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**Annual Review 2007**

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# Large-Scale Photovoltaic Power Plants

Annual and Cumulative Installed Power Output Capacity

# Introduction

In this report, basic statistical data about commissioned large-scale photovoltaic power plants is presented. The report includes data about power plants sorted by region, country, etc. Annual and cumulative installed power output capacities for the most important markets are also presented. The text and numbers in this report are identical to the original pdf edition published in April 2008.

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 – such a fast moving market makes it very difficult to maintain such a report and keep it completely up to date. In this report, the majority of photovoltaic power plants that were commissioned by 31 December 2007 – provided press releases or other official statements were made before the date of publishing this report (Revised Edition, published on 14 April 2008) – are considered. This report was prepared as carefully as possible, however mistakes and errors are possible. Because there are no reliable databases or other national or international sources of information available concerning large-scale photovoltaic power plants, the statistical data presented here should be considered as "conservative" values. This report and the pvresources.com data include only commissioned photovoltaic power plants or plants that should be commissioned soon. 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 warranties 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.

*Images courtesy City Solar, Epuron, Juwi*

# Large-scale photovoltaic power plants

In Table 1, basic data in regard to 25 of the largest photovoltaic power plants, put into service before 31 December 2007, is presented. Additionally, there are several large-scale PV power plants in the power range >10 MW under construction, but there were no official press releases or announcements about their commissioning available before 31 March 2007. These power plants will be included in the 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 |

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

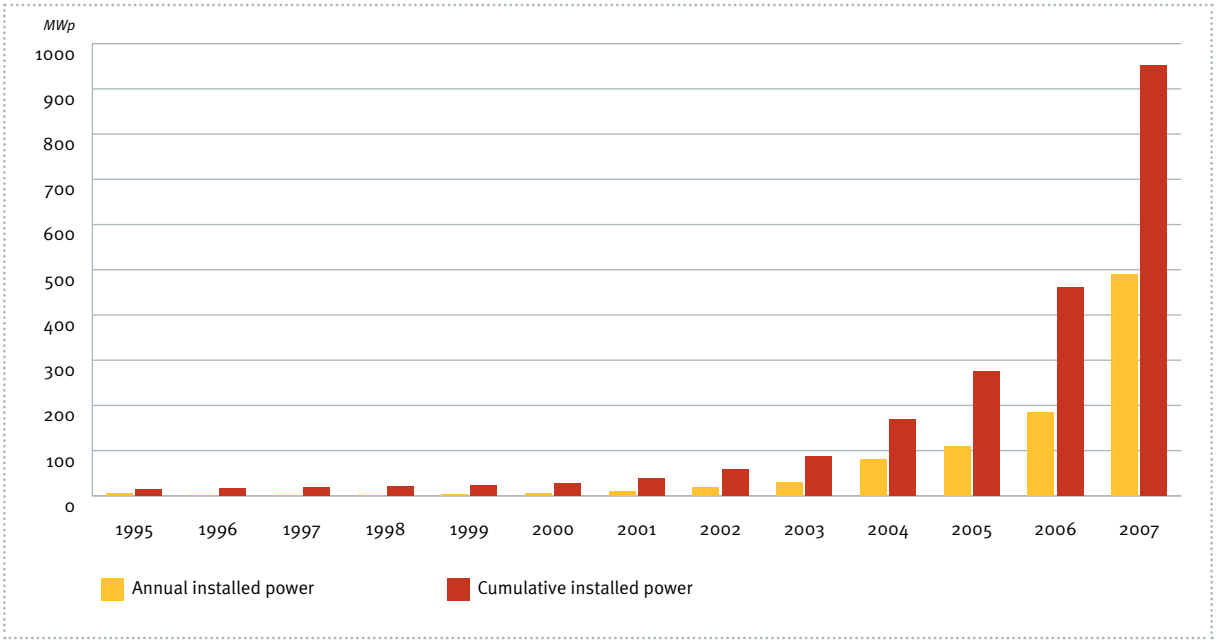


FIGURE 1 *Large-scale photovoltaic power plants – annual and cumulative installed power output capacity worldwide in period from 1995 to 2007*

