



# PV POWER PLANTS 2010

Industry Guide

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## Towards an era of megawatts: Challenges facing quality and reliability

By Karl-Heinz Remmers, CEO of Solarpraxis AG



**Dear Readers,**  
**In 1992, when my former company, consisting of just two university students, was trying to set up its first PV plant with an output of 5 kilowatt peak (kWp), it was faced with significant technical and financial obstacles. The regional energy supplier, for example, had concerns about a possible negative effect the plant might have on the network. Back then, it was only thanks to a courageous regional director at Sparkasse that we were able to obtain the 70,000 euros needed to pre-finance the plant. Once hooked up to the network, the then unreliable networks played numerous tricks on us that we were fortunate to overcome.**

The small plants that were in operation during those times provided information that significantly advanced existing technologies. In 2001, the first commercial megawatt peak (MWp) plant was launched in Germany. Another six years later, the solar boom in Spain commenced the era of the MWp solar energy plants that are now playing an increasingly larger role in photovoltaics in countries such as the USA, South Korea, China, and once more in Germany. Germany, and therefore also the Solarpraxis engineering team, will again soon boast the world's largest plant with 88 MWp.

In the past, the challenges revolved around obtaining a few thousand euros, but now, the financing volumes for MWp projects stretch to several hundred million euros. As a result, the financing volumes equal those of the traditional energy production segment. Quality and reliability requirements grow with every increase in size, especially with regard to increased plant availability, which has a direct effect on the continuously growing efficiency of the plants (performance ratio).

Increasingly detailed concepts improve the monitoring and maintenance processes of finished plants and make them more precise. The quality assessment of products and materials used, and comprehensive planning discussions regarding the calculation of profits, statics, inverters, their circuitry concepts and the cabling of all components continue to present new challenges.

In order to keep up with installation cost reductions for modules and inverters, we are becoming increasingly successful in optimizing installation and adjusting sub-products that, as yet, do not quite fit precisely. A good example of this is the intersection between the module and mounting rack. Once launched, protection against theft and optimized commercial operations also become important issues so that plants can be used in a worthwhile manner even after the normal operating duration of 20 years.

This brochure addresses all these aspects. It is intended as a guide to and an overview of the industry, but is also aimed at responsible policy makers, and seeks to clarify the economic importance of large PV plants in assisting with the establishment of the appropriate framework conditions.

We would like to thank all the companies who helped create this brochure by providing special expertise and suitable products, and hope you will enjoy reading it!

Karl-Heinz Remmers

## Large PV power plants: A new quest for growth

By Stephan Hansen, Board Director European Photovoltaic Industry Association (EPIA)



**Dear Readers,**  
**Photovoltaic electricity, once confined to space exploration, has, since the beginning of the 21st century, gained access to the realm of power generation.**

The impressive growth of the PV market, mainly driven during those years by the European interest for this particular technology, has since then led to a major decrease in system prices, bringing PV technology among the emerging technologies for power generation on a large scale.

In addition to classic installations, on rooftops, PV systems have been proven to suit the needs of large power plants. At the end of 2009, the largest 60 MW PV power plant in operation was running in Spain, in Olmedilla, producing around 85 GWh of electricity yearly. But the best is yet to come, with many larger projects announced for the coming years. More than a dozen very large scale PV plant projects were announced in the past months, ranging from 100 MWp to 2 GWp, in France, China and the USA. Other future growth markets such as India, the Middle East and Northern Africa will also be dominated by utility scale photovoltaic power plants.

With about 3 ha needed to install 1 MWp, space availability is not an issue, those numbers decreasing with the evolution of technology. Furthermore, PV power plants can be erected in the so-called "zero impact areas", that is, areas which do not enter into conflict with other land. The technology is ready today; it is highly versatile and not very demanding in terms of site, as it can be built on sloped areas and does not require water.

The proven economic feasibility of large and very large scale PV power plants, as well as the foreseen improvements in grid integration, herald a bright future for photovoltaic electricity as a centralized energy source.

Stephan Hansen





Industry



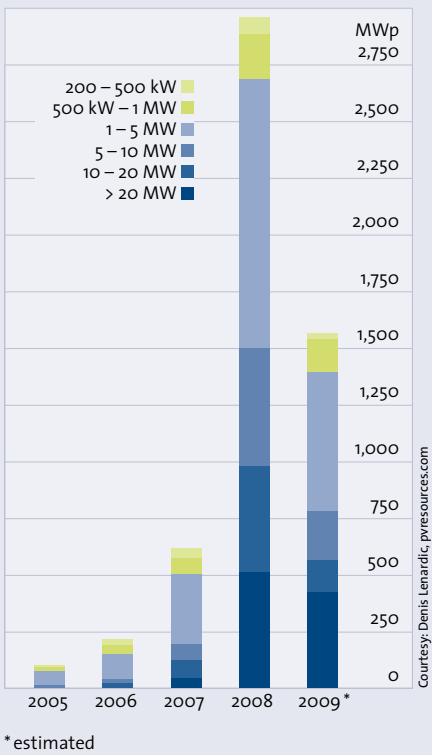
Power plants and the global success of photovoltaics



