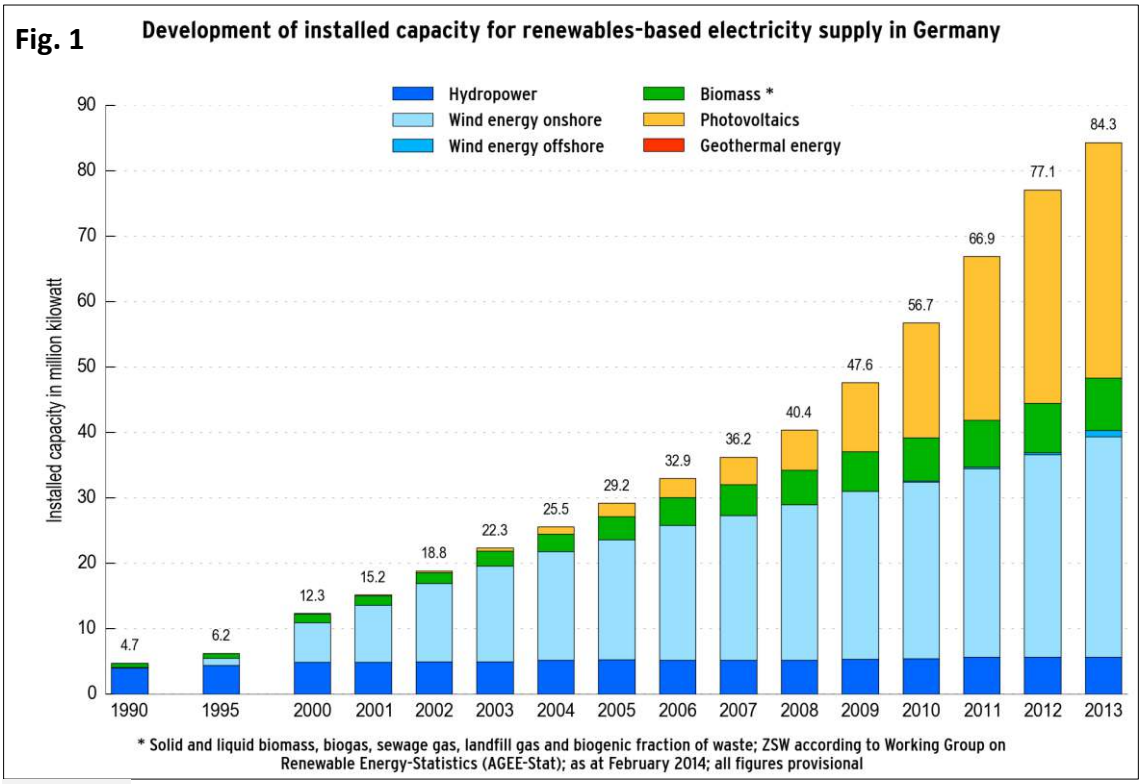
Up to now, the main driving force for the PV market in Germany is the Renewable Energy Sources Act. In terms of achieving expansion targets for renewable energies in the electricity sector, the EEG is the most effective funding instrument at the German government's disposal. It determines the procedure 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 additional amendments to the EEG are announced from the new German Government for the second half of the year 2014. 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 2,5 – 3,5 GW.

Regarding the installation figures of 2013 the amendment has achieved its goal. The new PV installations in 2013 have a capacity of about 3,3 MW. The decreasing installations figures combined with decreasing system prices and margins during the year caused a lot of 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.

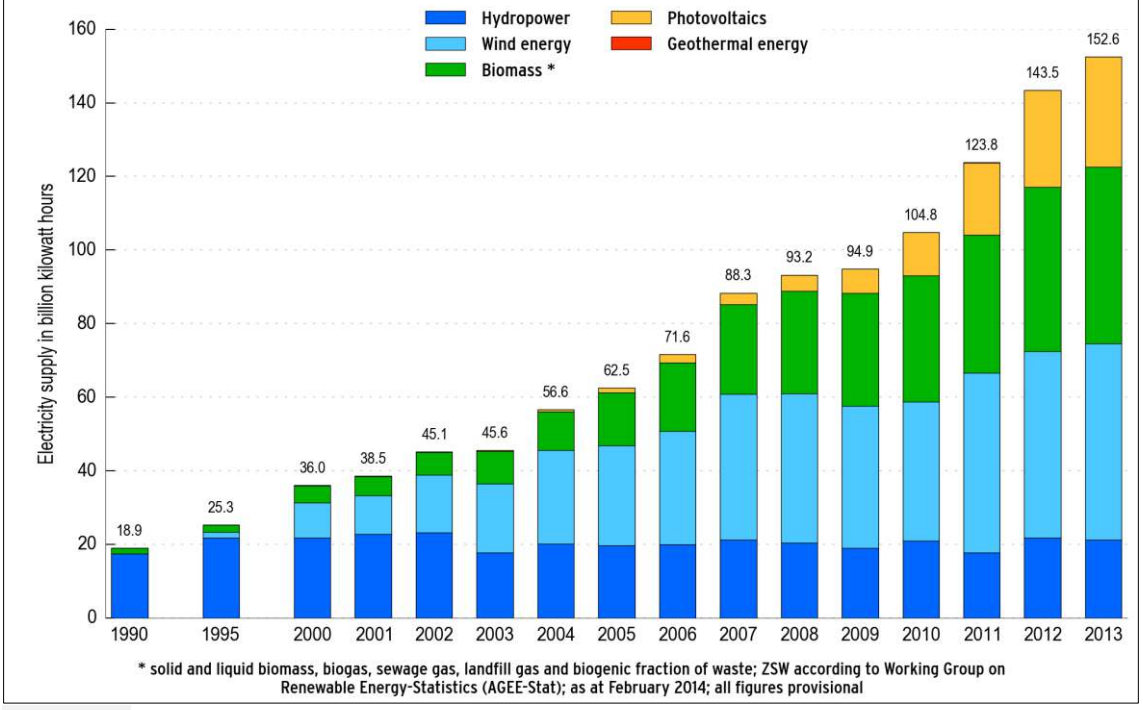
In Germany, the responsibility for the renewable energies has been with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) until the end of 2013. In order to streamline the German energy policies the new federal government decided to concentrate all energy related activities within the Federal Ministry for Economic Affairs and Energy (BMWi).

Fig. 1 Development of installed capacity for renewables-based electricity supply in Germany



Ref. [3]

Fig. 2 Development of electricity supply from renewable energy sources in Germany



Ref. [3]

1.2 Total photovoltaic power installed

Since the beginning of 2009 the owner of new PV systems are legally obliged to register their systems at the German Federal Network Agency [4]. Another official source is the "Working Group on Renewable Energy Statistics" (AGEE-Stat) [3] 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.

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.