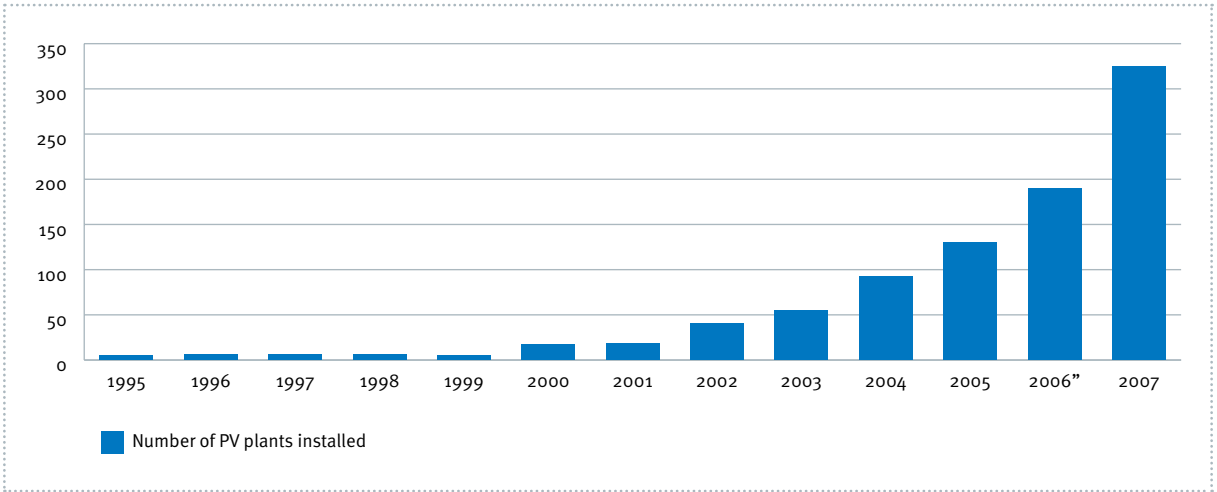


FIGURE 2 *Large-scale photovoltaic power plants – number of annually installed power plants in period from 1995 to 2007*