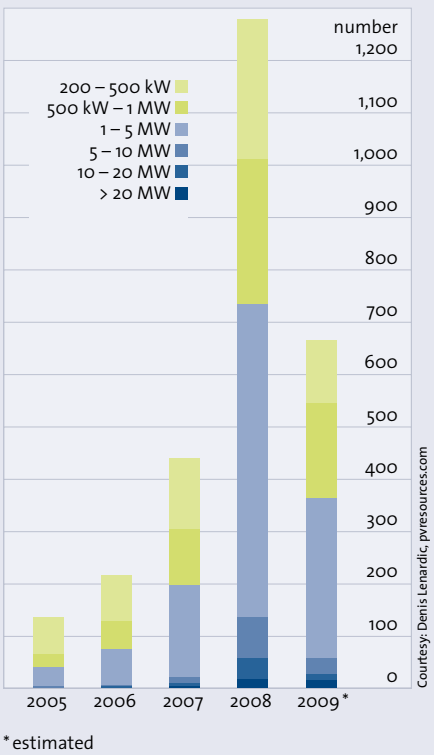
In the past, global growth in photovoltaics was primarily sustained by small and medium-sized installations with an output below one megawatt peak. PV power plants with an output of over one megawatt – or even more than ten megawatts – were the exception. Since 2007, this has fundamentally changed. Falling technology prices and the rising costs of fossil fuels are making solar parks increasingly attractive for large investors.

Unlike small roof-top installations, large PV power plants generally feed into the medium voltage grid. In addition, PV power plants with an output of more than one megawatt are almost exclusively free-standing. A survey conducted by the internet service pvresources.com revealed that, since 2008, approximately 2,000 PV power plants with an output of over 200 kilowatt peak (kWp) were built and taken into operation. Among them, over 1,000 solar parks have outputs of more than one megawatt peak (MWp). Many of them were built in sections, each of which represents an independent power plant.

Annual installed power output capacity worldwide for the period from 2005 to 2009, sorted by power class



Number of large-scale photovoltaic power plants installed annually during the period from 2005 to 2009, sorted by power class



PV power plant in Kolitzheim (Germany) with an output of 1.8 MW

Measurement of characteristic curves as part of performance evaluation



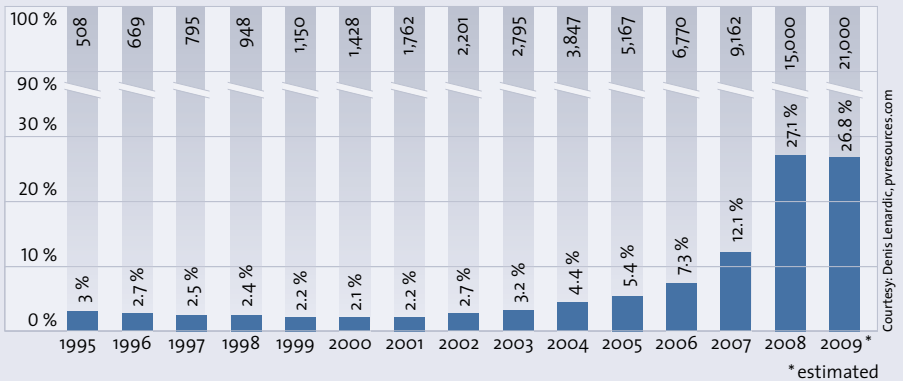
In 2008, pv power plants made the breakthrough. With an annual output of over 2.9 gigawatts (GW) per year, large plants supplying 200 kilowatt peak (kWp) or more made up more than half the total output of all PV plants installed worldwide in 2008 – according to pvresources.com this total is 5.5 GW. Power plants exceeding ten megawatts furnished over one gigawatt all told.

In 2009, 1.6 GW were installed globally. This decrease can be primarily traced back to altered subsidy conditions in Spain. But large power plants still had a share of almost a quarter of all output installed. This clearly shows that solar parks significantly contribute to the global success of photovoltaics.

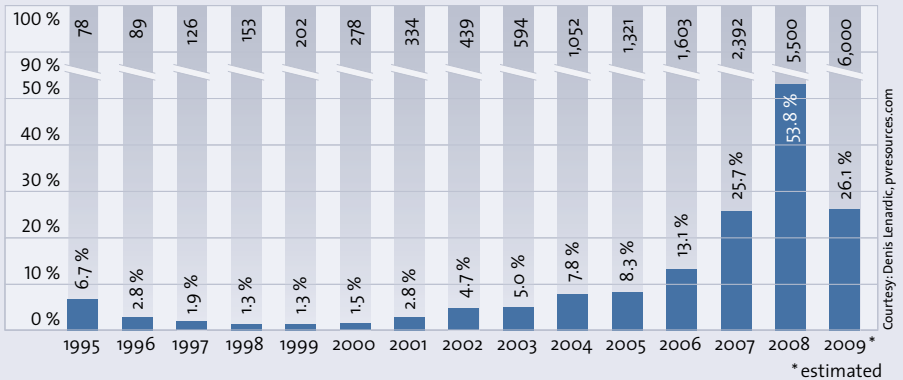
In 2010, the German government announced significant cuts in the feed-in tariffs for large solar plants. Nevertheless, on a global level, framework conditions are steadily improving: Rising cell and module efficiencies will cause the price of solar power to continue to fall, and this is further helped by the severe price drops in solar technology seen since late 2008. Costs for modules and cells fell by one third over the course of 2009. Module prices are expected to fall by another third by 2012.