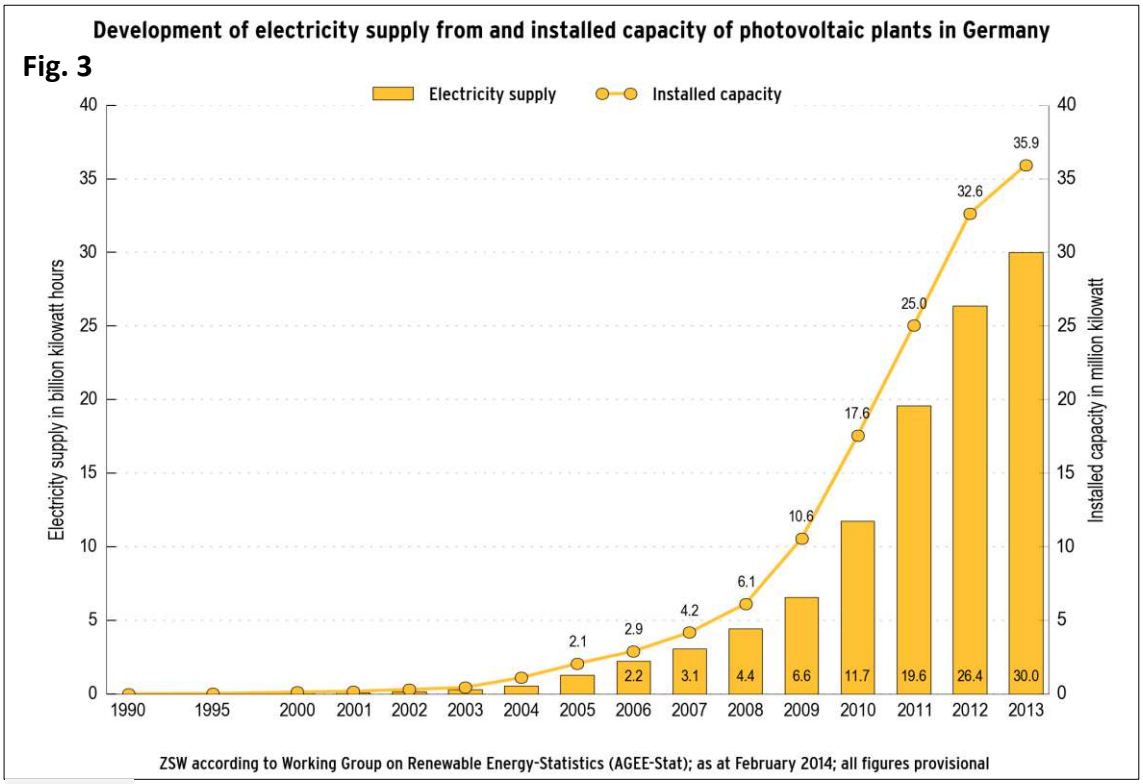
Due to the official registration procedure by German Federal Network Agency the accuracy of these data can be assumed better than ± 1 %.

Since 2009 AGEE-Stat takes over the data the German Federal Network Agency.

Table 1: PV power installed during calendar year 2013

Sub-market/ application	off-grid domestic	off-grid non-domestic	grid-connected distributed	grid-connected centralized	Total
PV power installed (kW)	n.n.	n.n.	3.305	n.n.	3.305

Fig. 3



Ref. [3]

Fig. 4 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)

Ref. [3]

Fig. 5 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 %

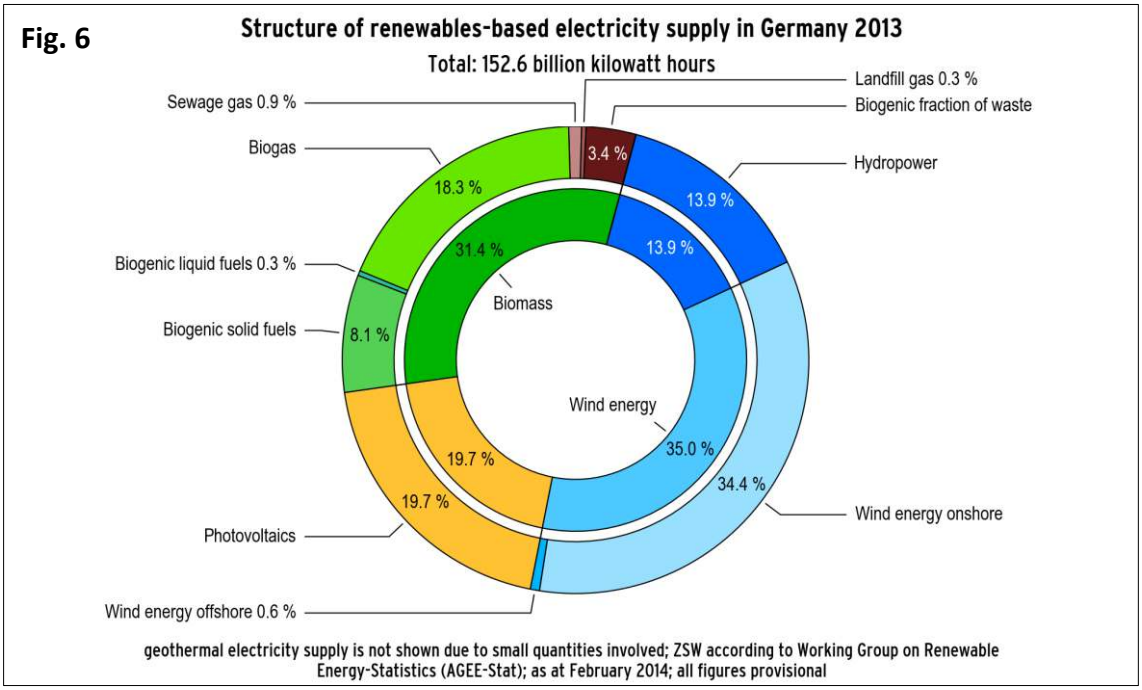
ZSW according to Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2014; all figures provisional

[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

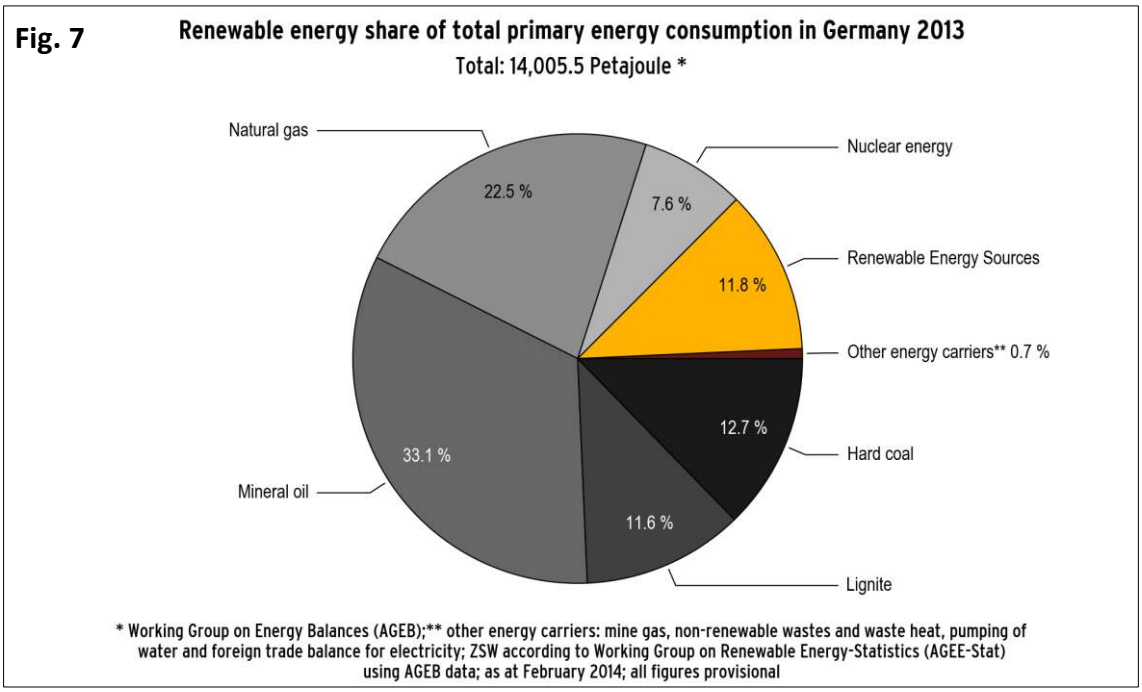
Ref. [3]