| 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*

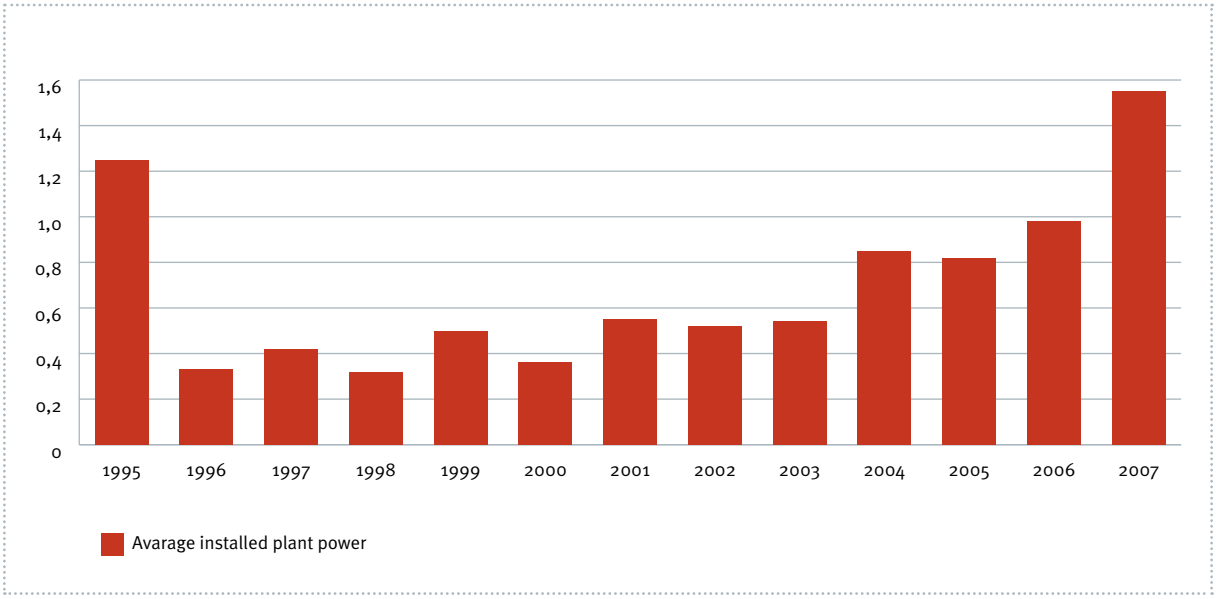


FIGURE 3 *Large-scale photovoltaic power plants - average power output of large-scale photovoltaic power plants constructed in period from 1995 to 2007 (considering year of construction)*

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) was very high (1.3 MWp) in comparison with subsequent years, therefore this does not represent the real picture of the development of the PV market at that time – see also Figures 1 and 2.

## Types of large-scale photovoltaic power plants

At the end of 2007, nearly 70% of all large-scale photovoltaic power plants (power related) are ground mounted, 29% are roof mounted and other plants (about 1%) include photovoltaic power plants integrated into building envelopes, noise barriers and similar applications. While 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 a city district for example.

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

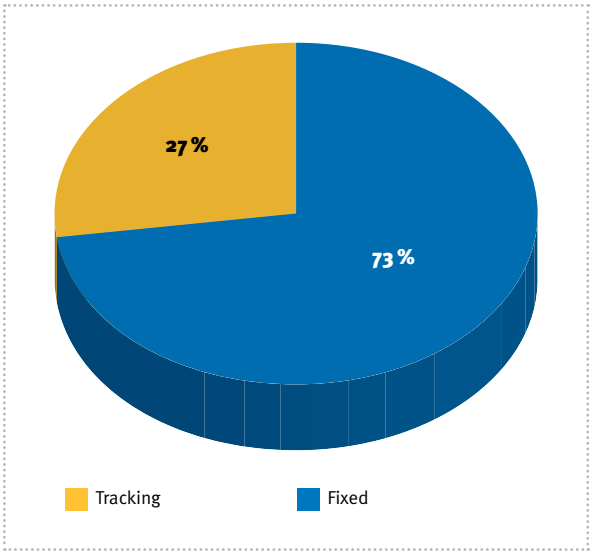


FIGURE 4 *Large-scale photovoltaic power plants – market shares of fixed and tracking arrays as on 12/2007*

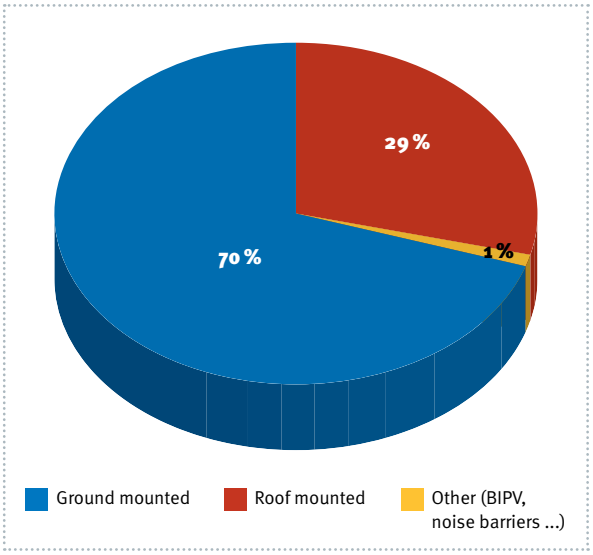


FIGURE 5 *Large-scale photovoltaic power plants – market shares of ground- and roof-mounted arrays as on 12/2007*