In particularly sunny regions such as Spain, the Middle East, North Africa, the southern States of the USA, India and parts of China, modern solar modules are on their way to achieving grid parity. And even in

Large-scale PV power plants (> 200 kWp): cumulative power capacity (%) as market share of all PV power capacity annually installed (MWp)



Large-scale PV power plants (> 200 kWp): annual power capacity (%) as market share of total PV power capacity annually installed (MWp)



countries situated further to the north such as Germany, France or the Czech Republic, grid parity is within reach and is expected within the next five years.

**Economic viability the deciding factor**  
Project planning and management, installation and the operation of large PV power plants present new challenges for planners, investors and bankers alike. Precise analysis of the technical, financial, fiscal and legal details can make or break a project, especially for plants from approximately 350 kWp upward, which require an investment of at least one million euros.

Quality assurance, standardization, location-specific plant layout and intelligent integration into the medium voltage grid for grid connection are indispensable if the project is to be financially feasible and generate sufficient yield in the course of its twenty-year life span. The larger the plant, the more likely it will be that the economic viability of the project, rather than the client's credit standing, will determine whether the bank will grant funding.



# National Markets for PV Power Plants

## Spain and Germany leading globally

Solar park in Waldpolenz (Germany): One of the largest PV power plants worldwide with 550,000 modules and an output of 40 MW.

2 MW power plant in El Cura (Spain)



According to statistics from pvresources.com, in 2009 plants with an output of 200 kWp upward generated 2,854 MW in Spain, 1,314 MW in Germany, 372 MW in the United States and 155 MW in South Korea.

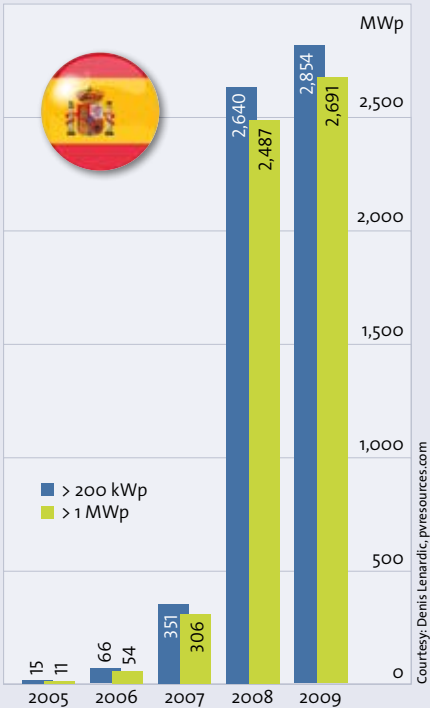
With regard to annual installed capacities, Spain was clearly in pole position in 2008 with 2,290 MWp installed, followed by Germany with 258 MWp. But after the Spanish government limited subsidies for solar power in the fall of 2008, its ranking was lost. Germany has once again been leading the European market in 2009, with 573 MWp installed over the course of the year compared to 214 MWp in Spain.

However, experts expect the Spanish market to recover quickly owing to the country's high insolation, which is around 50 per cent above German levels. Further important European markets include Italy, France, Belgium, Portugal, and the Czech Republic.

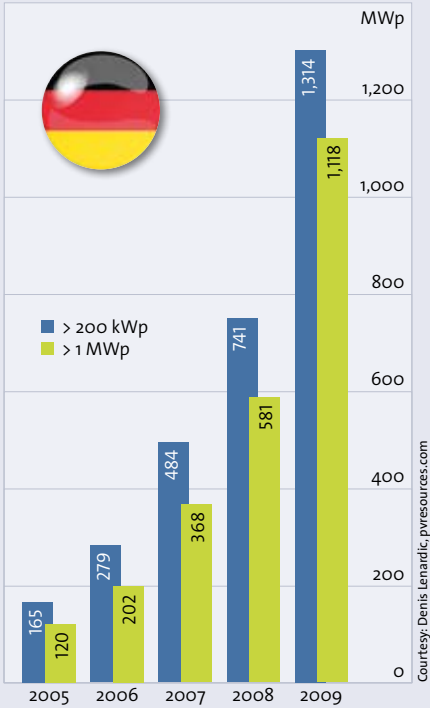
### Different markets

By the end of 2008, eight of the world's ten largest PV power plants were to be found in Spain. As of April 2010, Germany now leads 5:4. But the German and Spanish markets are fundamentally different: In Germany, the Feed-in Act has been a primary advocate for roof-mounted installations since the year 2000 and was preceded by the 1,000 roofs program. Even today, around 80 percent of Germany's PV plants are installed on roof-tops. Spain has none of this prehistory and also makes no distinction between feed-in tariffs for roof-mounted and free-standing installations. As a result, almost all PV power plants in Spain are free-standing.

