

# Large-Scale Photovoltaic Power Plants

## Cumulative and Annual Installed Power Output Capacity

pvresources.com  
**Annual Report 2007**

**Revised Edition, April 2008**



*"Heavier-than-air flying machines are impossible."  
(Lord Kelvin, president, Royal Society, 1895)*

Copyright: ©Denis Lenardic  
pvresources.com, April 2008

## Introduction

In this report basic statistical data about large-scale photovoltaic power plants currently in operation is presented. The report includes data about power plants by region, country etc. Annual and cumulative installed power output capacities for the most important markets are presented as well.

**Please note that only photovoltaic power plants producing more than 200 kWp are considered in this report.**

Due to the specific situation on the photovoltaic market – the number of large-scale photovoltaic plants is increasing very fast – in such a fast moving market it is therefore very difficult to maintain such a report and keep it totally up to date. In this report the majority of photovoltaic power plants that were completed by 31.12.2007 - provided press releases or other official statements were made before the date of publishing this report (Revised Edition, published on April 14<sup>th</sup>, 2008) – are considered. This report was prepared as carefully as possible; however mistakes and errata can not be excluded. Because there are no reliable databases, or other national or international sources of information concerning large-scale photovoltaic power plants available, statistical data presented here should be considered as “conservative” values. This report and the pvresources.com data include only completed photovoltaic power plants or plants that are very close to completion. In this report planned or photovoltaic plants under construction are not considered. Exceptions are explicitly noted (like Solarpark Waldpolenz for example).

**The report is presented "at face value" without warranty of any kind. Mistakes, errors or omissions in the pvresources.com list of large-scale photovoltaic power plants - <http://www.pvresources.com/en/top50pv.php> - should be reported directly to [contact@pvresources.com](mailto:contact@pvresources.com).**

## Cover photos

Cover photos show some large-scale (MW range) photovoltaic power plants, constructed in 2007: Solar Park Beneixama, Alicante, Spain (top left), Solarpark Darro, Granada, Spain (top right), Solarpark Brandis, Saxony, Germany (bottom).

### **Cover photos copyright notice:**

Solar Park Beneixama, Alicante, Spain, copyright Accener S.L. / City Solar AG  
Solarpark Darro, Granada, Spain, copyright EPURON GmbH  
Solarpark Brandis, Saxony, Germany, copyright juwi GmbH

## Copyright

If you wish to use data from this report please cite source of information as **”credit: pvresources.com“** or **”copyright: ©pvresources.com”**.

**Copyright:** data from this report may be used free of charge for research and educational purposes and for journalistic and press purposes providing credit is cited properly. For other commercial use the author's consent is required. No rights are granted by the author of this report for use of material (maps, pictures etc.) owned by any third party. Before using such material, permission of the original author(s)/owner(s) is required.

The author has been systematically collecting data about large-scale photovoltaic power plants since 2001. The data that represent the basis of this report is published on <http://www.pvresources.com/en/top50pv.php> and is available to the public free of charge.

## Special Thanks

Without the contributions of third parties – personal contacts, press releases, press material available on different web sites etc. – it would never be possible to create such report. All individuals and companies who - in the period from 2001 to 2008 – have contributed to the pvresources.com list of large-scale photovoltaic power plants, are listed under "special thanks" on pvresources.com's web pages, <http://www.pvresources.com/en/top50pv.php>.

**Special thanks:** The author would additionally like to express his very special thanks to the companies, and their representatives, listed below (listed in alphabetic order):

Beck Energy GmbH  
City Solar AG  
Goldbeck Solar GmbH  
Elektro Kirchner GmbH  
EPURON GmbH  
GEOSOL Gesellschaft für Sonnenenergie mbH  
juwi GmbH  
Phoenix Solar AG  
Solarserver  
SunEdison LLC  
SunStrom GmbH  
TAUBER SOLAR Management GmbH

## Large-scale photovoltaic power plants

In Table 1 basic data of 25 of the largest photovoltaic power plants, put into service before 31.12.2007, is presented. Additionally there are several large-scale power plants in the power range >10 MW under construction, but there were no official press releases or announcements about their completion available before March 31<sup>st</sup> 2007. These plants will be included into pvresources.com's list as soon as they are completed and officially put into service.

Power (MWp)	Country	Location	On-grid since
20	Spain	Jumilla	2007
20	Spain	Beneixama	2007
14	USA	Nellis, NV	2007
13,8	Spain	Salamanca	2007
12,7	Spain	Lobosillo	2007
12	Germany	Erlasee / Arnstein	2006
11	Portugal	Serpa	2007
10,35 (16,1 MW***)	Germany	Brandis *	2007
10	Germany	Pocking	2006
9,55	Spain	Milagro	2007
8,76	Spain	Viana	2007
8,4	Germany	Göttelborn **	2004 – 2007
8,22	USA	San Luis Valley, Alamosa, CO	2007
6,3	Germany	Mühlhausen	2004
6,277	Spain	Aldea del Conde	2007
6	Spain	Olmedilla	2007
6	Germany	Doberschütz	2007
5,8	Spain	Darro	2007
5,568	Germany	Oberottmarshausen	2007
5,27	Germany	Miegersbach	2005
5,21	Japan	Kameyama	2006
5,076	Germany	Kleinaitingen	2007
5,04	Spain	Alvarado	2007
5	Germany	Thierhaupten	2007
5	Spain	Bullas	2007

