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Annual Review 2010

Free Edition

Denis Lenardič

Large-Scale Photovoltaic Power Plants

Annual and Cumulative Installed Power Output Capacity
2000 - 2010

Dear Reader,

This report presents basic statistical data about large-scale photovoltaic power plants put into service by the end of 2010 and a detailed overview for the past decade (2000–2010). The database representing the foundation for this report was built during long-term research related to large scale photovoltaic power plants by the author of this report. The report is based on data of more than 6,000 large-scale PV plants with cumulative peak

power greater than 10 GWp. Please note that only photovoltaic power plants producing more than 200 kWp put into service by December 2010 are considered – provided that press releases or other official statements were made before the date of publishing this report. Because there is still a lack of reliable databases, or other available national or international sources of information concerning large-scale photovoltaic power plants, statistical data presented here should be considered to be “conserva-

tive” values¹. For grid connection time, the start of (test) operation is considered. If this data is not available, then official data about grid connection is considered to be the official start of operation. Please note that delays between the start of test operation and official grid connection can extend to several months in some cases.

*Denis Lenardič
Jesenice, December 2011*

¹ Data published in this report is partially based also on detailed data available for Czech Republic and Italy:

- Výběr provozoven solárních elektráren k 31. 12. 2010, http://eru.cz/user_data/files/statistika_elektro/rocní_zprava/2010/rz/subjekty/9.htm
- GSE – ATLASOLAE, <http://atlasole.gsel.it/atlasole/>

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Credits (in alphabetic order)

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References

- Výběr provozoven solárních elektráren k 31. 12. 2010, http://eru.cz/user_data/files/statistika_elektro/rocní_zpráva/2010/rz/subjekty/9.htm
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Introduction

Power Capacity



Parque solar Sarinena, courtesy: Suravia, fotografía aerea, Madrid

Power capacity installed

Pvresources.com's database includes more than 6,000 large-scale photovoltaic power plants (put into service in 2010 or earlier), each with peak power of 200 kWp or more (Figure 1). The cumulative power of all these photovoltaic power plants is more than 10 GWp. More than 2,000 large scale PV power plants are located in Italy, more than 1,200 in Germany, about 1,000 in Spain and more than 600 in the northern America (USA and Canada). Several large-scale PV power plants have been partially constructed, and in such case the power plant consists of several smaller power plants. If all parts

of a PV plant represent one single PV plant with the same technology, then a particular PV plant is considered as one single power plant. If the year of construction was different for different parts of a particular PV power plant or if in different parts different technology is used, then such PV power plant is considered as many different PV plants, located on the same site. However, multiple distributed residential projects are considered as a single plant only if all parts are located within same municipality or city district and were constructed at the same time as a result of a particular PV programme.

In 2010, more than 2,400 large-scale PV plants were constructed and put into service worldwide, more than ever before. In Italy more than 1,400 PV power plants were put into service, followed by Germany with about 400 PV power plants. Among other countries it is worth mentioning Czech Republic and France – in both countries together about 300 large-scale PV power plants were put into service.

Regarding large-scale PV power plants, China took on a leading role in Asia where several multi MW-range PV power plants were put into