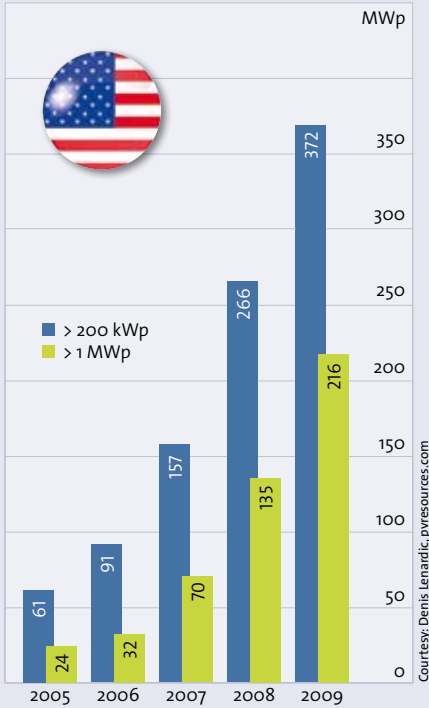
Large-scale PV power plants: cumulative power capacities in Spain, 2005 to 2009



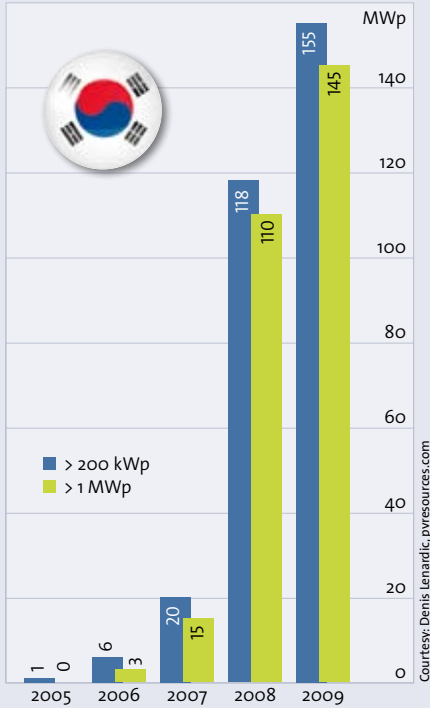
Large-scale PV power plants: cumulative power capacities in Germany, 2005 to 2009



Large-scale PV power plants: cumulative power capacities in the USA, 2005 to 2009



Large-scale PV power plants: cumulative power capacities in South Korea, 2005 to 2009





46 MW solar park in Amareleja (Portugal)



Solar park Montalto di Castro (Italy) with 6 MW nominal power



Assembly of modules



Ground-mounted photovoltaic power plants (> 200 kWh) · Ranking 1 - 10 (as of April 2010)

	Power	Location	Description	Constructed
1	60 MW	Spain Olmedilla	Parque Fotovoltaico Olmedilla de Alarcón ground-mounted	2008
2	54 MW	Germany Strasskirchen	Solarpark Strasskirchen ground-mounted	2009
3	53 MW	Germany Turnow-Preilack	Solarpark Lieberose ground-mounted	2009
4	50 MW	Spain Puertollan	Parque Fotovoltaico Puertollano ground-mounted	2008
5	46 MW	Portugal Moura (Alentejo)	Moura photovoltaic power plant ground-mounted, tracking system	2008
6	45 MW	Germany Köthen	Solarpark Köthen ground-mounted	2010
7	42 MW	Germany Finsterwalde	Solarpark Finsterwalde ground-mounted	2009
8	40 MW	Germany Brandis	Solarpark Waldpolenz ground-mounted	2007/2008
9	34.5 MW	Spain Trujillo (Cáceres)	Planta Solar La Magascona & La Magasquilla ground-mounted, tracking system	2008
10	34 MW	Spain Arnedo (La Rioja)	Planta Solar Arnedo ground-mounted	2008

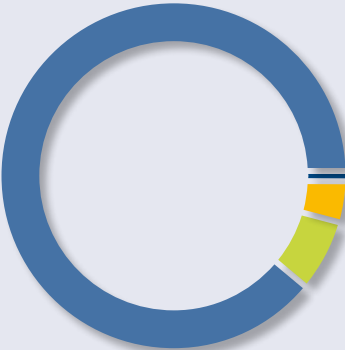
The US photovoltaic market amounted to 440 megawatt peak in 2009. Of this, 372 megawatt peak were generated by plants with an output above 200 kilowatt peak each. Current trends indicate that a large number of photovoltaic power plants will be built, particularly in the south and southwest of the United States. And there is no lack of land in the sunny deserts of California, Nevada and Arizona. Large properties are being bought here with the aim of building PV power plants which achieve an output of ten megawatt peak or more. The United States are therefore expected to catch up with frontrunners Spain and Germany over the next few years.

China is aiming to install around twelve gigawatts of free-standing power plants by 2013. The state renewable energy development plan provides for as much as 20 gigawatts by 2020. This came into effect in March 2009 and will have a strong influence on the Asian market.