\* 40 MWp Solarpark Waldpolenz is still under construction (10 MWp on-grid since 2007)

\*\* Plant Göttelborn was constructed in 2004 (4 MWp). 4,4 MWp part added in 2007

\*\*\* Construction ongoing - 16,1 MWp in April 2008

**TABLE 1: Largest photovoltaic power plants  
as at December 2007**

## Annual and cumulative installed power output capacity

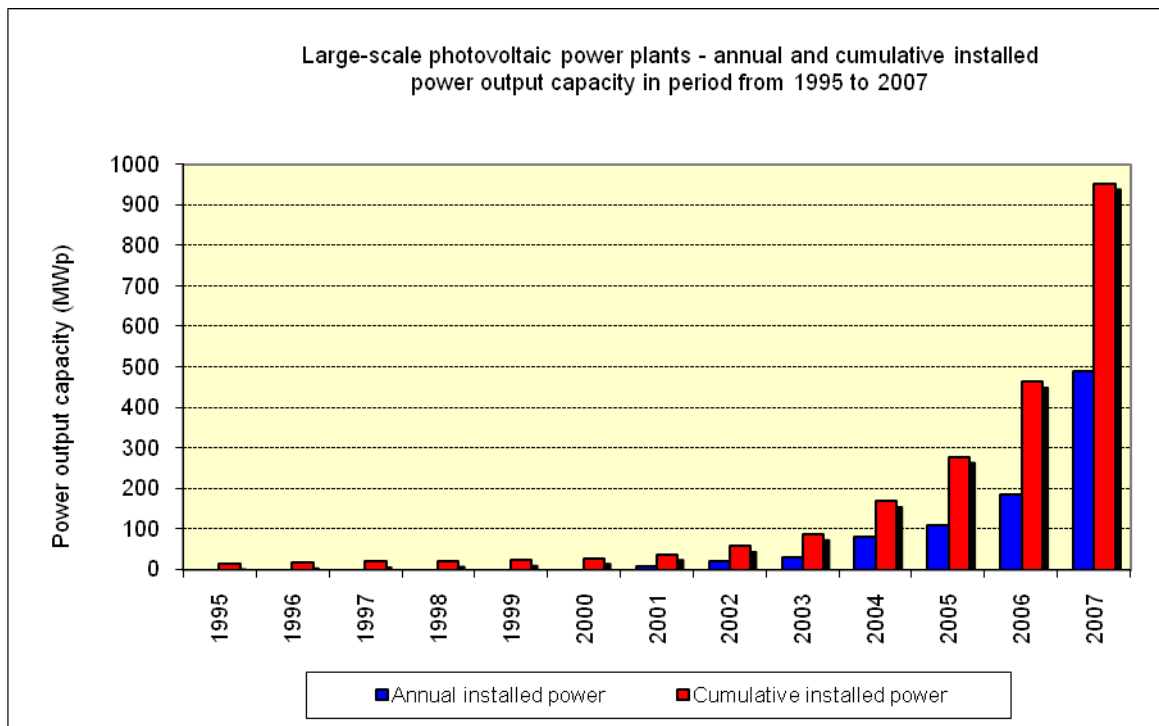
On pvresources.com's web site almost 880 photovoltaic power plants (put into service in 2007 or earlier), each with peak power of 200 kWp or more, are listed. Cumulative power of all these photovoltaic power plants is about 955 MWp and average plant power output is slightly more than 1.24 MWp. More than 390 large-scale photovoltaic plants are located in Germany, 225 in USA and more than 130 in Spain. These are also the most important markets worldwide.

### Annual installed power output capacity (MWp) 1995 – 2007

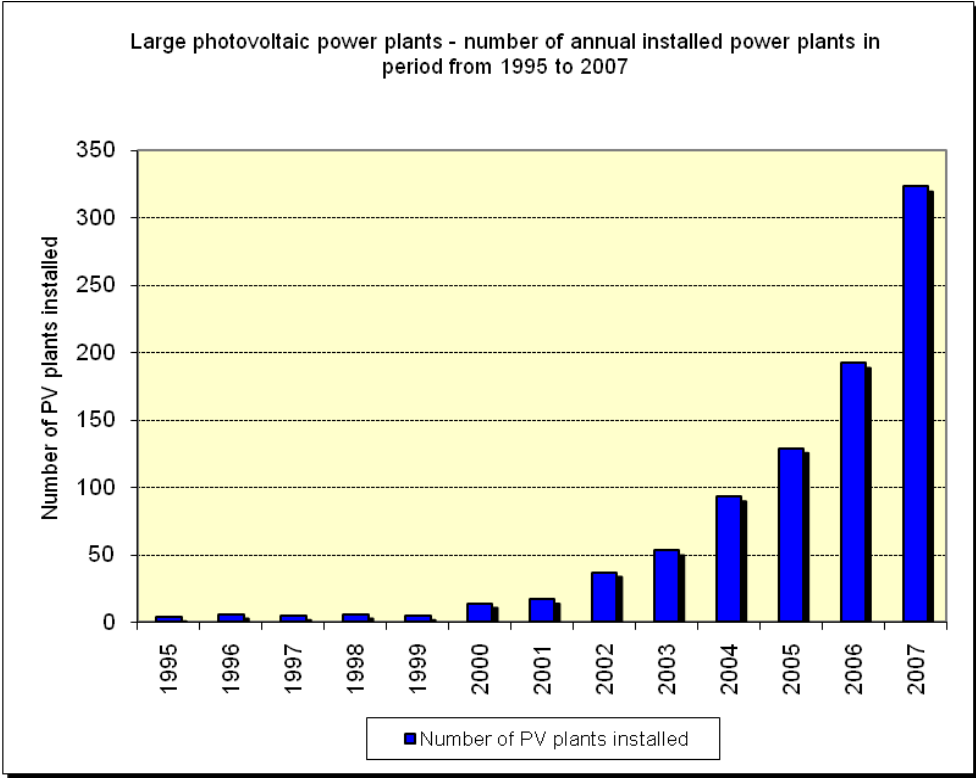
1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
5,3	2,0	2,2	1,9	2,4	4,8	9,7	19,7	29,2	81,5	108,7	185,6	489,2
15,3	17,3	19,5	21,4	23,8	28,6	38,3	58,0	87,2	168,7	276,4	462,0	951,2