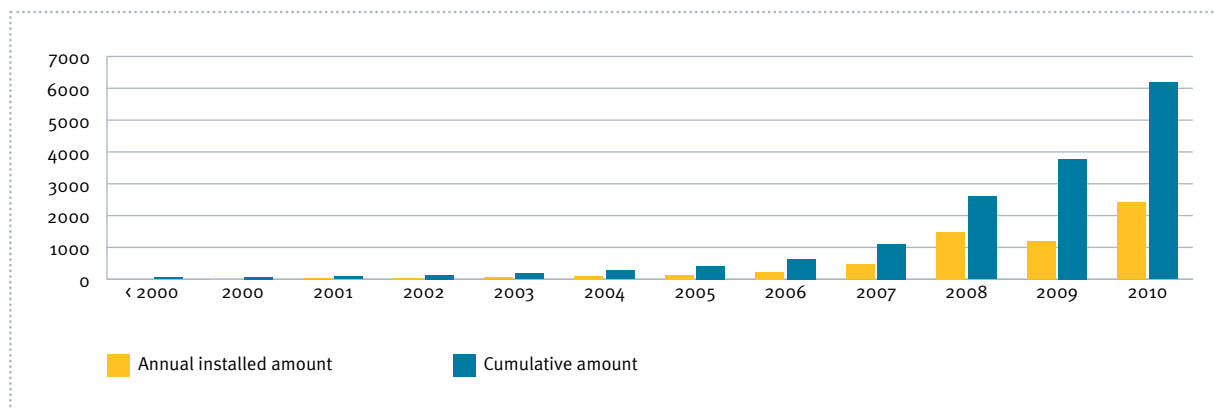


FIGURE 1 Annual installed and cumulative amount of large-scale, grid-connected photovoltaic power plants in the period from 2000 to 2010.



Parque solar Sarinena, courtesy: Suravia, fotografía aerea, Madrid

service in last year. China is followed by India, whereas both countries could develop into world leading PV markets in the near future. Europe is

still by far the most developed region with more than 2,000 large-scale PV plants put into service in 2010. In Europe about 5,000 utility-scale PV

power plants are currently in operation, followed by the USA and Canada with about 600 utility-scale PV power plants.

MWp*	COUNTRY	LOCATION	REGION/PROVINCE	DESCRIPTION
97	Canada	Sarnia **	Ontario	Sarnia PV power plant
84.2	Italy	Montalto di Castro	Lazio	Montalto di Castro PV Power Plant
80.2	Germany	Finsterwalde	Brandenburg	Finsterwalde I,II,III
70.6	Italy	San Bellino	Veneto	Rovigo PV power plant
60	Spain	Olmedilla de Alarcón	Castilla-La Mancha	Parque Fotovoltaico Olmedilla de Alarcon
54	Germany	Straßkirchen	Bavaria	Solarpark Straßkirchen
53	Germany	Turnow-Preilack ***	Brandenburg	Solarpark Lieberose
48	USA	Boulder City, NV	Nevada	Copper Mountain 1
47.6	Spain	Puertollano	Castilla-La Mancha	Parque Solar Puertollano
46	Portugal	Moura	Alentejo	Moura photovoltaic power plant
42.7	Italy	Cellino San Marco	Apulia	Cellino San Marco PV power plant
40	Germany	Brandis	Sachsen	Solarpark Waldpolenz
38.3	Czech Republic	Ralsko	Liberecký kraj	FVE Ralsko
38	France	Losse	Aquitaine	Parc Solaire Gabardan
36.2	Italy	Alfonsine	Emilia-Romagna	Parco Fotovoltaico Alfonsine
35.9	Germany	Reckahn	Brandenburg	Solarpark Reckahn I,II
35.1	Czech Republic	Nová Ves	Středočeský kraj	FVE Vepřek
34,6	Italy	Sant'Alberto	Emilia-Romagna	Sant'Alberto PV Power Plant
34,5	Spain	Trujillo	Extremadura	Parque Fotovoltaico La Magascona, La Magasquila
34,4	Germany	Dörlesberg ****	Baden-Württemberg	Solarpark Ernsthof

* DC array power capacity is not available for all PV power plants

** Official AC power capacity is 80 MW. Data presented in this table is unofficial DC power and is based on personal communication.