Fig. 6



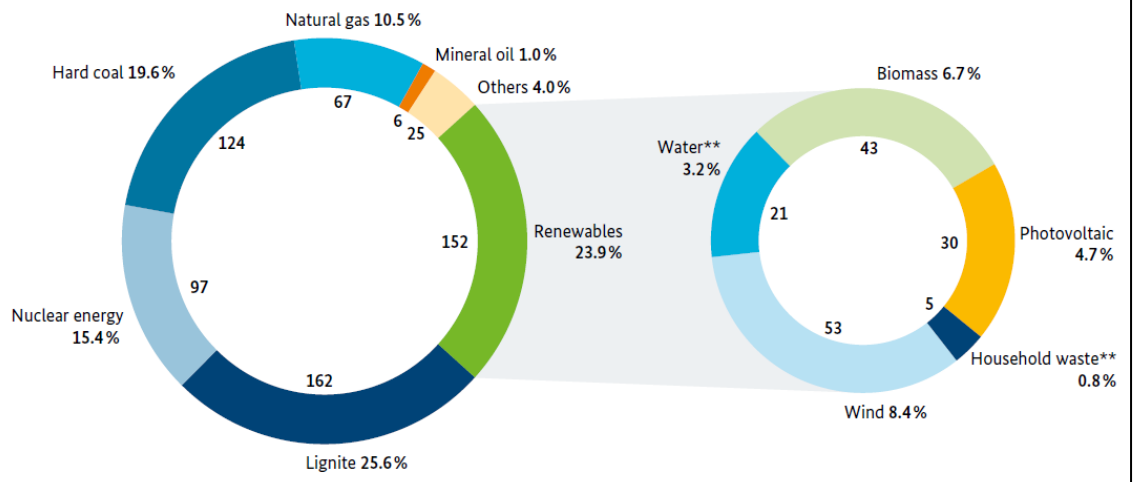
Ref. [3]

Fig. 7



Ref. [3]

Fig. 8: **Gross electricity generation in Germany in 2013** (633 TWh* in total)

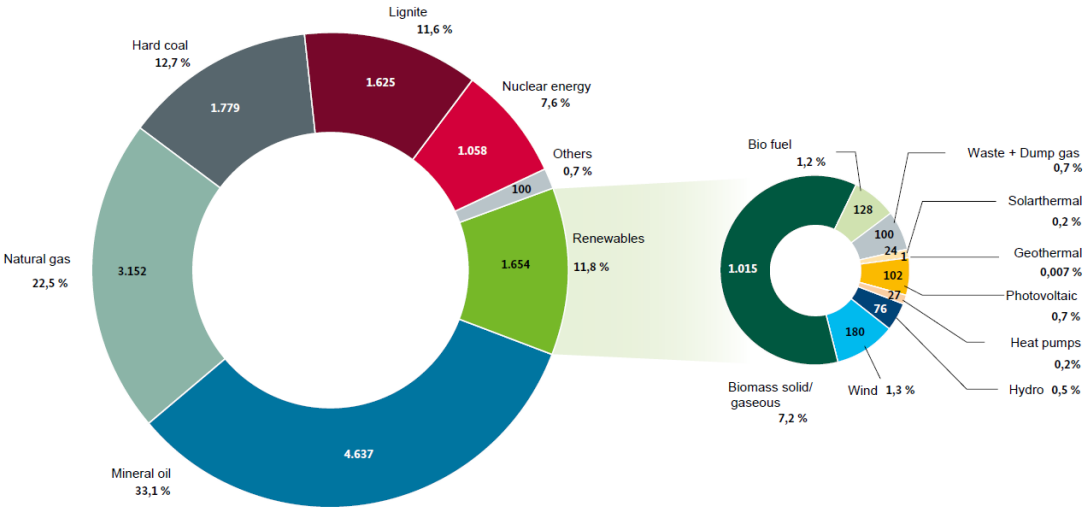


* provisional ** biogenic

Source: Working Group on Energy Balances (AGEB), Status: Februrary 2014

Ref. [3]

Primary Energy Consumption in Germany 2013 (14.005 PJ*) **Fig. 9**



* preliminary

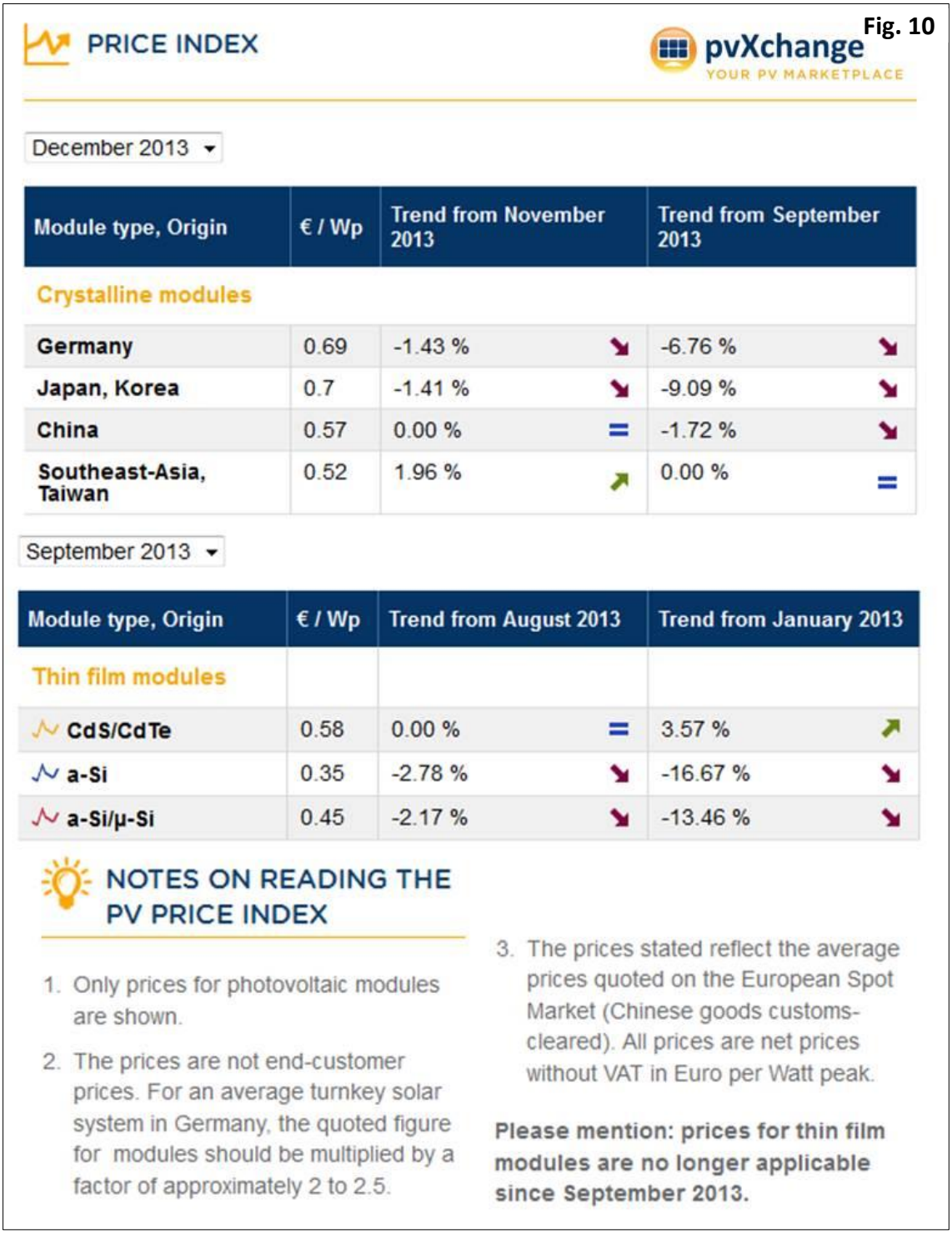
translated after source: Arbeitsgemeinschaft Energiebilanzen (AGEB), Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat)

Ref. after [3]

2 COMPETITIVENESS OF PV ELECTRICITY

2.1 Module prices

Fig. 10



PRICE INDEX

pvXchange
YOUR PV MARKETPLACE

December 2013

Module type, Origin	€ / Wp	Trend from November 2013	Trend from September 2013
Crystalline modules			
Germany	0.69	-1.43 % ↘	-6.76 % ↘
Japan, Korea	0.7	-1.41 % ↘	-9.09 % ↘
China	0.57	0.00 % =	-1.72 % ↘
Southeast-Asia, Taiwan	0.52	1.96 % ↗	0.00 % =

September 2013

Module type, Origin	€ / Wp	Trend from August 2013	Trend from January 2013
Thin film modules			
CdS/CdTe	0.58	0.00 % =	3.57 % ↗
a-Si	0.35	-2.78 % ↘	-16.67 % ↘
a-Si/µ-Si	0.45	-2.17 % ↘	-13.46 % ↘

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 2.5.
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.