### Cumulative installed power output capacity (MWp) 1995 – 2007

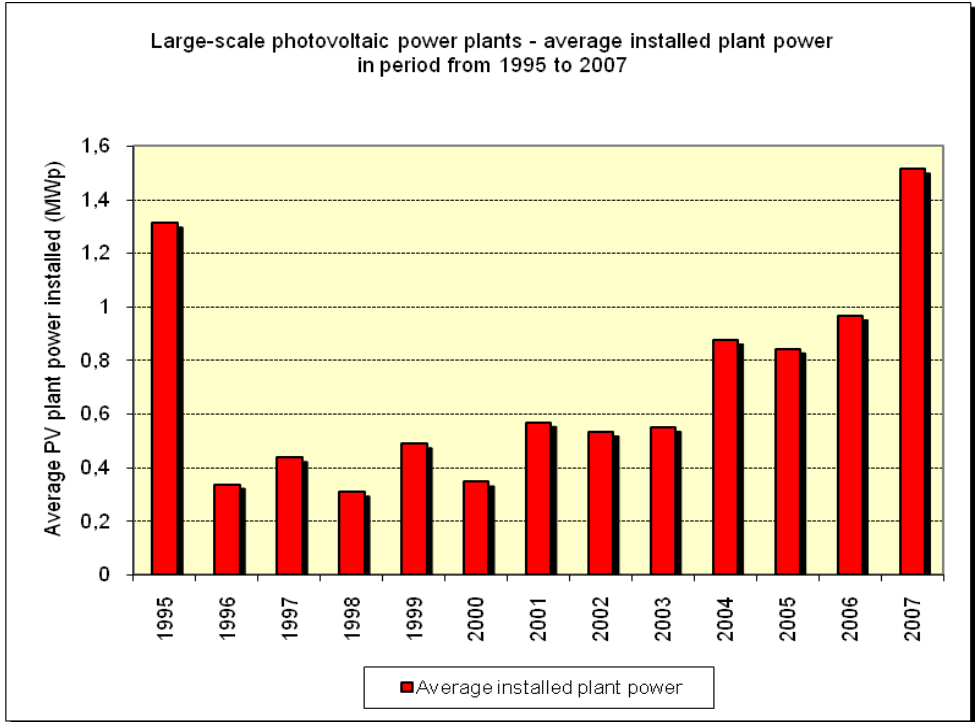
**TABLE 2:** Large-scale photovoltaic power plants - annual and cumulative installed power output capacity worldwide in period from 1995 – 2007



**FIGURE 1:** Large-scale photovoltaic power plants – annual and cumulative installed power output capacity worldwide in period from 1995 to 2007



**FIGURE 2:** Large-scale photovoltaic power plants – number of annually installed power plants in period from 1995 to 2007



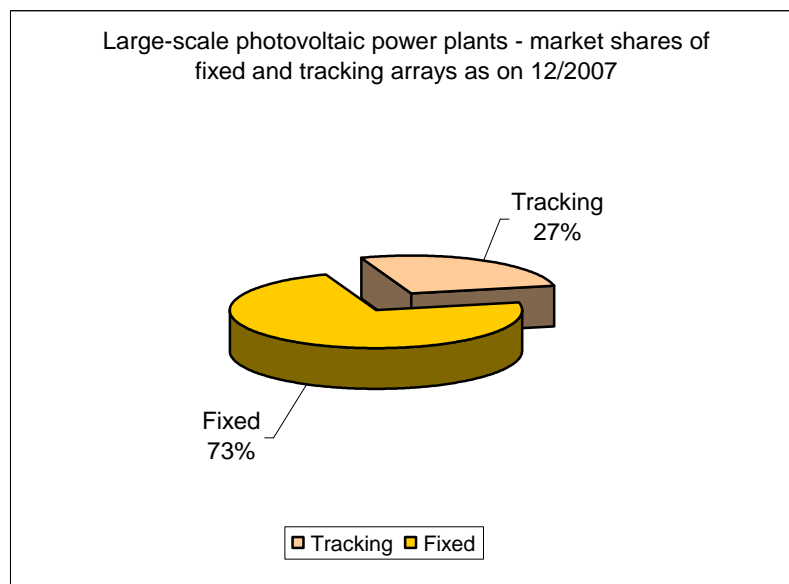
**FIGURE 3:** Large-scale photovoltaic power plants - average power output of large-scale photovoltaic power plants constructed in period from 1995 to 2007 (considering year of construction)

**Remark:** In 1995 only a few large-scale photovoltaic power plants were completed, one of them was the Serre power plant with 3.3 MW peak power. Thus the average photovoltaic power capacity installed in 1995 (as presented in Figure 3) is very high (1.3 MWp) in comparison with following years therefore this does not represent the real picture of the development of PV market at that time – see also Figures 1 and 2.