Courtesy: Denis Lenardic, pvresources.com

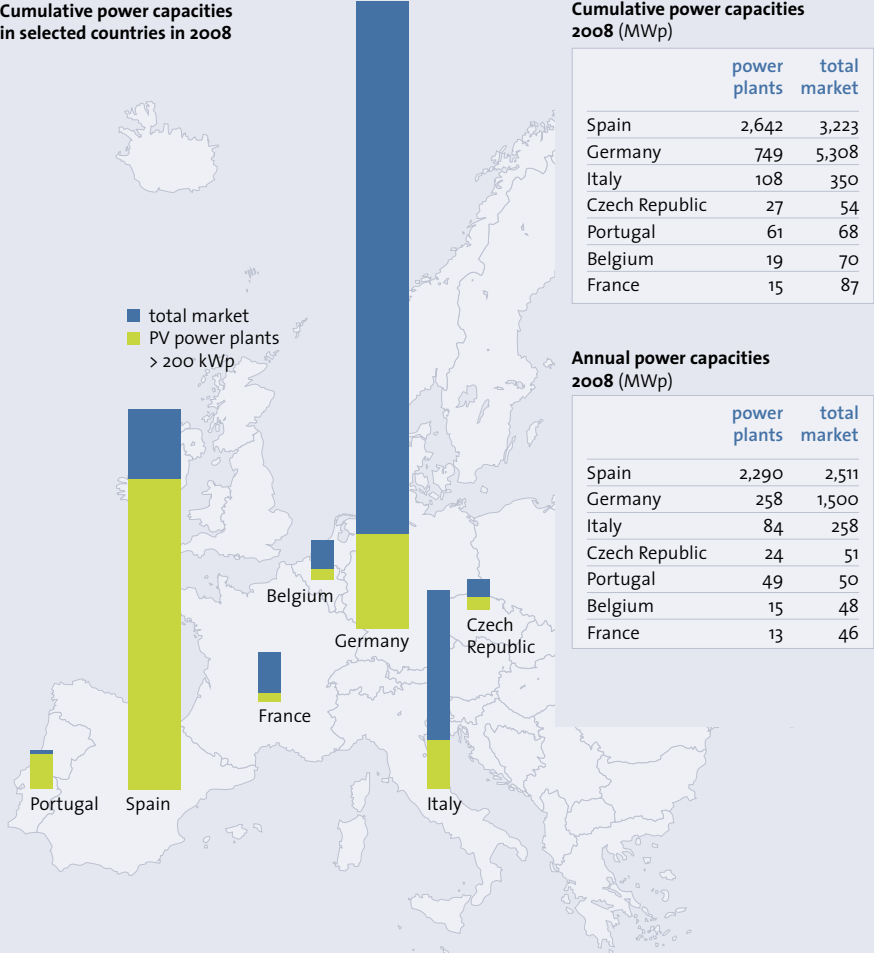
In 2008, pv power plants made the breakthrough. Thanks to Spain, Europe held a total of almost 90 percent of all power plants (>200 kWh) worldwide.

Large-scale PV power plants (> 200 kWp): cumulative power capacity by region 2008



Europe	3,631 MWp	89.4 %
USA	266 MWp	6.6 %
Asia	157 MWp	3.9 %
RoW	6 MWp	0.15 %

Cumulative power capacities in selected countries in 2008



Courtesy: Denis Lenardic, pvresources.com / EPIA



New challenges for planners and investors



Mounting clamp



Crystalline silicon and cadmium telluride modules dominate the market for PV power plants.

Business in megawatt-scale PV power plants is currently dominated by crystalline silicon (the total market share is around 85 percent, while the market share of PV power plants is an estimated 65 percent) and cadmium telluride (the total market share is around eight percent, with an estimated PV power plant market share of 30 percent). As there is a lack of long-term experience with modules using new types of solar cells, banks are cautious to provide financing for them.

**Crystalline silicon versus thin film**  
The costs of solar power can essentially be covered in two ways: either by improving cell or module efficiency, or by reducing production and mounting costs. The solar industry is making considerable progress on both counts. Advantages of thick film modules: Commercial mono- and poly-crystalline silicon modules achieve up to 20 or 17 percent efficiency respectively. The technology is mature and extensive operational experience is available, sometimes spanning decades. In terms of installed plant output, they require a smaller surface and thus less support structure and cabling.

As thin-film modules are considerably less efficient than crystalline modules (with around 11 percent efficiency), they require a significantly greater surface area to achieve the same output. This increases the costs of installation. However, comparing the specific plant costs and yields, this disadvantage may be outweighed by the fact that thin-film modules show better behavior under diffuse light conditions and that they have a lower module output temperature coefficient. In addition, the production costs of thin-film modules are lower owing to the possibility of automation. For this reason, each project plan must start with an accurate analysis of the lighting and mounting conditions (ground, terrain). Both technologies will be developed further. Even though thin-film technology is currently growing at a faster pace than thick-film technology, the falling costs of solar silicon will allow crystalline modules to preserve their market share.

**Temperature coefficient**

The temperature coefficient shows the percentage by which a module's efficiency changes per temperature unit. For crystalline silicon modules (in this case: mono-Si) it is around minus 0.5 % / K, and for thin-film modules (in this case: CdTe) around minus 0.25 % / K.

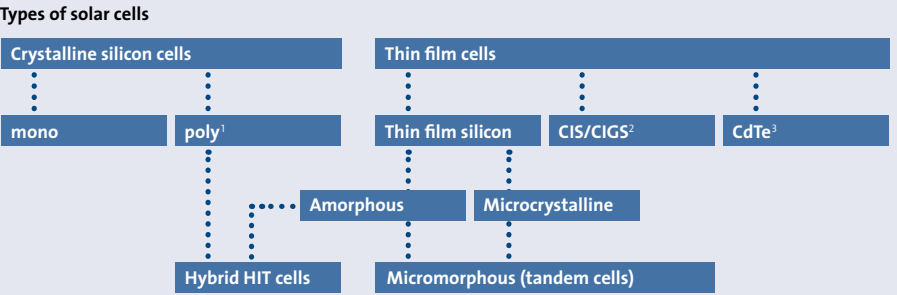
Consequently, a solar park with an output of one megawatt peak (measured under standard test conditions, i.e. with a module temperature of 25 °C) will show slightly inferior performance once the module temperature reaches 65 °C (a temperature easily reached in