Please mention: prices for thin film modules are no longer applicable since September 2013.

Ref. [5]

2.2 System prices

Table 2: Turnkey Prices of Typical PV Applications (19% VAT excluded, net prices rounded, prices at end of 2013, usually grid connected) [6]

2 – 5 kWp: 2.035 €/kWp

5 - 10 kWp: 1.800 €/kWp

> 10 kWp: 1.463 €/kWp

Table 3: National trends in system prices (< 10MWp, VAT excl., end of 2013)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Price €/kW	6540	6400	5600	5080	5300	5600	5400	5500	4200	3200	2700	2000	1800	1600

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.

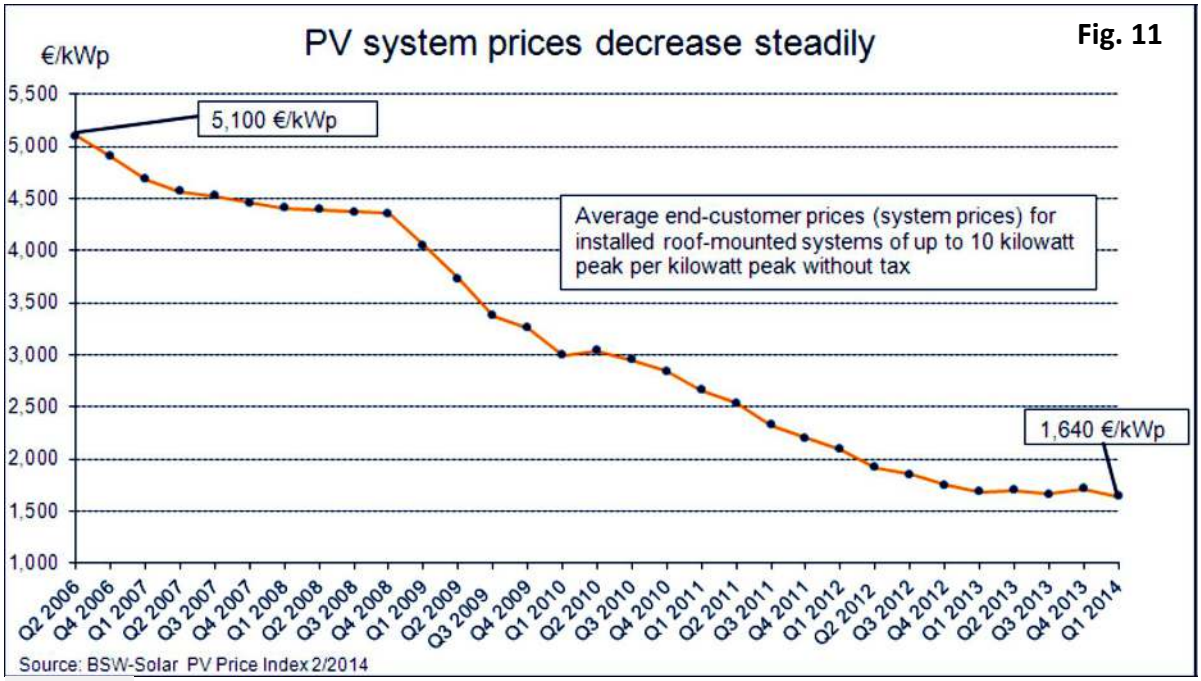


Fig. 11

Ref. [7]

2.3 Financial Parameters and programs

Due to the developed market for PV installations most of the banks offer loans for private and commercial investments. The annual interest rate is between 3 and 5 %.

2.4 Additional country information

1) Electricity prices: 0,27 – 0,31 €/kWh + basic fee for households. As an average 0,29 €/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 3 – 8 €ct/KWh. Strong influence by price level of oil and gas and source of information.

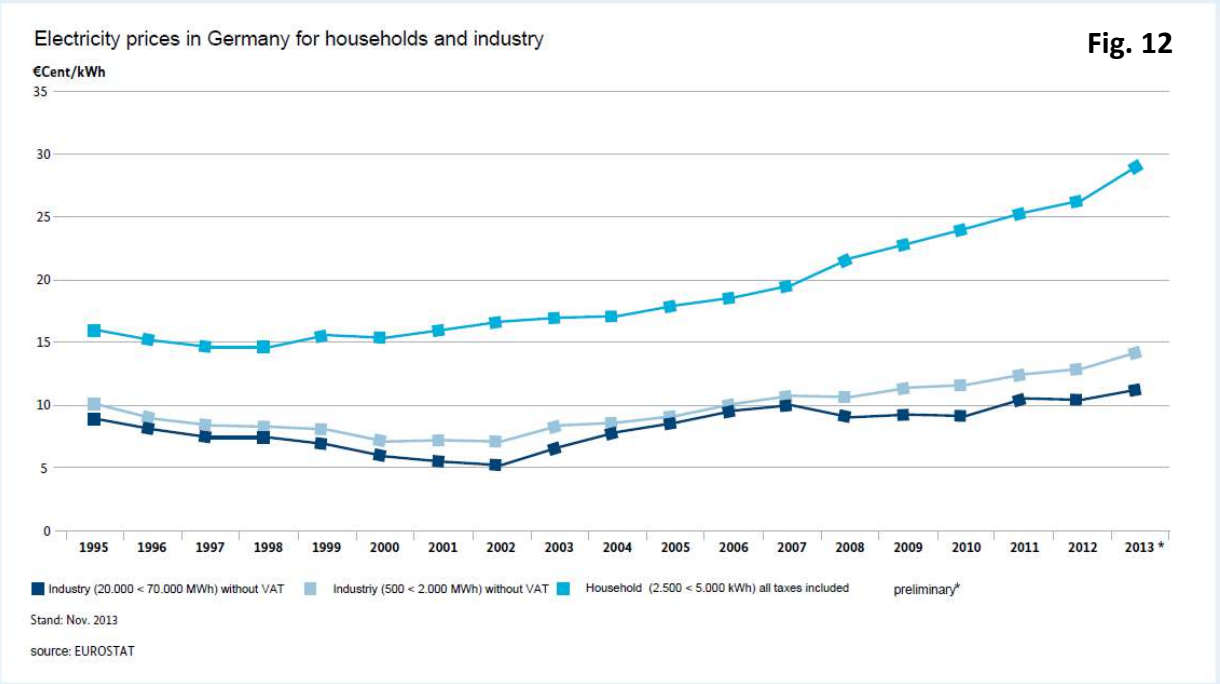


Fig. 12

Ref. [8]

2) Standard household consumption: 3359 kW/yr.

Structure of electricity consumption in Germany in kWh/y **Fig. 13**

1-person	2.256
2-persons	3.248
3-persons	4.246
4-persons	5.009
5-persons	5.969
6-persons	6.579

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 gross income: 31.089 €/yr
5) Average household income: around 48.000 €/yr (gross, 2012) (household income can vary by different private status).
6) Typical mortgage interest rate: around 2,5 %/yr
7) Voltage: 230 V / 380 V
8) Price of diesel fuel: 1,40 – 1,50 €/l.
9) Typical values for PV system of household: 3- 8 kWp.
10) Country size is 357.021 km².
11) Population is 80,8 Mio.

3 POLICY FRAMEWORK

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. 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. With respect to the electricity supply, the share for renewable energies has reached approx. 25 % of the gross consumption of Germany in 2013. The aim of the German Energy Concept is to reach 35 % in 2020 and 80 % in 2050. Photovoltaic is a major part of this development driven by the Renewable Energy Sources Act on the one hand and a noticeable decrease of system prices on the other hand. More than 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 additional amendments to the EEG are announced from the new German Government for the second half of the year 2014. 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 2,5 – 3,5 GW.

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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 Germany, the responsibility for the renewable energies has been with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) until the end of 2013. In order to streamline the German energy policies the new federal government decided to concentrate all energy related activities within the Federal Ministry for Economic Affairs and Energy.