*** Solarpark Lieberose was expanded for an additional 18 MW stage in 2011

**** Solarpark Ernsthof includes Solarpark Ernsthof Ost and Ernsthof West I-IV

TABLE 1 Largest photovoltaic power plants as at December 2010

Power Capacity

MWp*	COUNTRY	LOCATION	REGION/PROVINCE	DESCRIPTION
97	Canada	Sarnia **	Ontario	Sarnia PV power plant
84.2	Italy	Montalto di Castro	Lazio	Montalto di Castro PV Power Plant
80.2	Germany	Finsterwalde	Brandenburg	Finsterwalde I,II,III
80	Ukraine	Ohotnikovo	Crimea	Ohotnikovo PV power plant
80	Ukraine	Perovo	Crimea	Perovo PV power plant
78	Germany	Senftenberg	Brandenburg	Solarpark Senftenberg II,III
71	Germany	Turnow-Preilack ***	Brandenburg	Solarpark Lieberose
70.6	Italy	San Bellino	Veneto	Rovigo PV power plant
70	Germany	Wittstock	Brandenburg	Solarpark Alt Daber
67.2	France	Losse	Aquitaine	Parc Solaire Gabardan
68	Canada	Sault Ste.Marie	Ontario	Starwood SSM I,II,III
60	Spain	Olmedilla de Alarcón	Castilla-La Mancha	Parque Fotovoltaico Olmedilla de Alarcon
54	Germany	Straßkirchen	Bavaria	Solarpark Straßkirchen
52	Germany	Tutow	Brandenburg	Solarpark Tutow I,II,III
48	Italy	Canaro	Veneto	Serenissima PV Power Plant
48	USA	Boulder City, NV	Nevada	Copper Mountain 1
47.6	Spain	Puertollano	Castilla-La Mancha	Parque Solar Puertollano
46	Germany	Zerbst	Saxony-Anhalt	Solarpark Zerbst
46	Portugal	Moura	Alentejo	Moura photovoltaic power plant
45	USA	Kettleman Hills, CA	California	Avenal Solar Facility

* DC array power capacity is not available for all PV power plants

** Official AC power capacity is 80 MW. Data presented in this table is unofficial DC power and is based on personal communication.

*** Solarpark Lieberose was expanded for an additional 18 MW stage in 2011

TABLE 2 Largest photovoltaic power plants as at December 2011

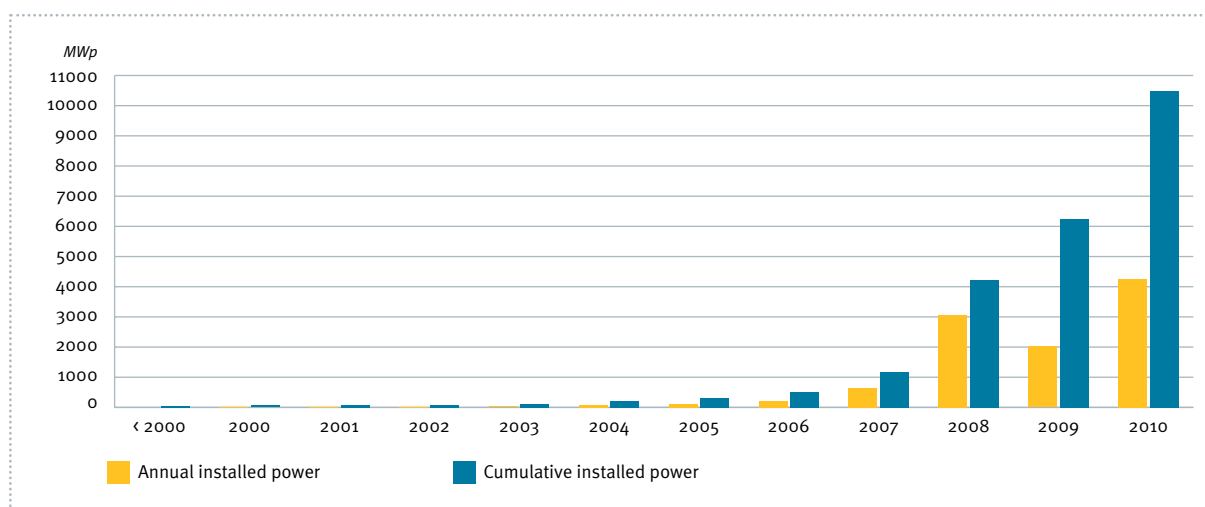


FIGURE 2 Annual installed and cumulative power output capacity of large-scale, grid-connected photovoltaic power plants in the period from 2000 to 2010.