## Large-scale photovoltaic power plants installed by region

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

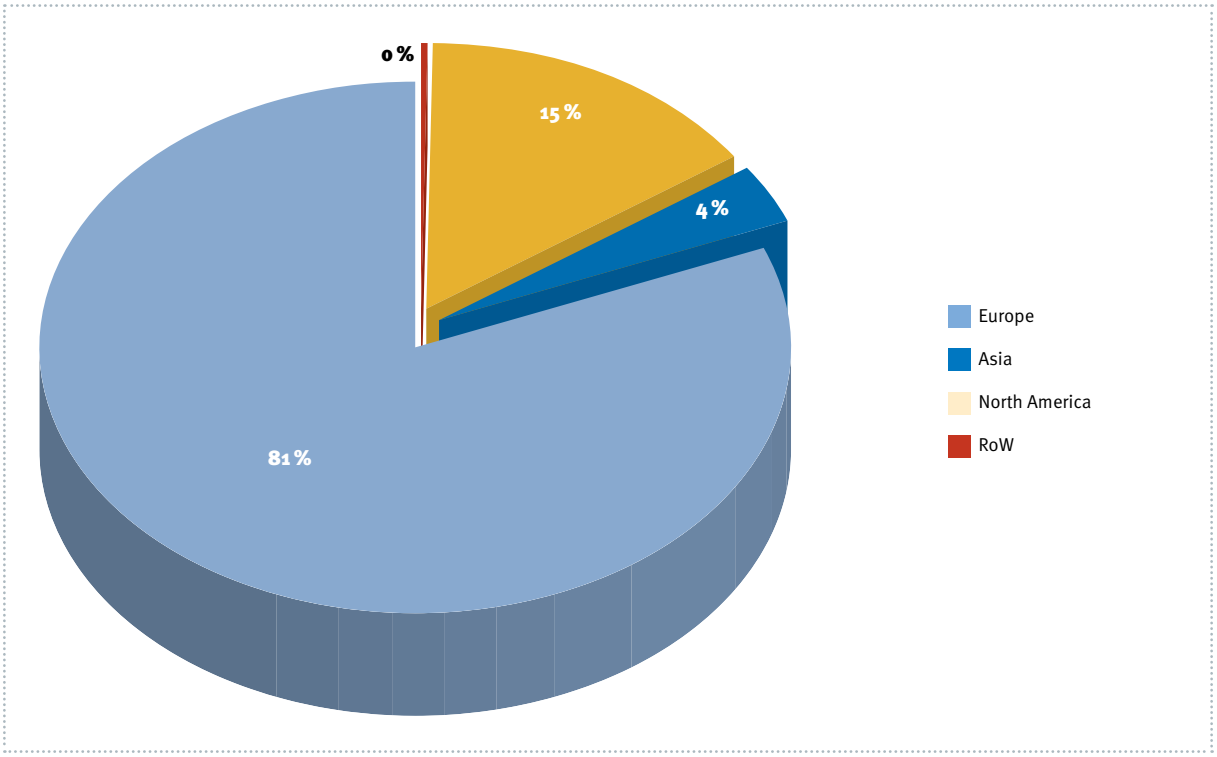


FIGURE 6 *Large-scale photovoltaic power plants – power capacity by region as on 12/2007*

## Countries hosting large-scale photovoltaic power plants

Countries with a total power output of 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), the United Kingdom, Malaysia, Saudi Arabia, Luxembourg, Rwanda, India and Mexico.