3.1 Support Measures

Table 4: PV support measures (summary table)

	On-going measures	Measures that commenced during 2013
Feed-in tariffs (gross / net?)	Renewable Energy Sources Act (EEG)	Monthly 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	
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 Feed-in-tariff in 2013

Table5: Development of the Fit-in Tariff for small roof-top system (< 10 kWp) in Germany

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013*	2014*
EURcents/ kWh	50,6	48,1	45,7	57,4	54,5	51,8	49,2	46,75	43,01	39,14	28,74	24,43	17,02	13,68

** adjusted by a flexible monthly degression rate between 1 – 2,8 % throughout the year*

A description of the FiT-Mechanism can be found at [17].

4 HIGHLIGHTS OF R&D

In Germany, the responsibility for the renewable energies has been with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) until the end of 2013. In order to streamline the German energy policies the new federal government decided to concentrate all energy related activities within the Federal Ministry for Economic Affairs and Energy (BMWi).

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"[16], which came into force in August 2011. Within this framework, the BMU 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 BMU

In December 2011, the BMU released a new call for tender, which reflects the targets of the new energy research program. Concerning PV, the call addresses five focal points which are all connected to applied research:

- Silicon wafer technology,
- Thin-film technologies, especially based on Silicon and Chalcopyrites (CIS/CIGS),
- 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.

In 2013, the BMU support for R&D projects on PV amounted to about 48,7 MEUR shared by 242 projects in total. That year, 43 (2012: 85) new grants were contracted. The funding for these projects amounts to 36,2 (68,3) MEUR in total. The budget reduction is explained by the fact that the phase of granting new projects under the "Innovation Alliance PV," was terminated in 2012. Details on running R&D projects can be found in the BMU "Annual Report on Research Funding in the Renewable Energies Sector" [9] 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.

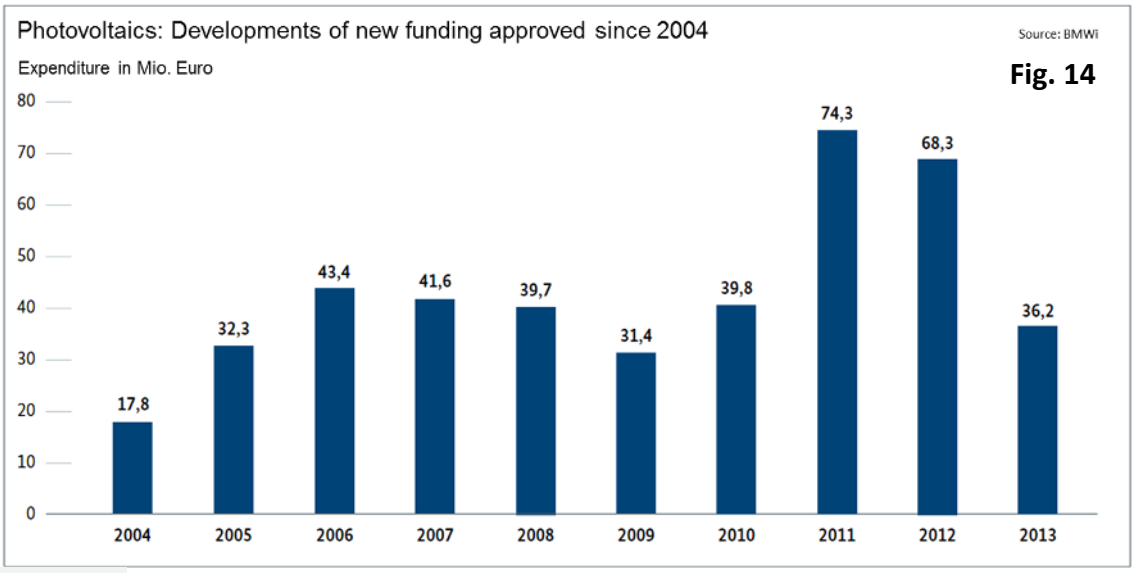


Fig. 14

Ref. [9]

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 Innovation Alliance PV – a Joint Initiative of BMU and BMBF

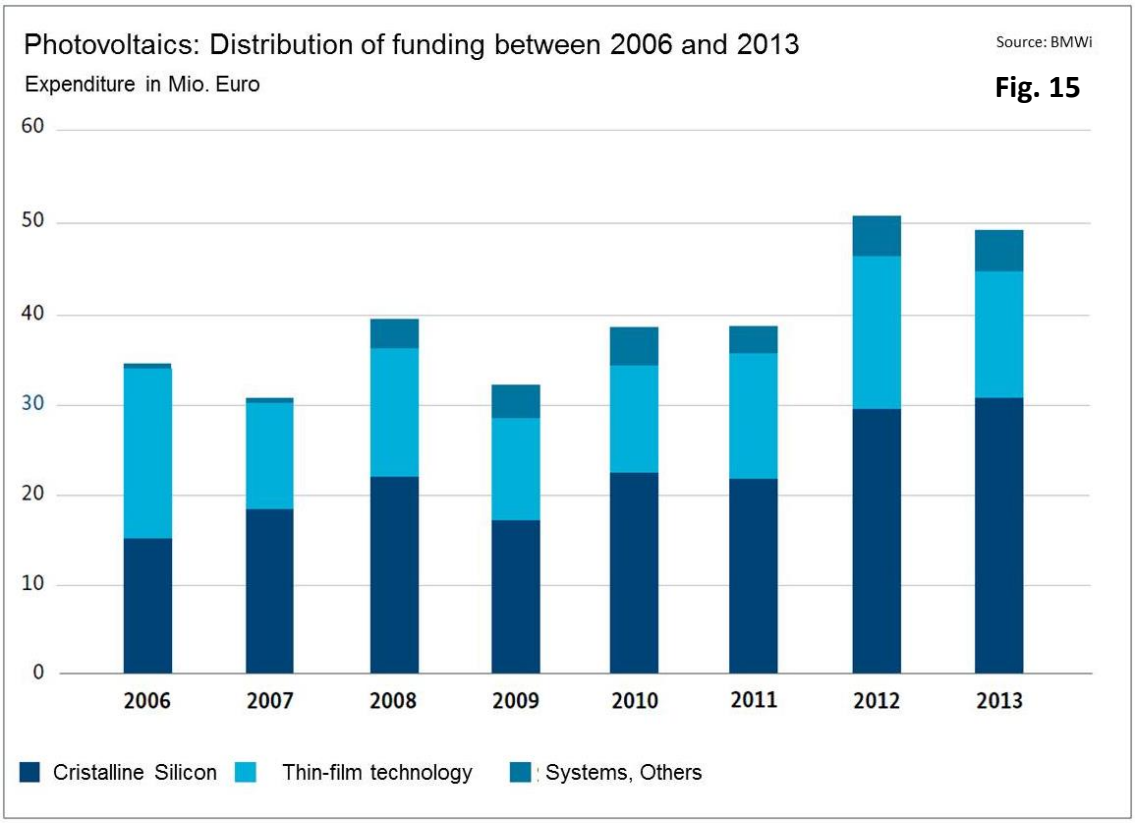
In summer 2010, BMU and BMBF initiated the Innovation Alliance PV. Under this scheme R&D projects are funded which support a significant reduction of PV production costs in order to enhance the competitiveness of Germany’s industry. Therefore, projects under industrial leadership integrating different 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. The approval procedure took place in 2011 and 2012. Currently 19 R&D projects are in progress. The recent outcomes of all projects have been presented at a workshop held 29th of April 2013 [10].

4.4 FuE for Photovoltaic – a Joint Initiative of BMU and BMBF

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 “FuE for Photovoltaic” 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. The approval procedure of 10 joint projects will start in 2014 [10].