summer). The mono-Si park will only have an output of 800 kilowatt peak instead of one megawatt peak [1 MWp \* (-0.5 % / K \* 40 K)]. The CdTe park will still furnish 900 kilowatt peak in place of its 1 megawatt peak [1 MWp \* (-0.25 % / K \* 40 K)]. In contrast, on cold and sunny winter days, the peak output of the solar modules will be higher. Nevertheless, the yield during summer (MWh) is considerably higher than during the colder winter months because the average summer's day will provide more hours of more intensive insolation than the average winter's day.

**Price reductions**

At the beginning of 2010, one Watt of energy generated from photovoltaic sources cost between 2.50 euros and three euros in Germany.

As the degression factor, which reduces the feed-in tariffs each year, encourages technical innovation and cost cutting, further price reductions are inevitable. »



1 Manufacturing methods: traditional, metallurgical, EFG, string ribbon ...  
2 Combinations of copper, indium, gallium, sulfur, selenium  
3 Cadmium telluride



Simulation of sunlight



Quality assurance during module production



#### Quality assurance from the factory to the site

Plant-related quality tests which examine the key components of a PV plant with respect to efficiency and service life are becoming increasingly important for proving a plant's profitability. As solar modules are exposed to extreme climatic changes during their life span, they are always tested before being put to use.

Photovoltaics Module Test



Whereas certification is usually granted as a result of tests performed on modules provided by the manufacturers, a new, independent "PV test" (by Solarpraxis AG with TÜV Rheinland and partners) tests random samples bought anonymously on the open market. The results will be published in the industry publications "photovoltaik" and "pv magazine" from summer 2010.

#### Process steps in quality control

Quality control is not only applicable to modules, but to the entire life cycle of an installation, from development to operation:

**Project development and planning**  
Yield assessment • inspection of details with respect to grids, site subsoil, shading etc. • review and optimization of DC and AC planning

**Module quality control**  
Precise module specification • technical consulting • factory inspections • before shipment or after receipt: High level of sample tests to assess performance (flash testing by an accredited test laboratory) / high level of electroluminescence sample testing / destructive testing

**Quality control during construction and acceptance of work**  
Construction management • training for installers • sample electrical measurements (output, characteristic curve, open-circuit voltage, short-circuit current) • function testing and acceptance measurements (thermal imaging under load) • test reports

Prior to warranty expiry  
Visual check of entire installation • thermal imaging under load

**Monitoring**  
String monitoring • 365 day monitoring

© Solarpraxis Engineering



Central inverter (left)  
String inverter (below)

#### Inverter design: central versus string

Solar generators are created using a combination of series and parallel connected solar modules. Depending on the voltage of each solar module, up to 20 modules may be connected in series to form a string. These strings are then connected to the inverter(s) in parallel.

Inverters have the task of tracking the temperature-dependent and irradiation-dependent maximum power point (MPP), and adjusting the solar generator to this optimum operation point. The second essential task is the conversion of direct current produced by the solar modules into alternating current compatible with the grid. Depending on their size, PV power plants are either connected to the low voltage grid (for plants up to approx. 250 kilowatt peak), or to the medium voltage grid (for plants from 100 kilowatt peak upward).

In a central inverter layout, a number of strings are connected to one central inverter. This concept has become established for solar parks with an output of 100 kilowatt peak or more. The largest central inverter units have an output of up to two megawatts. In order to increase solar yield, individual central inverters should be configured to work in a master-slave combination. 2 megawatt plants may consist of four units, each with an output of 500 kilowatt peak, in a master-slave-slave-slave combination. When irradiance is weak, only one of the 500 kilowatt peak inverter units will operate; only once the solar park generates more than, say, 400 kilowatt peak, will a second inverter unit be activated. This process is repeated for the third and fourth inverters respectively, until all four inverters are active under full insolation.

In a string inverter concept, a few strings are connected to many small inverters. Tracking systems in particular generally have one inverter per module table. This



concept has become established for solar parks in an output range of one megawatt or more. There are therefore many applications where it is unclear which technology should be preferable. Taking into consideration the actual investment costs will, in most cases, help establish which solution is best in a particular case.

Good inverters have a peak efficiency of almost 99 percent. In relation to actual use over a day, week or year, the efficiency will be lower than this, but should still reach an average of 95 to 97 percent. Experts currently state varied information regarding the lifespan of inverters. It is therefore imperative to either conclude maintenance contracts or set aside reserves for exchanging components in order to ensure that the financing is sound. Solar parks with string inverters can generally survive without maintenance contracts, but should have substitute components available for quick exchange in case of failure.

High efficiency and plant availability above all mean higher yields. If the average efficiency of an inverter rises, or annual availability increases by three percent, a solar park with an output of one megawatt may

expect to earn an additional one million US dollars over ten years. Not every inverter type is suitable for every type of module (DC input voltage, transformer, earthing). The inverters used must have been approved for the solar modules in question.