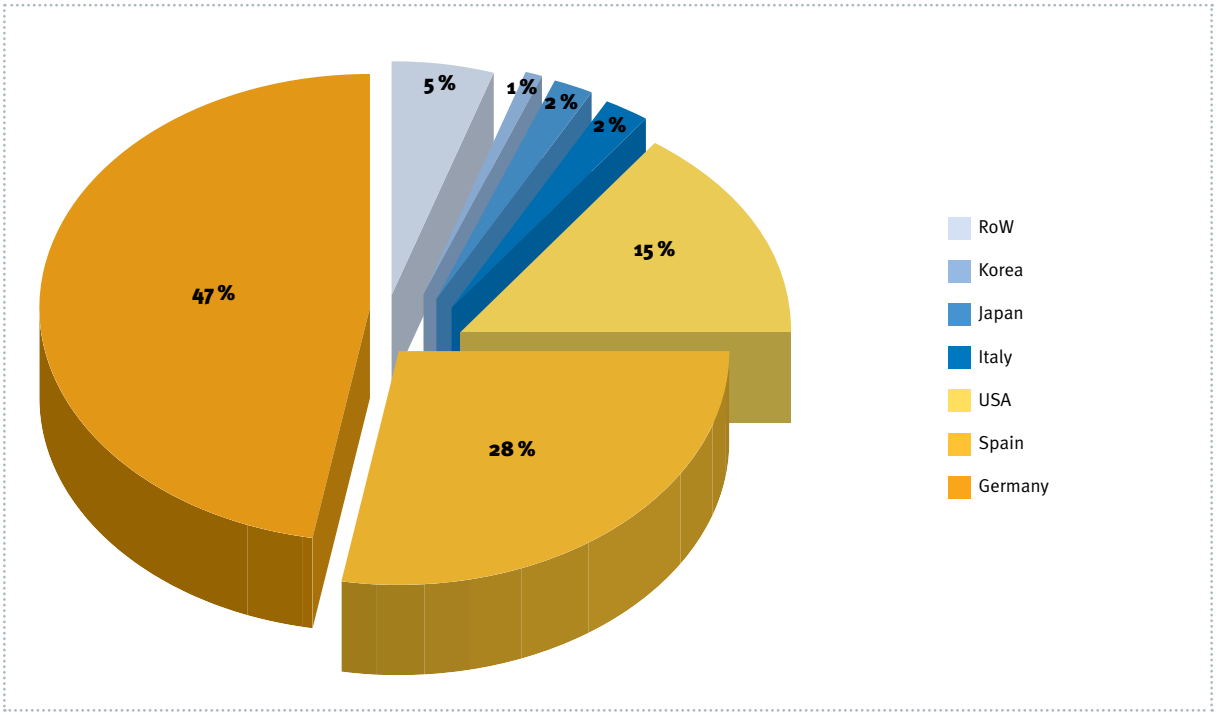


FIGURE 7 *Large-scale photovoltaic power plants – market leaders, amount of power output as on 12/2007*

| 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 a 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 at 12/2007*

## Large-scale photovoltaic power plants installed in Europe

Nearly 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 1% of the power output on the European territory. Other European countries represent less than 1% of large-scale photovoltaic output in Europe. These countries are Switzerland, Belgium, Czech Republic, France (excluding overseas territories), Austria, Luxembourg, the 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) | 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 at 12/2007*

## Most important markets

The most important world markets are still Germany, with about 45% of the installed power, Spain with 28% and the USA with 16%. According to reports in the last few months, the promising new markets in Europe seem to be Italy and France, with 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*