Photovoltaics: Distribution of funding between 2006 and 2013
Source: BMWi
Expenditure in Mio. Euro
Fig. 15
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
Cristalline Silicon
Thin-film technology
Systems, Others

Ref. [9]

5 INDUSTRY

The year 2013 again, was another difficult year for photovoltaic industry, machinery construction and component suppliers. Throughout the world, a current production capacity of 60-70 gigawatts faces a market of around 40 gigawatts. This results to an oversupply with low-price modules which achieved around 0.60 Euros per watt. 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. An improvement of the situation might be expected earliest end of 2014 or beginning of 2015, when production capacities and markets will achieve a compliant level.

This difficult economic situation led to the fact that two of the large German market leader had to realign their business: The company Q-Cells was taken over by the Korean Hanwha Group. Bosch Solar announced to give up the production of solar modules based on crystalline silicon at the end of 2013.

At end of 2013 there were only around 40 photovoltaic companies with around 11,000 employees in Germany operating compared to 2008 with 62 companies with more than 32,000 employees.

5.1 Production of feedstocks, ingots and wafers

Table 6: Production of silicon feedstock and wafer in Germany for 2013, after [11]

Producers	Process & technology	Total Production	Maximum production capacity	Product destination
Silicon feedstock		*t/year*	*t/year*	
Wacker-Chemie	Silicon feedstock	46.000	52.000	market
Joint Solar Silicon GmbH & Co. KG	Silicon feedstock	0	0	
Schmid Silicon Tech Technology GmbH	Silicon feedstock	100	180	market
Silicon Products Bitterfeld GmbH & Co. KG	Silicon feedstock	30	1.800	market
Total		**46.130**	**53.980**	
Wafer		*MW/year*	*MW/year*	
Bosch Solar Energy AG	sc/mc-Si wafer	250	720	market
Deutsche Solar AG (Solarworld)	mc-Si wafer	400	750	subsidiary, market
PV Crystalox Silicon GmbH	sc-Si wafer	150	350	market
Total		**800**	**1.820**	

5.2 Production of photovoltaic cells and modules

Table 7: Production and production capacity information in Germany for 2013 [11]

Technology Type	Production MW	Capacity MW
Si-Module	1282,5	**2735**
amorphous Si cells	40	280
CIS cells	45	365
CdTI cells	15	25
CPV cells	30	70
Sum thin-film cells	130	740
Si-cells	1100	1700
All cells	**1230**	**2440**

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" [12]:

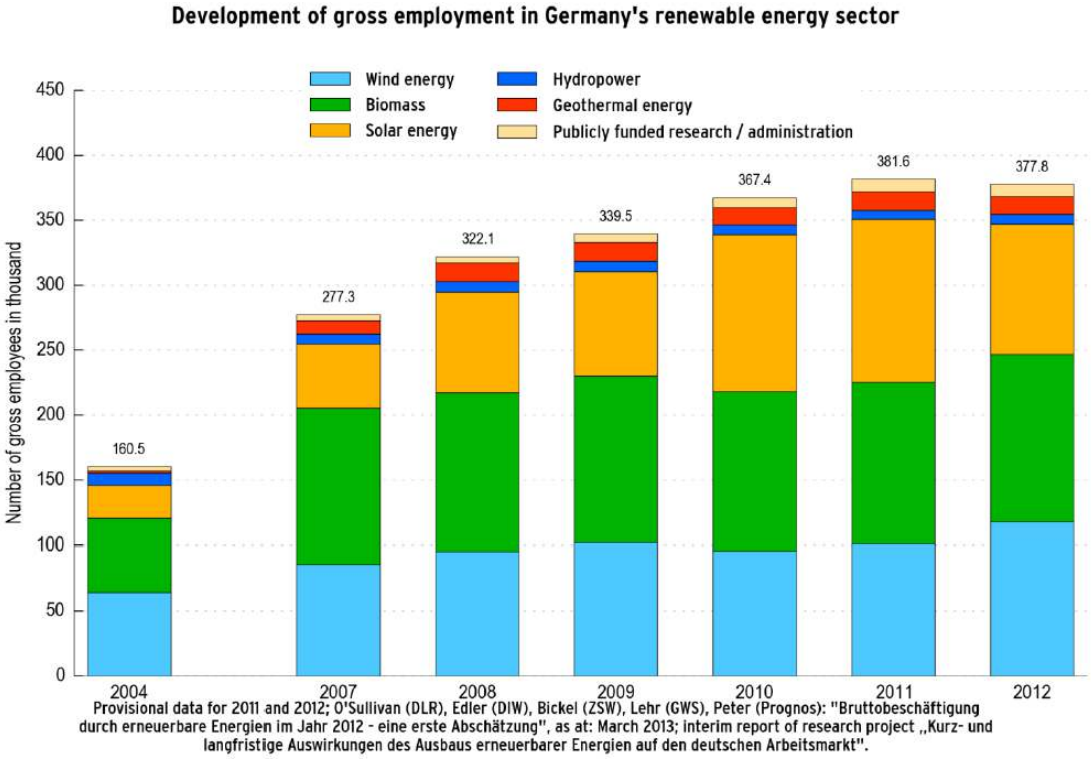
- Fact Sheet - CSP Industry in Germany [PDF, 420 KB]
- Fact Sheet - Battery Manufacturers [PDF, 390 KB]
- Fact Sheet - Photovoltaic BOS Components [PDF, 397 KB]
- Fact Sheet - Photovoltaic Equipment [PDF, 508 KB]
- Fact Sheet - Photovoltaic Manufacturers [PDF, 357 KB]
- Fact Sheet - Photovoltaic Module Materials [PDF, 346 KB]
- Fact Sheet - Photovoltaic R&D [PDF, 413 KB]
- Fact Sheet - Photovoltaic Project developers, system integrators & wholesalers [PDF, 459 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.

6 PV IN THE ECONOMY

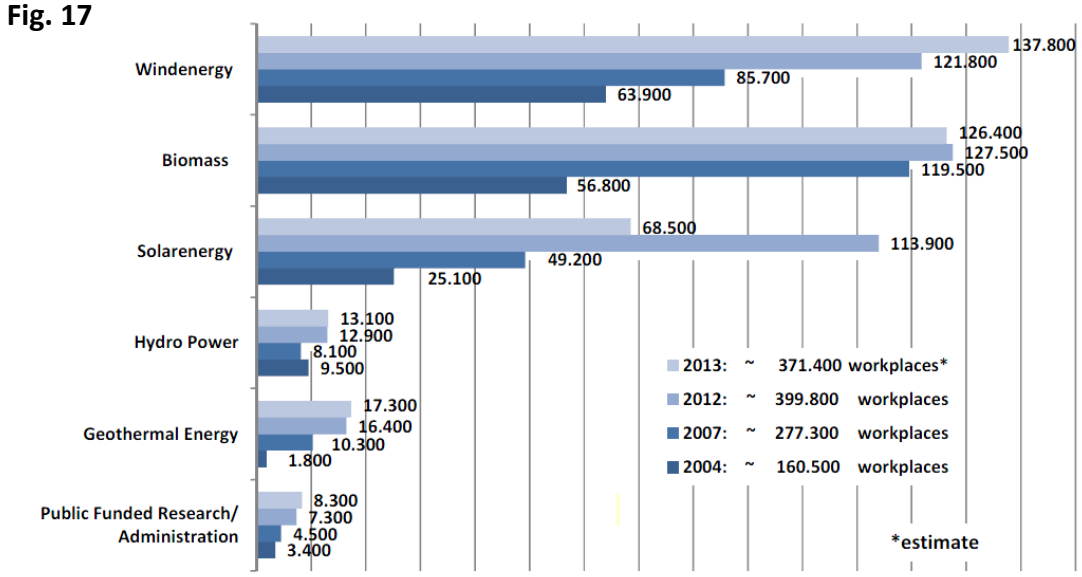
6.1 LABOUR PLACES

Fig. 16



Ref. [3]