With the intention of simpler comparisons of different power plants related to their size, power plants presented in this report are divided into seven power classes:

Class VII	20 MW – 100 MW
Class VI	10 MW – 20 MW
Class V	5 MW – 10 MW
Class IV	3 MW – 5 MW
Class III	1 MW – 3 MW
Class II	500 kW – 1 MW
Class I	200 kW – 500 kW

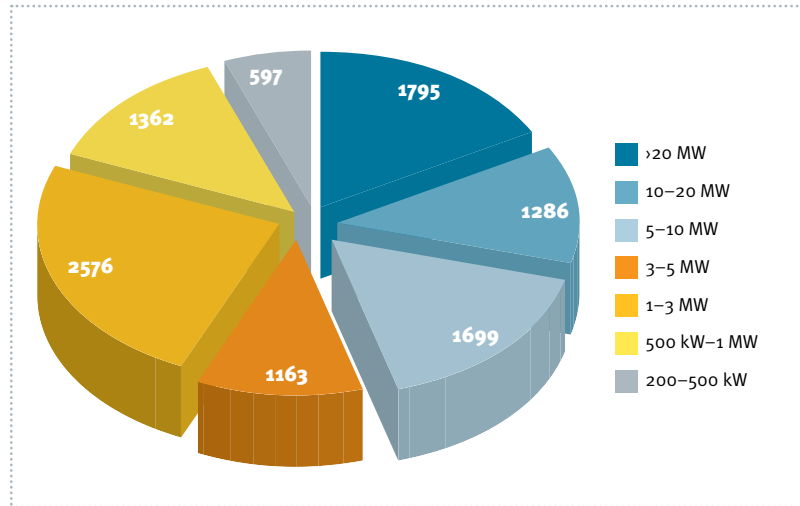


FIGURE 3 Estimated cumulative market share (MWp) of different power classes of large-scale, grid-connected photovoltaic power plants as at December 2010.

The definitions of power classes are based on facts and features characterising each power class. Power Class I includes power plants with less than 500 kW peak power. Most PV power plants owned by single investors or small sized companies belong to Class I. Class II includes

the majority of large-scale flat roof mounted power plants. Class III includes ground mounted power plants in the power range from 1 MW to 3 MW. Ground mounted power plants of such size are, for example, common in Italy, Germany and Spain. PV plants in power classes IV

through VII tend to be almost exclusively ground mounted, and the majority of power plants in these power classes is located in Spain, Italy and Germany. In the future Class VIII could be added for PV power plants with more than 100 MW power capacity.



Parque solar Malpartida, courtesy: Suravia, fotografía aerea, Madrid

Power Capacity

Large-scale PV power plants installed in Europe

As at December 2010, more than 3 GW of large-scale PV power plants were located in Spain, followed by Germany (>2.67 GWp) and Italy (>1.966 GWp). Cumulative power capacity in Czech Republic has reached almost 1 GW, but all other countries are far behind. Power installed in France, including its overseas departments, was about 240 MW as at December 2010. Other markets worth mentioning were Belgium and Greece. Other small markets that have shown some progress in recent years include, for example, Slovakia and Slovenia.

COUNTRY	MWp
Country	MWp
Spain	3,015
Germany	2,670
Italy	1,966
Czech Republic	902
France	192 (240 *)
Belgium	118
Portugal	85
Greece	41

* Including overseas departments

TABLE 3 Estimated cumulative power output capacity of utility-scale PV power plants in some European countries as at December 2010

	SPAIN	GERMANY	ITALY	CZECH REPUBLIC	USA
2000	< 2	37	7	< 1	11
2001	< 2	40	7	< 1	15
2002	< 5	47	7	< 1	22
2003	< 5	60	8	< 1	32
2004	< 10	119	8	< 1	43
2005	15	199	8	1	60
2006	65	314	9	1	90
2007	359	524	31	3	158
2008	2660	812	161	31	269
2009	2887	1536	520	286	387
2010	3015	2670	1966	904	663

TABLE 4 Estimated cumulative power output capacity (MWp) of utility-scale PV power plants for World largest PV markets



Large-Scale PV Investment Costs

A significant decrease of investment cost of large-scale photovoltaic power plants has been observed in recent years. Investment cost decreased from about 6 million EUR per MWp in 2008 to about 2 million EUR per MWp in year 2011. Investment cost for ground mounted PV power plants for recent years is presented in Figure 4.

The analysis of investment costs presented in Figure 4 is based on

detailed investment related data of about 500 PV power plants put into service from 2006 to 2010 and collected in recent years for the author's research. Based on the data of power plants put into service in Italy, investment costs are estimated to be within a similar range as in Germany or Spain with an average value between 2.5 and 3.5 million EUR per MWp in 2010. Much investment data are available for other countries, how-

ever Italy and the Czech Republic are especially worth mentioning. In Europe, the Czech Republic has offered some quite interesting financial conditions. An average investment value for crystalline PV power plants was at a similar level as the thin-film power plants in Germany in recent years. Basically no big differences between investment price (per kWp) for utility scale and smaller PV power plants were observed in recent years.