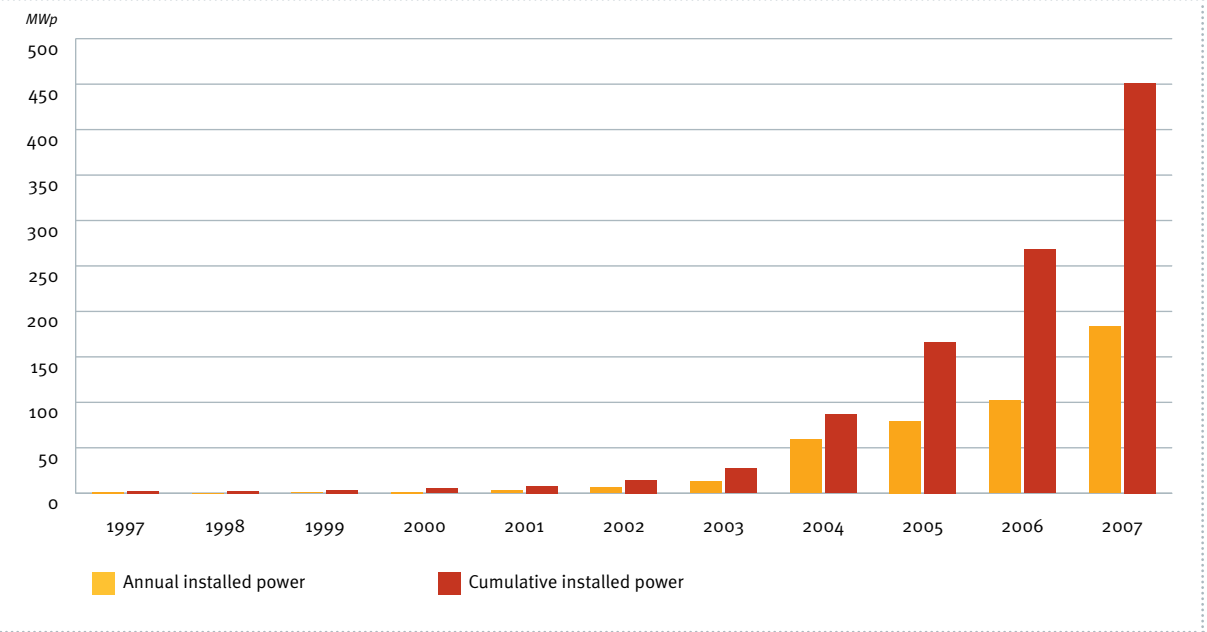


FIGURE 8 *Large-scale photovoltaic power plants – Germany, annual and cumulative installed power capacity in period from 1997 to 2007*

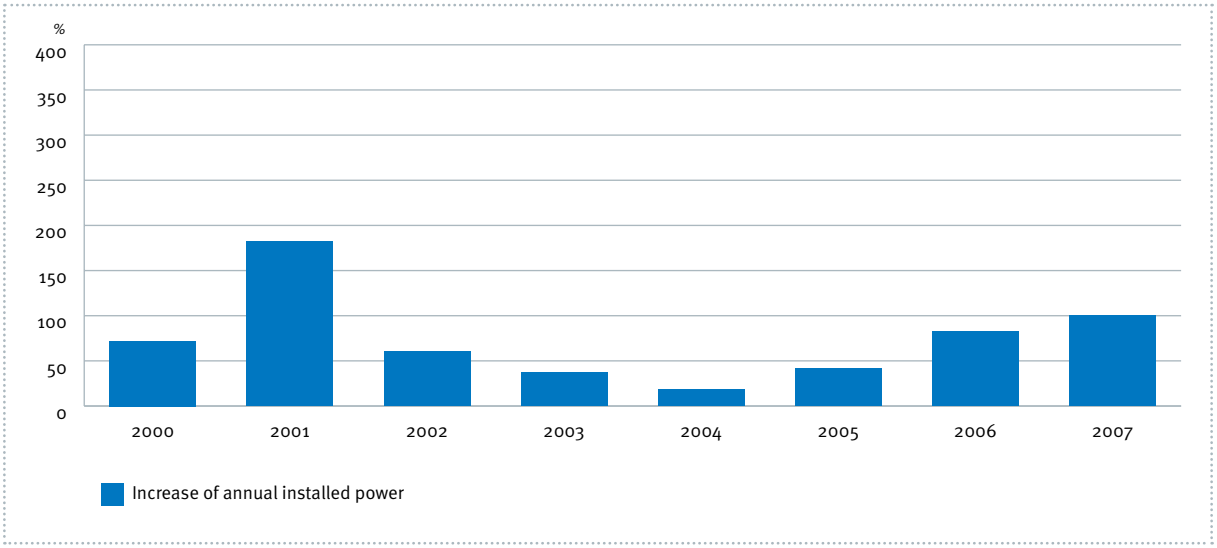


FIGURE 9 *Large-scale photovoltaic power plants – Germany, annual growth in power output in period from 2000 to 2007*