#### The key to the grid

Solar parks obtain their cash flow from feeding generated solar power into the regional utility grid for which they receive a – frequently statutorily guaranteed – feed-in tariff. The more power they feed into the grid the more important protection against grid failure becomes. If grid stability is in jeopardy, the grid operator will either switch the plant off or use it for stabilizing the grid. This means keeping grid voltage and grid frequency constant, balancing active and reactive power in the grid and phase position at the entry point. Precisely because of these capabilities, large PV plants possess great potential for stabilizing power grids. »



PV power plant with tracking system (left)  
Cabling of pv modules (right)



### Feed-in regulations

The preconditions for feeding solar power into the public grid vary from one EU country to the next; in some countries utilities have their own additional requirements.

In Germany, the medium voltage regulation issued by the German Association of Energy and Water Industries (BDEW) and the stipulations of the 2009 amended Feed-in Act apply. These regulations specify that the inverter must convert current in both directions. In Spain, the conditions for grid connection must be regulated by a contract between plant operators and grid operators (Art. 16 Royal Decree 661/2007). In the United States, the IEEE 1547 standard (voltage and frequency tolerances) applies.

Very large solar parks use several entry points, and all a park's medium voltage inverters must be connected to a central control center. In Germany, the BDEW medium voltage guideline came into force in January 2010 and will be applied to existing plants as of January 2011. From July 2010 on, only PV plants may be connected to the grid which have a special certificate confirming that the inverter was designed in accordance with the medium voltage directive.

### A sound investment

Solar parks should reliably generate electricity for twenty years. They are generally built on open land, such as former military grounds, fields, landfills, former mining fields or hitherto unused fallow land. A project's profitability strongly depends on the ability to construct the solar park with as little expense as possible. In addition, the module and inverter array, the solar

generator's electrical layout and the location of entry points all have a strong impact on the costs for support structures, foundations, cabling and mounting.

Planning starts with a survey of the relief, solidity and the quality of the ground. Combined wind and snow loads added to the modules' own weight and that of mounting profiles make planning extremely difficult. Similarly to bridges, large free-standing plants are at risk from wind-induced oscillations, whereby frameless solar modules show different deformation behavior to framed modules.

The simplest systems use pile foundations, where one or two piles are driven into the soil. Single-pile systems are usually cheaper, but have considerably lower load limits than two-pile systems. For the latter, more extensive soil preparation is required. Screw pile foundations, which are worked into the soil just like a screw, provide an alternative to ramming foundations. Concrete foundations made of shotcrete or in-situ concrete are another possibility – for tracking systems, for example.

The modules are supported by systems made of wood, aluminum or steel. Wooden structures are comparably light but will warp in the course of 20 years. They must be waterproofed and should not come into direct contact with the soil. Aluminum is also an extremely light material. Systems made of this are easy to install and hardly corrode, but the price of aluminum fluctuates greatly. Its thermal properties make this material subject to higher thermal tension. The bending and buckling characteristics of steel and aluminum respectively should be taken into account in the static design of the assembly frame. The disadvantages of steel are its heavy weight and the extensive corrosion protection measures required.

### Secure anchoring

The mounting system must be capable of supporting the solar modules securely for a long period of time. Mounting a free-standing PV power plant is frequently easier than many other types of installation, as the construction area is more easily accessible than, say, a slanted roof. A big disadvantage of free-standing plants, however, is that they lack a truss to which to screw the assembly system. This is why anchoring the mounting frame safely into the ground is a factor which should be given adequate consideration, as it will have to keep the equipment stable for decades.

### Tracking systems

Depending on their location, crystalline silicon modules can furnish up to 35 percent higher yields if they are mounted on trackers. Tracking systems require 15 to 20 percent higher investment, and maintenance and operations are also more expensive than for a fixed PV installation. This is because they comprise mechanical moving parts such as motors and actuators. Single axis tracking systems track the daily path of the sun (east-west-axis). Dual axis (hemispheric) systems also move in a north-south direction.

Using trackers involves considerable additional preparation of the foundations; the ground must be sufficiently stable. The surface area required for tracking systems is also larger than that for non-tracking PV installations since, to avoid shading, trackers must be positioned at a sufficient distance from each other. The warranty often only runs for ten years, while the installation is designed for twenty. In view of sinking module prices, some experts discuss whether it will generally make more economic sense to forgo tracking systems and opt for a fixed installation. However, in some cases – such as in areas of low insolation – trackers can be useful for improving yield.

### Losses due to cabling

Losses due to cabling are often underestimated. The positioning of modules and inverters determines the cable routes and the plans for laying cables. Depending on the plant layout, total energy losses in copper cables may amount to as much as 2.5 percent – but anything over one percent is unacceptable. To avoid high losses, the cable cross section must be relatively wide, while lengths should be as short as possible. During installation and operation of the PV plant, the plug connectors on the solar module cables must be checked to ensure that they are water tight and that the connections are not prone to fault voltage or short circuits.

### Lightning and overvoltage

Large free-standing PV plants always need their own protection system against lightning and overvoltage. Overvoltage is caused by electromagnetic induction in (excessively) large cable loops. According to TÜV Rheinland, in Germany 45 percent of all damage to PV plants is caused by overvoltage. The risk of overvoltage must therefore be reduced to an absolute minimum, as it frequently causes severe damage or even fires. For this reason, DC cables are kept in parallel and as short as possible.