## Types of large-scale photovoltaic power plants

At the end of 2007 almost 70 % of all large-scale photovoltaic power plants (power related) were ground mounted. 29 % roof mounted, other plants (about 1 %) include photovoltaic power plants integrated into building envelopes, noise barriers and similar applications. Whilst 27 % of all power plants (power related) have tracking arrays (single or double axis tracking), 73 % have fixed arrays.

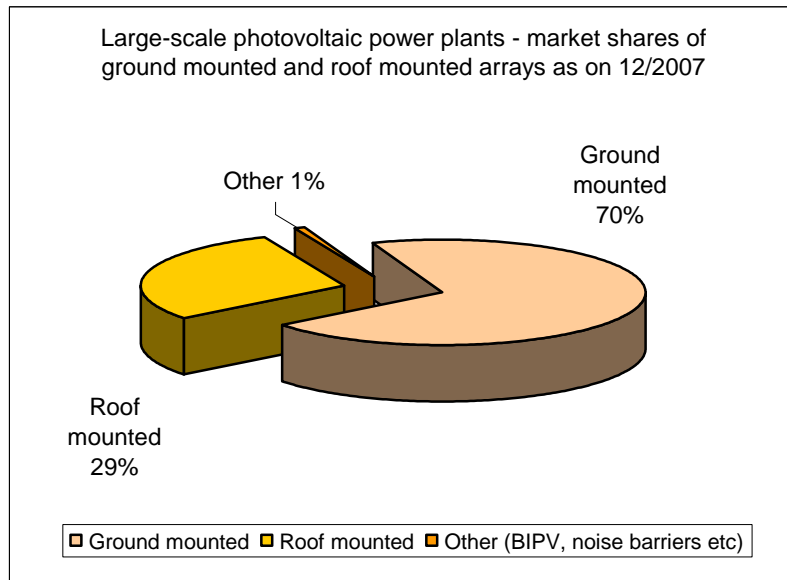
**Distributed PV power plants:** In the report even distributed photovoltaic power plants are considered as one large plant if they were built within one project on buildings very close to each other – like city district for example.



**FIGURE 4:** Large-scale photovoltaic power plants – market shares of fixed and tracking arrays as on 12/2007

Following abbreviations are used to differentiate between different types of photovoltaic power plants:

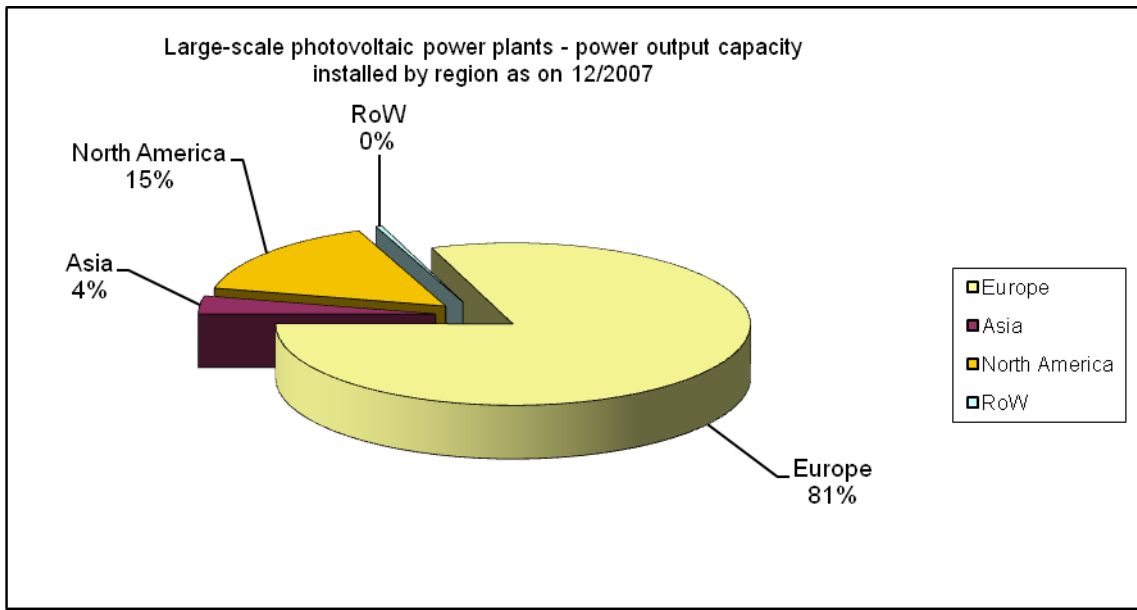
GM – ground mounted  
 RM, RI – roof mounted, roof integrated  
 FM, FI – facade mounted, facade integrated  
 TRAC – tracking  
 TRAN – transparent modules  
 BIPV – building integrated photovoltaic  
 DIST – distributed