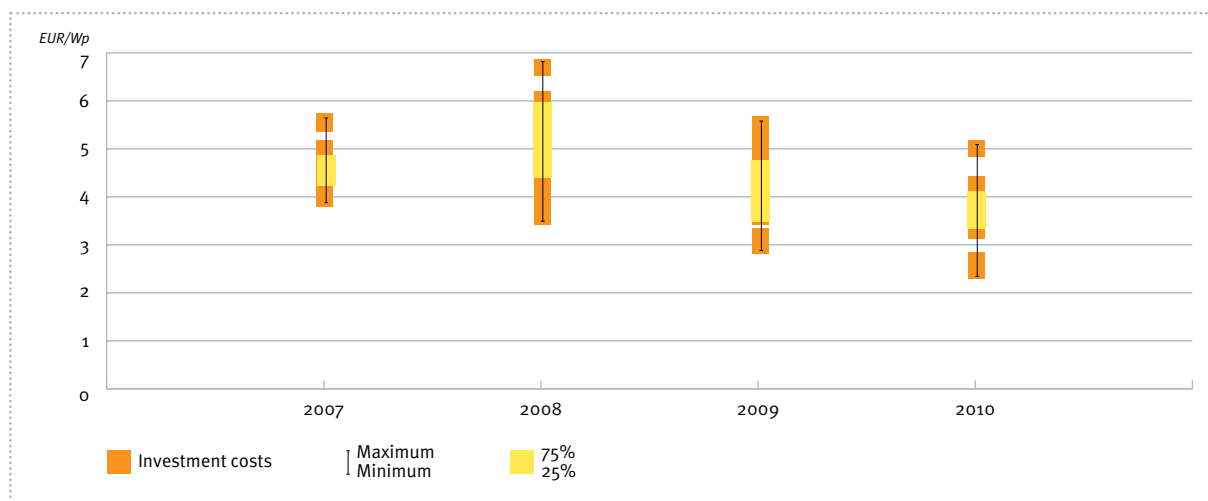


FIGURE 4 Investment costs (EUR/MWp) for ground-mounted PV power plants >200 kWp for time period from 2006 to 2010.