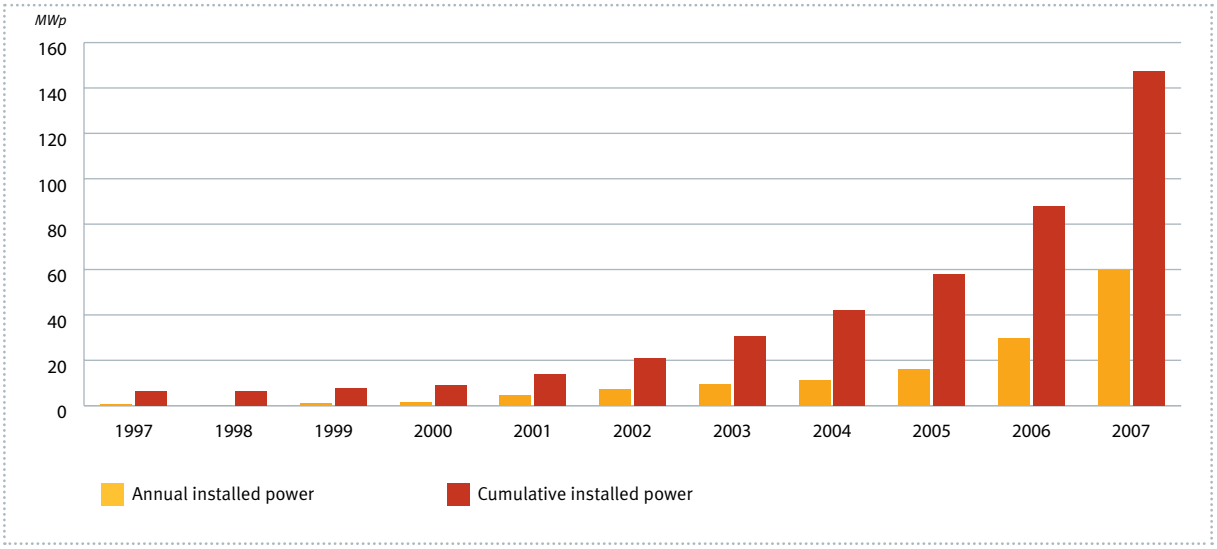


FIGURE 10 *Large-scale photovoltaic power plants – USA, annual and cumulative installed power capacity in period from 1997 to 2007*

| *Germany - 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*

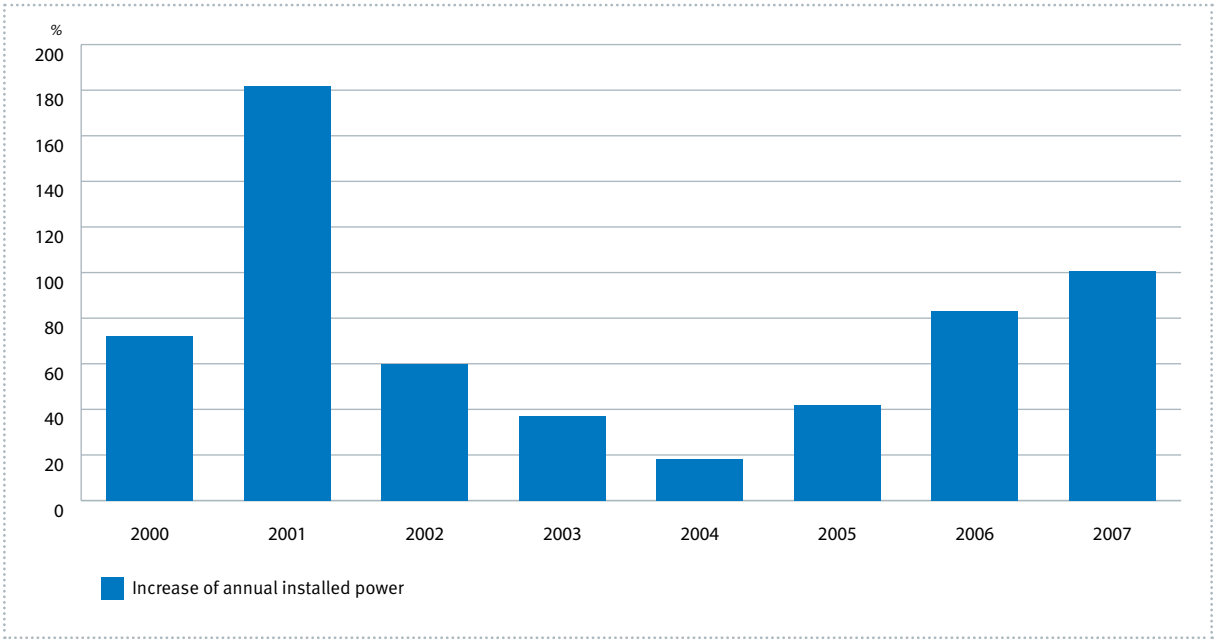


FIGURE 11 *Large-scale photovoltaic power plants – USA, annual growth in power output in period from 2000 to 2007*