**FIGURE 5:** Large-scale photovoltaic power plants – market shares of ground- and roof-mounted arrays as on 12/2007

**Large-scale photovoltaic power plants installed by region**

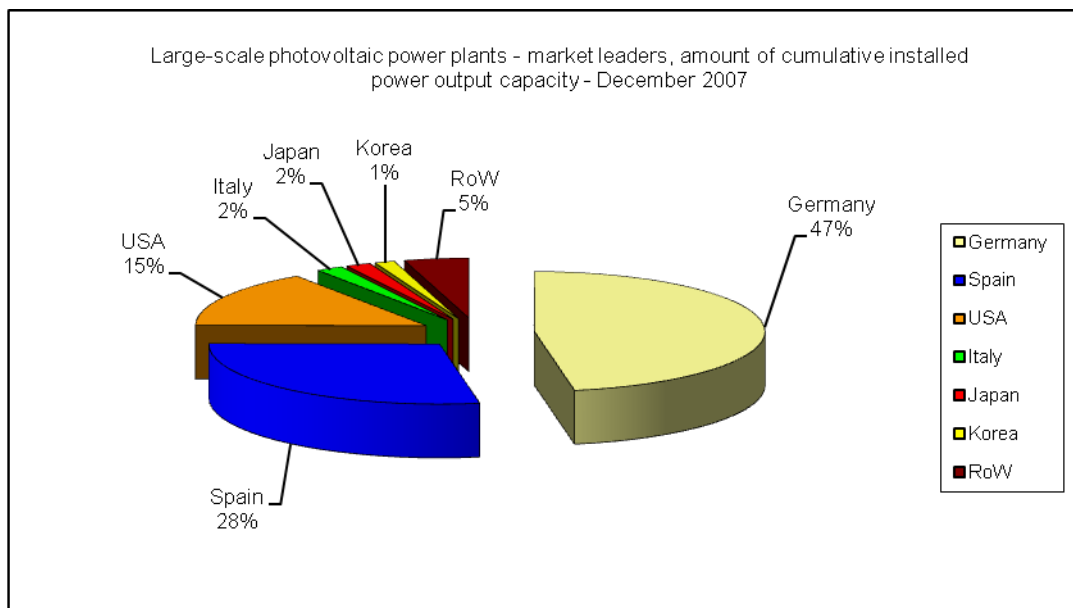
81 % of all large-scale photovoltaic plants (power related) are installed in Europe (770 MWp). In USA there is about 14 % (148 MWp) and in Asia a little less than 4 % (34 MWp). Germany has almost one half of all photovoltaic power installations, but its market share is decreasing slowly in recent months. The most dynamic market is Spain – where a huge increase in power capacity installed in year 2007 was observed. Only in USA and in Germany was the growth of the photovoltaic market steadily increasing over the last decade. Fast growth in Spain has taken place over the last three years with extreme growth in past year (2007). In the last few months further progress in Europe (Italy and particularly in France and in Greece as promising future markets) and in Korea is also visible. Rest of the world (Africa, South America, Australia...) represents less than 1 % of total capacity worldwide; these regions show significant potential for solar energy use in future.



**FIGURE 6:** Large-scale photovoltaic power plants – power capacity by region as on 12/2007

### Countries hosting large-scale photovoltaic power plants

Countries with total power output more than 1 MWp of large-scale photovoltaic power plants (only photovoltaic power plants >200 kWp considered) are listed in Table 3. Countries with less than 1 MWp capacity are Thailand, France (excluding overseas territories), United Kingdom, Malaysia, Saudi Arabia, Luxembourg, Rwanda, India and Mexico.



**FIGURE 7:** Large-scale photovoltaic power plants - market leaders, amount of 51tal power output as on 12/2007

Country	Power (MWp)	Market share (%)
Germany *	451,4	47
Spain *	266,7	28
USA *	147,2	15
Italy *	17,8	2
Japan	16,5	< 2
Korea *	13,3	< 2
Portugal	11,8	1,2
Netherlands	9,0	< 1
Switzerland	5,1	< 1
Belgium	3,3	< 0,5
Australia	2,2	< 0,5
Austria	2,2	0,2
Czech Republic	1,7	0,2
China	1,7	0,2
Philippines	1,1	< 0,1
Reunion	1,0	< 0,1

\* Countries where large projects are under construction and where increases or at least, similar market share is expected even in 2008. As a promising market France should also be considered.

**TABLE 3:** Large-scale photovoltaic power plants - countries with more than 1 MWp of total photovoltaic power output as on 12/2007

## Large-scale photovoltaic power plants installed in Europe

Almost 60% of all European large-scale photovoltaic plants (power related) are located in Germany (451 MWp), followed by Spain (266 MWp, 35%) and Italy (18 MWp, 2.3%). Countries like the Netherlands and Portugal contribute more than one percent of power output on the European territory. Other European countries represent less than one percent of large-scale photovoltaic output in Europe. These countries are Switzerland, Belgium, Czech Republic, France (excluding overseas territories), Austria, Luxembourg and United Kingdom etc. As promising markets Spain, Germany, France and Italy should be considered - at least in 2008, and most probably in 2009 and even beyond. For some other countries (like Greece for example) it is also believed that they could significantly increase their market share soon but in most cases due to bureaucratic obstacles the situation is not clear and therefore unpredictable.