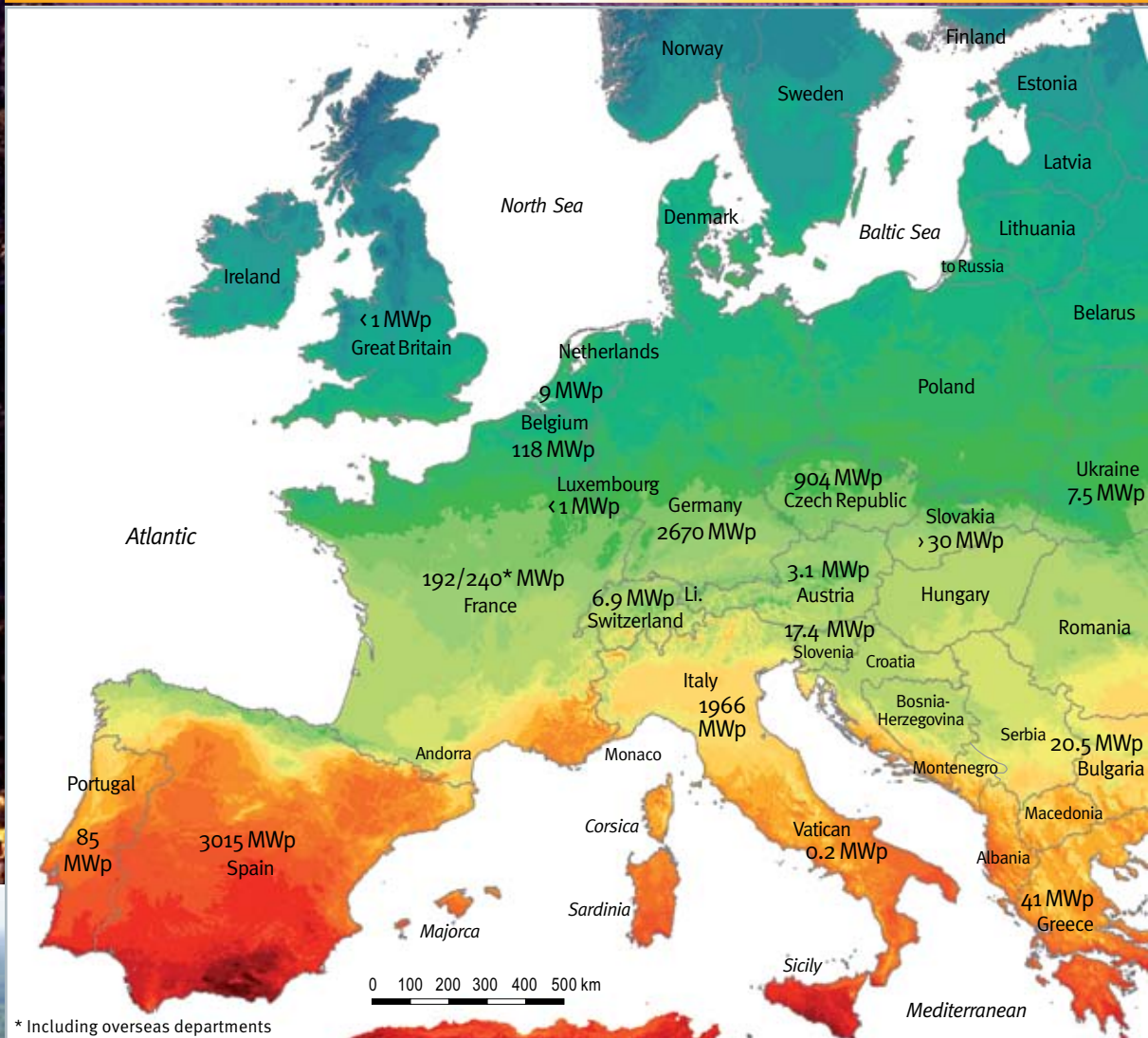
40 MWp – 100 MWp

Sarnia – Montalto di Castro – Finsterwalde – Ohotnikovo – Senftenberg – Lieberose – San Bellino – Wittstock – Gabardan – Perovo – Sault Ste.Marie – Olmedilla de Alarcon – Straßkirchen – Tutow – Serenissima – Boulder City – Puertollano – Zerst – Moura – Kettleman Hills – Köthen – Cellino San Marco

20 MWp – 40 MWp

Brandis – Reckahn – Alfonsine – Veprek – Sant' Alberto – Trujillo – Dörlesberg – Arnedo – Curbans – Dulcinea – Gunthawada – Cimmarron – Don Alvaro, Merida – Ševětín – Giebelstadt – Lönnewitz – Heideblick – Eiche – Fuente Alamo – Lauingen – Arcadia – Finow – Mixdorf – Saint-Symphorien – Lombardy – Sinan – Les Mees – Armprior – Lucainena de las Torres – Abertura – Jumilla – Almaraz – Pocking – Mengkofen – El Coronil – Villarrobledo – Blythe – Rothenburg – Geermu – Hongsibao – Sheyang – Seoul – Xuzhou City – Granadilla de Albona – Calasparra – Beneixama – El Bonillo

FIGURE 4 LARGE-SCALE PV POWER PLANTS - INSTALLED POWER CAPACITY IN EUROPEAN COUNTRIES AS AT DECEMBER 2010
 (map is courtesy of Sibylle Petrak, Focus Solar and Ulrich Dewald, Hans-Joachim Ehrig, RWTH University of Aachen)



Solarpark Finow Tower, courtesy: solarhybrid



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Solarpark Lieberose, courtesy juwi



Courtesy: Miguel Merino, mstudio, Madrid



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- _performance evaluation

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- _shipped via API interface



The image shows two Siemens SINVERT PV inverters. On the left is a smaller, compact unit with a control panel. On the right is a larger, taller unit with a prominent cooling grille. Both units are white with a teal vertical stripe and the 'SINVERT' logo. The background is a plain, light-colored wall.

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