Fig. 17

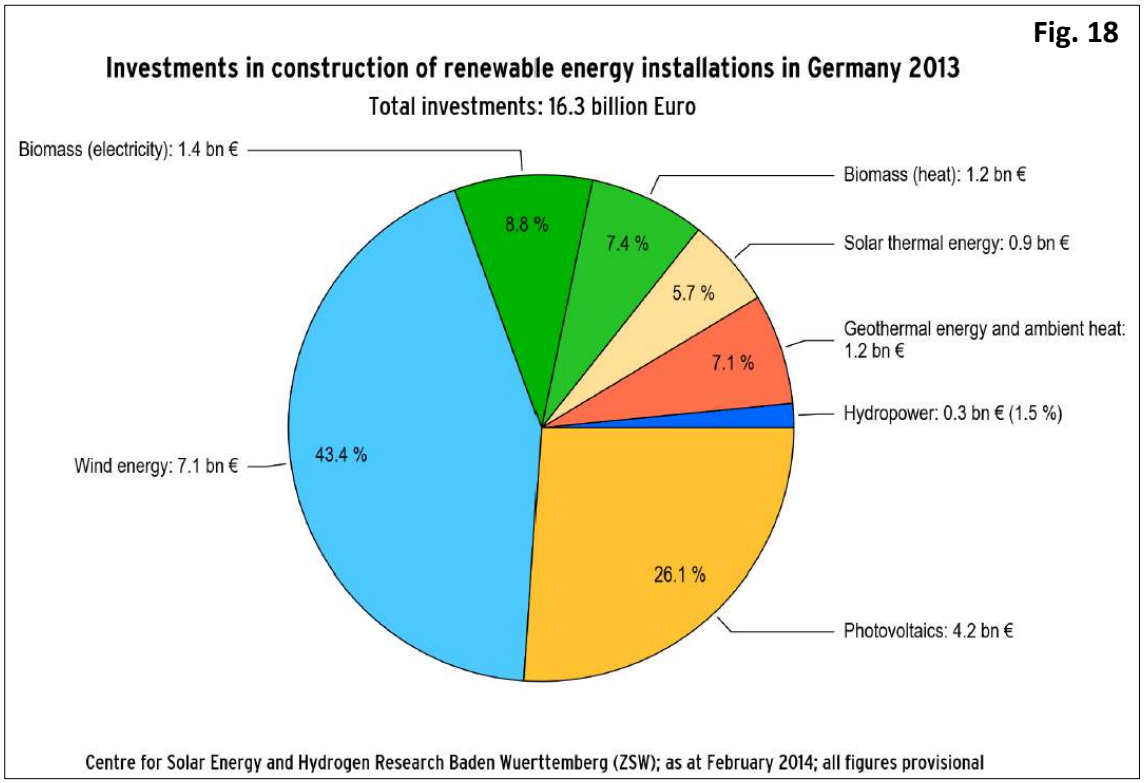


Development of gros employment by renewable energies in Germany

Ref. [13]

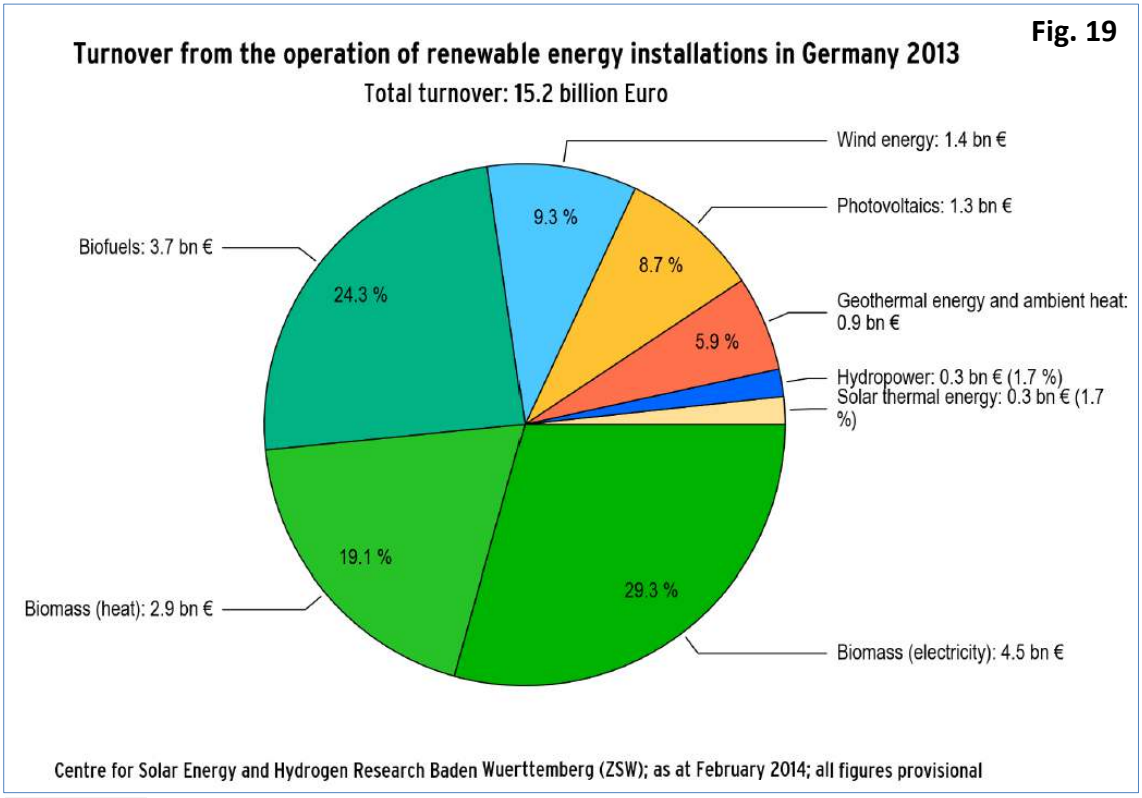
6.2 Business value

Fig. 18



Ref. [3]

Fig. 19



Ref. [3]

Fig. 20

Photovoltaic (solar power) industry in Germany —Profile in brief, as of end of 2013 (approx.)

New photovoltaic (PV) capacity installed in Germany 2013[1]	3,300 MWp
Total PV capacity installed in Germany 2013[1]	35,700 MWp
Power generation through PV systems 2013[2]	29,700 GWh
Total number of installed PV systems at the end of 2013[1]	1.4 million
PV share in German gross power consumption 2013 / 2020[3]	5% / 10%
CO_2 savings in 2013[4]	21 million t
Number of full-time jobs by photovoltaic technology 2013[5]	50,000 - 65,000
Number of photovoltaic companies (incl. installers and suppliers)[5] of which are producers of cells, modules and other components[5]	5,000 200
Export quota 2004 / 2013[5] / 2020[3]	14% / 65% / 80%

[1] Source: Bundesnetzagentur
[2] internal calculations, preliminary, Source: EEX
[3] BSW-Solar, according to PV-Roadmap 2020
[4] internal calculations according BMU
[5] preliminary estimation BSW-Solar, final data for 2013 are expected in May 2014

BSW SOLAR

Ref. [7]

7 INTEREST FROM ELECTRICITY STAKEHOLDERS

7.1 Structure of the electricity system

The electricity market and 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 [Fig. 21].