Country	Power (MWp)	European market share (%)
Germany	451,4	58,6
Spain	266,7	34,6
Italy	17,8	2,3
Portugal	11,8	1,52
The Netherlands	9,0	1,16
Switzerland	5,1	0,66
Belgium	3,3	0,42
Austria	2,1	0,27
Czech Republic	2,1	0,27
France *	0,68	<0,1
United Kingdom	0,59	<0.1
Luxembourg	0,3	<0,1

\* Excluding overseas territories

**TABLE 4:** Large-scale photovoltaic power plants – European countries with large-scale photovoltaic power plants installed as on 12/2007

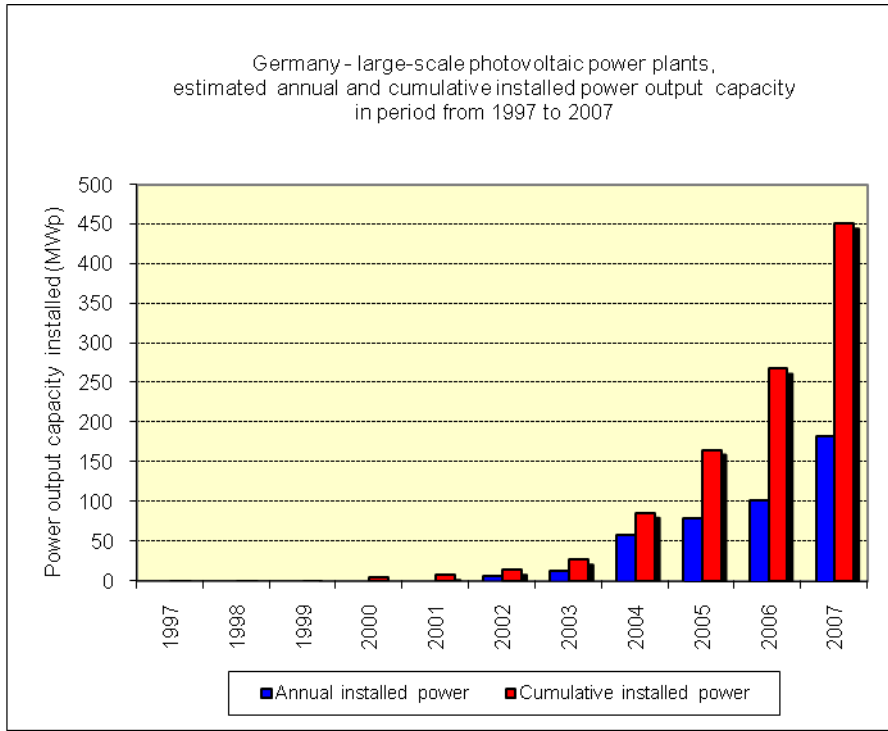
### Most important markets

Most important world markets are still Germany with about 45 % of power installed, Spain with 28 % and USA with 16%. According to reports in the last few months promising new markets in Europe seems to be Italy and France, perhaps even Greece. Some large-scale photovoltaic power plants are also under construction in Korea.

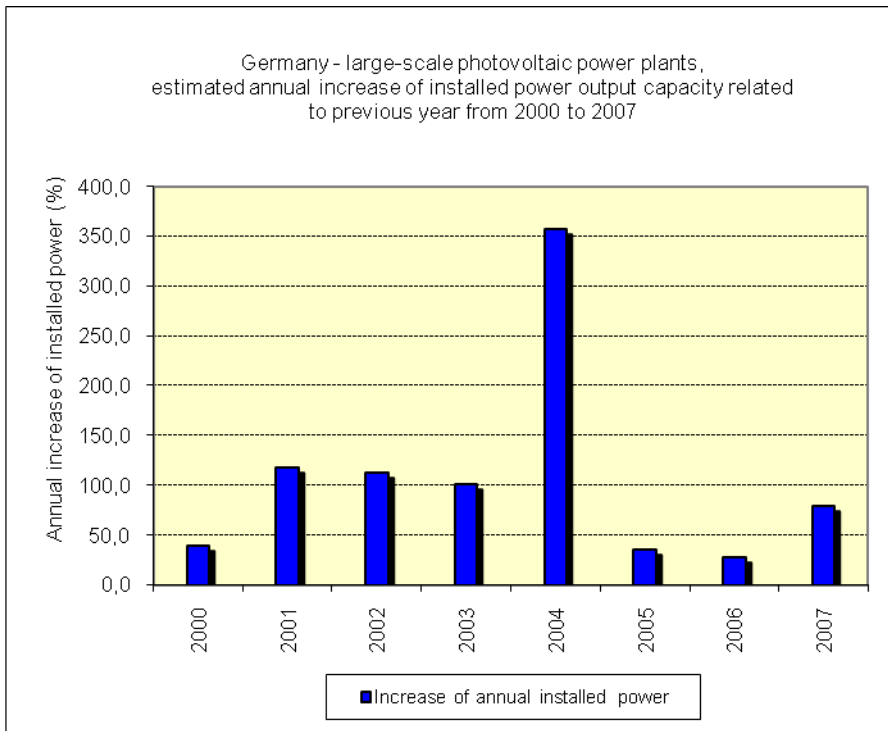
Germany - annual installed power output capacity (MWp) 1997 – 2007

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1,3	0,4	1,0	1,4	3,0	6,4	12,9	59,1	79,7	102,0	183,2
2,3	2,7	3,7	5,1	8,1	14,5	27,4	86,5	166,2	268,2	451,4
Cumulative installed power output capacity (MWp) 1997 – 2007										