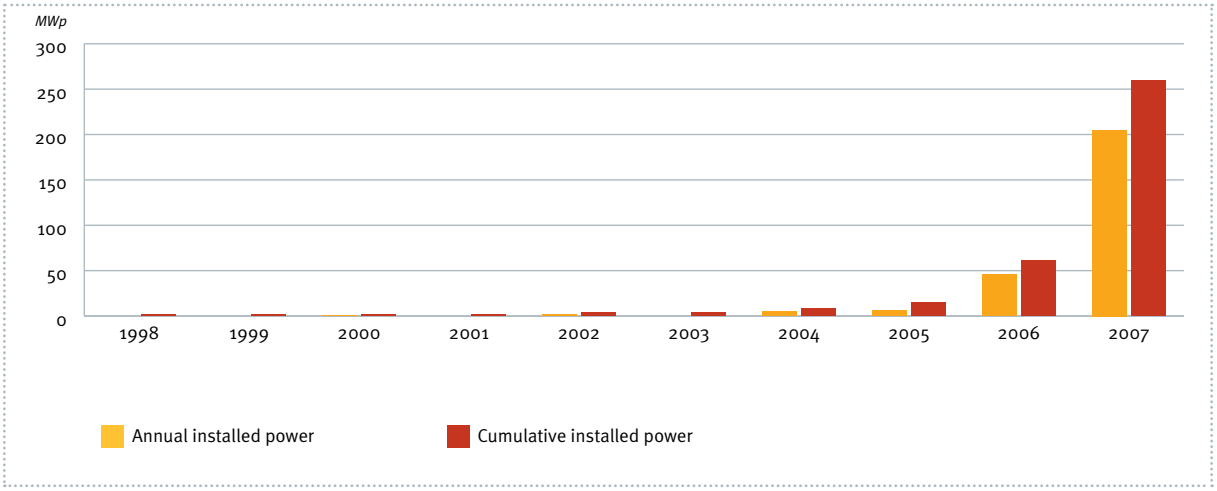


FIGURE 12 *Large-scale photovoltaic power plants – Spain, annual and cumulative installed power capacity in period from 1997 to 2007*

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 the 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

Dynamic markets and complex relationships between different companies (system integrators and subcontractors) make an overview of the power output capacity installed by particular companies hardly possible. Many of the system integrators are also closely linked to subcontractors, which is another reason why the situation is unclear. EPURON, for example, closely cooperates with SunTechnics, several large TAUBER SOLAR projects were installed by Ralos, etc. A 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, with each in the range of >200 kWp (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 the 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% of the 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, growth in regard to large-scale photovoltaic plants was on average at nearly 100% per year. 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 likely be lower this year. Average installed plant power increased from 400 kW in 1997 to 1.64 MWp in 2007. Last year, a significant increase in photovoltaic power plants constructed with thin film modules was observed. Due to insufficient data available, it is not possible to reliably estimate the 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 the 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.

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

## Cover photos

The 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).

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The author has been systematically collecting data about large-scale photovoltaic power plants since 2001.

## Special Thanks

Without the contributions of third parties – personal contacts, press releases, press material available on different web sites, etc. – it would never have been possible to create such report. All individuals and companies who – in the period from 2001 to 2008 – contributed to the pvresources.com list of large-scale photovoltaic power plants are listed under the “special thanks” section.

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 Geselschaft für Sonnenenergie mbH
juwi GmbH
Phoenix Solar AG
Solarserver
SunEdison LLC
SunStrom GmbH
TAUBER SOLAR Management GmbH