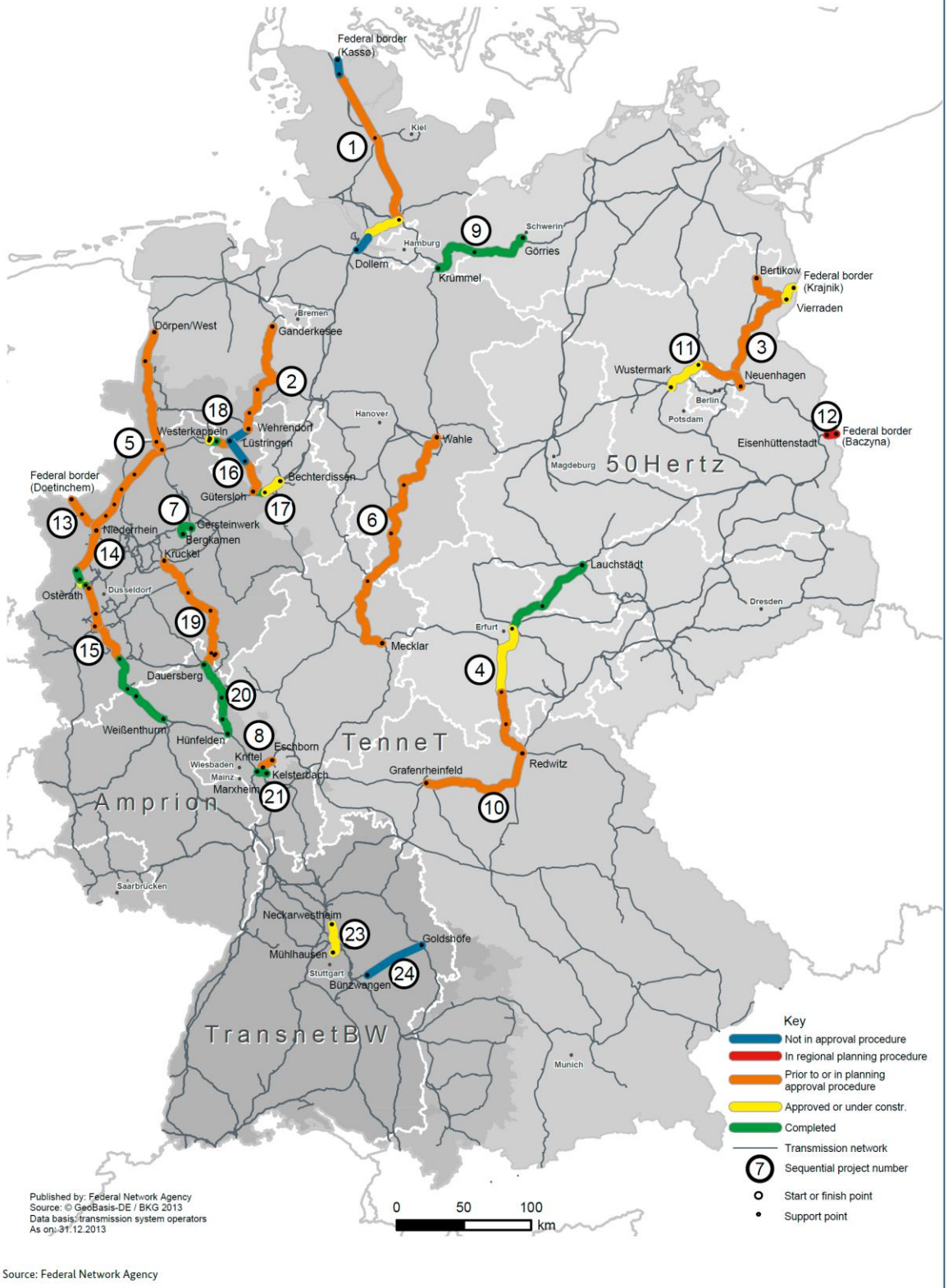
The grid belongs to Tennet, Amprion, 50hertz and Transnet BW [Fig. 22].

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) [14,15].

Fig. 21

Fig. 22

Figure 3: Status of the expansion of energy lines pursuant to the Energy Line Extension Act (EnLAG) **Fig. 23**



Source: Federal Network Agency

Ref. [15]

7.2 Interest from electricity utility businesses, municipalities and local governments

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 developer 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.

9 REFERENCES AND USEFUL SOURCES OF INFORMATION

9.1 References

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[2] Renewable Energy Sources Act (EEG), http://www.bmub.bund.de/fileadmin/bmu-import/files/english/pdf/application/pdf/eeg_2012_en_bf.pdf

[3] Development of renewable energy sources in Germany 2013, February2014, Based on statistical data from the Working Group on Renewable Energy-Statistics(AGEE-Stat); http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/arbeitsgruppe-erneuerbare-energien-statistik.html

[4] Bundesnetzagentur / German Federal Network Agency; http://www.bundesnetzagentur.de/cln_1422/EN/Home/home_node.html

[5] PVxChange: http://www.pvxchange.com/priceindex/Default.aspx?langTag=en-GB

[6] Photon, 4/2014, page 58

[7] BSW (Bundesverband Solarwirtschaft); http://www.solarwirtschaft.de/fileadmin/media/pdf/2013_2_BSW-Solar_fact_sheet_solar_power.pdf

[8] Energiedaten: Gesamtausgabe, Stand April 2014, BMWi; http://www.bmwi.de/DE/Themen/Energie/Energiedaten-und-analysen/Energiedaten/gesamtausgabe,did=476134.html

[9] Innovation durch Forschung -Jahresbericht 2013 zur Forschungsförderung im Bereich der erneuerbaren Energien, BMWi; http://www.bmwi.de/EN/Service/publications.html

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[11] Photon, 1/2014, page 20-24

[12] Germany Trade and Invest- Fact sheets Photovoltaic; http://www.gtai.de/GTAI/Navigation/DE/Invest/Industrien/Energie-umwelt-technologien/Solar-industrie/solar-industrie-downloads-medien.html

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[14] Grid expansion: http://www.netzausbau.de/cln_1411/EN/Home/home_node.html

[15] Second Monitoring Report "Energy of the future" Summary, BMWi; http://www.bmwi.de/EN/Service/publications,did=639404.html

[16] Research for an environmentally sound, reliable and affordable energy supply: 6th Energy Research Programme of the Federal Government; http://www.bmwi.de/DE/Mediathek/publikationen,did=427698.html

[17] EEG Amendment 2012 – What will change as of 1 January 2012? http://www.solarwirtschaft.de/fileadmin/media/pdf/EEG-Novelle2012_EN.pdf

9.2 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

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

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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^{o}C, AM 1,5 solar spectrum – (also see 'Rated power').

Rated power: Amount of power produced by a PV module or array under STC, written as W.

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

CPV: Concentrating PV

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

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

Off-grid domestic PV power system: System installed to provide power mainly to a household or village not connected to the (main) utility grid(s). Often a means to store electricity is used (most commonly lead-acid batteries). Also referred to as 'stand-alone PV power system'. Can also provide power to domestic and community users (plus some other applications) via a 'mini-grid', often as a hybrid with another source of power.

Off-grid non-domestic PV power system: System used for a variety of industrial and agricultural applications such as water pumping, remote communications, telecommunication relays, safety and protection devices, etc. that are not connected to the utility grid. Usually a means to store electricity is used. Also referred to as 'stand-alone PV power system'.

Grid-connected distributed PV power system: System installed to provide power to a grid-connected customer or directly to the electricity grid (specifically where that part of the electricity grid is configured to supply power to a number of customers rather than to provide a bulk transport function). Such systems may be on or integrated into the customer's premises often on the demand side of the electricity meter, on public and commercial buildings, or simply in the built environment on motorway sound barriers etc. They may be specifically designed for support of the utility distribution grid. Size is not a determining feature – while a 1 MW PV system on a rooftop may be large by PV standards, this is not the case for other forms of distributed generation.

Grid-connected centralized PV power system: Power production system performing the function of a centralized power station. The power supplied by such a system is not associated with a particular electricity customer, and the system is not located to specifically perform functions on the electricity grid other than the supply of bulk power. Typically ground mounted and functioning independently of any nearby development.

Turnkey price: Price of an installed PV system excluding VAT/TVA/sales taxes, operation and maintenance costs but including installation costs. For an off-grid PV system, the prices associated with storage battery maintenance/replacement are excluded. If additional costs are incurred for

reasons not directly related to the PV system, these should be excluded. (E.g. If extra costs are incurred fitting PV modules to a factory roof because special precautions are required to avoid disrupting production, these extra costs should not be included. Equally the additional transport costs of installing a telecommunication system in a remote area are excluded).

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

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

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

Final annual yield: Total PV energy delivered to the load during the year per kW of power installed.

Performance ratio: Ratio of the final annual (monthly, daily) yield to the reference annual (monthly, daily) yield, where the reference annual (monthly, daily) yield is the theoretical annual (monthly, daily) available energy per kW of installed PV power.

Currency: The currency unit used throughout this report is EURO

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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