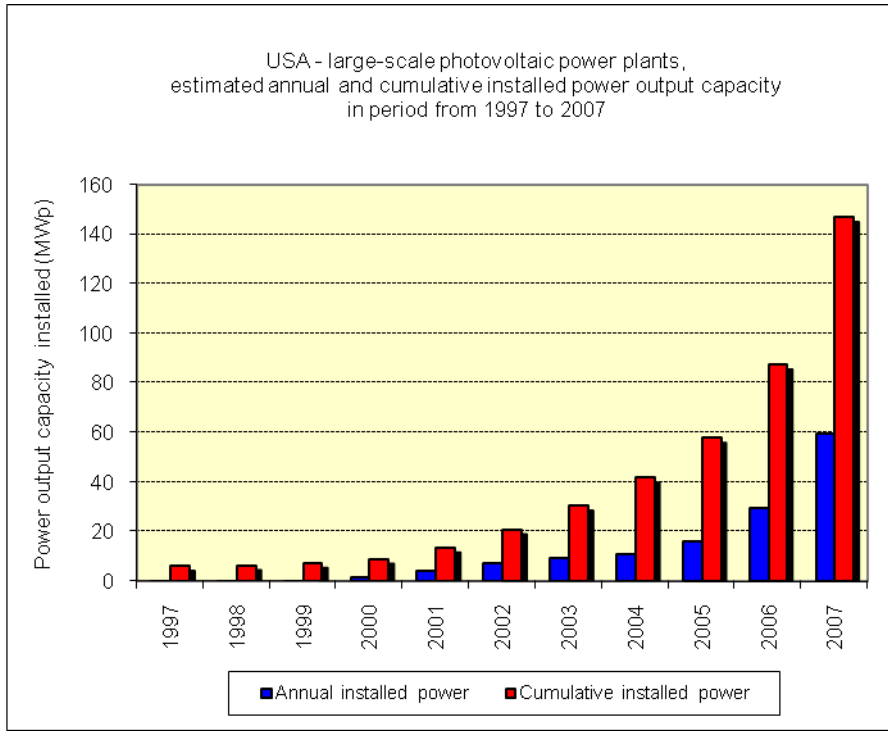
**TABLE 5:** Large-scale photovoltaic power plants – Germany, annual and cumulative installed power capacity in period from 1997 – 2007



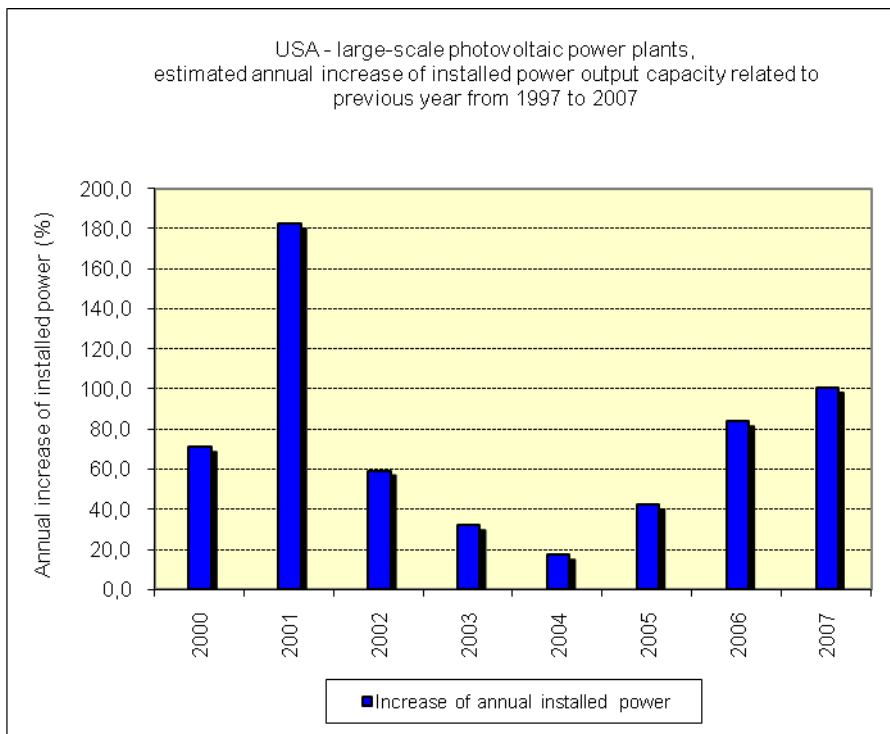
**FIGURE 8:** Large-scale photovoltaic power plants – Germany, annual and cumulative installed power capacity in period from 1997 to 2007



**FIGURE 9:** Large-scale photovoltaic power plants – Germany, annual growth in power output in period from 2000 to 2007



**FIGURE 10:** Large-scale photovoltaic power plants – USA, annual and cumulative installed power capacity in period from 1997 to 2007



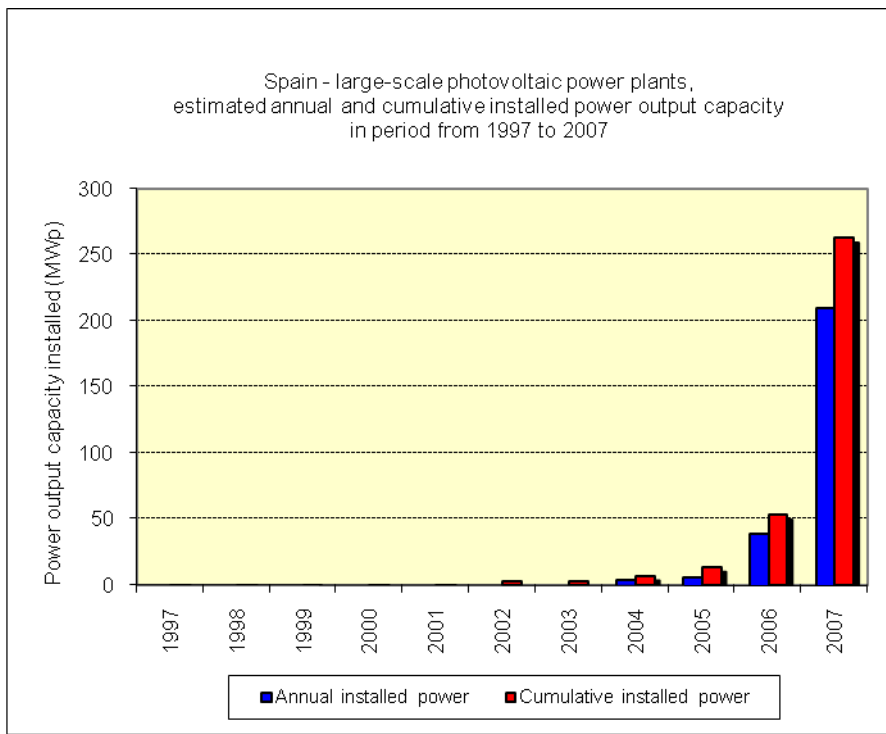
**FIGURE 11:** Large-scale photovoltaic power plants – USA, annual growth in power output in period from 2000 to 2007

USA – annual installed power output capacity (MWp) 1997 – 2007

1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
0,5	0,3	0,9	1,6	4,6	7,3	9,6	11,3	16,1	29,6	59,5
6,3	6,6	7,6	9,2	13,8	21,1	30,7	42,0	58,1	87,7	147,2

Cumulative installed power output capacity (MWp) 1997 – 2007

**TABLE 6:** Large-scale photovoltaic power plants – USA, annual and cumulative installed power capacity in period from 1997 – 2007



**FIGURE 12:** Large-scale photovoltaic power plants – Spain, annual and cumulative installed power capacity in period from 1997 to 2007

**Remark:** Spain as the most prospective market at the moment offers only a limited and unreliable overview of power capacity and number of large-scale photovoltaic power plants. The data presented on pvresources.com is reliable and was carefully checked, but because of a fluid situation and extremely fast market growth it is believed that more facilities (even in the MW range) were put into service in recent months. When reliable data becomes available new plants will be added to pvresources.com's list.

## System integrators

Dynamical markets and complex relationships between different companies (system integrators and subcontractors) make an overview of power output capacity installed by particular companies hardly possible. Many of the system integrators are also closely linked to subcontractors; another reason the situation is not clear. EPURON for example closely co-operates with SunTechnics, several large TAUBER SOLAR's projects were installed by Ralos etc. General overview of power supply installations shows that SunPower Corp. (including PowerLight's projects) and EPURON GmbH are market leaders. Both companies have completed installations of more than 60 MWp of large-scale photovoltaic power plants, in the range >200 kWp each (only completed projects considered). These companies are followed by juwi GmbH and City Solar AG. City Solar AG has installed almost 50 MWp, juwi GmbH is responsible for possibly even a little bit more. The Spanish company Acciona Energia takes next position followed by SunEdison LLC, Phoenix Solar AG, BP Solar, Beck Energy GmbH, Solarparc AG, TAUBER SOLAR etc. The ten largest system integrators control more than 40% market share. It is expected conservatively that at least one company will reach the 100 MW limit this year and another three will surpass 70 MW of installations by the end of this year.

## Conclusion

In the past three years annual growth considering large-scale photovoltaic plants was on average almost 100% annually. It is expected that strong market growth will continue even in 2008, growth is also expected for 2009. Market growth in Spain was extreme in 2007 and it will most probably be lower this year. Average installed plant power has increased from 400 kW in 1997 to 1.64 MWp in 2007. Last year a significant increase of photovoltaic power plants constructed with thin film modules was observed. Due to insufficient data available, it is not possible to reliably estimate market share of different technologies (c-Si, mc-Si, a-Si, CdTe etc...) related to large-scale photovoltaic power plants. Due to partially confidential investment related data it is also not possible to reliably estimate average investment per kWp (EUR/kWp or USD/kWp). If enough data will become available, average investment and technology related market share will be calculated and published later this year.

Current situation shows that it is hardly possible to maintain an overview about photovoltaic power capacity and number of large-scale photovoltaic power plants installed. Ideas about some kind of photovoltaic (renewable energy) registry are not new and this report, among others, proves that some kind of such registry or database is urgently needed

## About the author

The author holds a degree of electrical engineering from University of Ljubljana, Slovenia. He is ISES and Eurosolar member and supporting member of WWF and Greenpeace. Currently he is also a chairman of Slovene national section of IEC »TC82« Technical Committee.

## About pvresources.com web site



Pvresources.com is an independent privately owned web site related to photovoltaic applications and technologies. It was developed as a non-commercial helpful informative web site to serve teachers, students and others interested in photovoltaics. The web site is not supported or sponsored by any third party, neither by any PV related company nor by any governmental institution or agency. The server where pvresources.com's domain is hosting is powered by green energy.