Protection against direct strikes (direct strike lightning protection) or coupling as a result of strikes elsewhere in the grid (indirect strike lightning protection) must be taken into consideration during the initial stages of planning.



Lightning and surge protection



## No money without security

21 MW power plant in Blythe (California, U.S.A.)  
generating over 45,000 megawatt hours per year



If they are profitable, large PV plants will finance themselves. The decisive factor here is the creditworthiness of the project – not of the investors. Financing can take place via bank loans or via investment funds. In both cases, cash flow, that is to say the earnings from selling the electricity, forms the basis of the project's financial viability.

Actual investment costs fall between three and five million euros per megawatt, depending mainly on the module types installed and the mounting or tracking systems. Thin-film plants are at the bottom end of the scale, while monocrystalline silicon parks with tracking systems sit toward the top.

### Political conditions in Europe

In Germany and many other EU countries, solar power is sold to utilities for a feed-in tariff guaranteed by law. This tariff is above the price for power from a conventional power plant mix. In some EU countries, the feed-in tariff is reduced by a certain amount each year, depending on the time the plant was taken into operation. In Germany, the new government is planning to change the tariffs for large scale power plants.

Other nations have limited the total amount of subsidies. In Spain, for example, the government decided in the fall of 2008 to restrict subsidies to a maximum of 500 megawatts. Other possible state or regional incentives for PV plants include grants, tax incentives or special rules for depreciation. Italy, the Czech Republic, Bulgaria, Romania, Poland, Hungary and Croatia also pay feed-in tariffs. EU applicant Turkey has likewise decided to introduce a feed-in tariff

### RES-LEGAL

The free RES-LEGAL database provides an overview of the whole range of Europe's subsidy models. It contains all important legal regulations on subsidies and the feed-in of power from renewable sources within the EU. The collection of models for remuneration, tax incentives and certificates as well as grid access comprises 27 countries. A search assistant enables users to analyze and compare legislation in the different countries.

[www.res-legal.eu](http://www.res-legal.eu)

### New feed-in tariffs for Germany

In Germany, the Cabinet has currently passed a bill, which allows for additional cuts beyond the yearly decreases already in place and links subsidization to market growth. Among the bill's provisions is a one-off, 15 percent cut in subsidization for free-standing plants, due to take effect on July 1, 2010. Remuneration for plants on redeveloped land will probably see a less dramatic reduction. Furthermore, the question as to whether trading estates, industrial areas and land flanking motorways and railway lines should be incorporated into the Renewable Energy Act (EEG) under a new land category is being reviewed. It is intended that photovoltaic plants on agricultural land will no longer receive subsidies, and that targets for capacity expansion be raised to 3,500 MWp. A final decision is expected for May 2010.

(As at April 2010)

### A "jungle of incentives" outside Europe

The picture outside of the EU is somewhat less homogenous. India is considering a feed-in law with guaranteed pay-back. China wants to earmark large areas of land for PV plants with outputs of up to several gigawatts but does not yet have a uniform feed-in tariff. A central feed-in tariff may be introduced once the current five year plan comes to an end, as China, one of the most important producers of PV technology, wants to develop a strong home market. To date, responsibility for solar projects has mainly been assumed by provincial governments and local authorities.

In the United States, the most important incentives are investment tax credits, which can be offset with tax debts. For those who do not have any tax debts, tax credits are paid out to the investors as negative tax. Some states also remunerate each kilowatt hour fed into the grid; others offer tax bonuses and grants. Models include the Power Purchase Agreement (PPA) scheme, which is mainly used for large, centralized PV plants with an output of several hundred megawatts.

Under this scheme, local utilities guarantee to purchase electricity at a set price for a period of ten to 15 years. This price may vary according to the seasons and the time of day.

In California, for example, peak load is between eleven a.m. and seven p.m. During this time, refrigerating units and air conditioning systems use a lot of energy. If a solar park feeds electricity into the local grid during peak load, the tariff could be three times that of the standard price.

### Financial crisis hampers business

Financing stands or falls with the actual annual solar power yield fed into the grid. Banks expect a return on project investment of at least eight to nine percent. The 2008 financial crisis has slowed down lending the world over. Since its onset, solar projects have been valued conservatively and their risks thoroughly analyzed, with banks concentrating on just a few key accounts. This has led to module producers themselves becoming active in the development of large solar parks. In this business, equipment is bought directly from the producer. »



The European Energy Exchange AG (EEX) in Leipzig, Germany, is a leading trading market in European energy trading.



15,000 thin film modules:  
1 MW solar park in Salmdorf, Germany



Banks play varying financing roles. They either pay out the project loan via the house bank, meaning that the full risk will be shown on their books, or they form syndicates from several banks in order to spread the credit risk. Since the banking crisis, this model has hardly been used at all in the solar industry, where "club deals" are frequent. This means that several banks pool a loan together through a skeleton agreement, each of them on different terms. A credit institution coordinates the syndicate and acts as a contact with the client (borrower). With this model, the time between the application and the approval is longer and investment costs are higher.

#### No money without security

Loans are never granted without security. Examples of securities include the transfer of ownership of the PV plant, the transfer of rights from project contracts (delivery contracts, operating and maintenance contracts, contracts of use and occupation for the site, insurance contracts), encumbrances, pledging of the operator's account or pledging of shares in the business. In the past, project financing was sometimes too tight, which led to non-performing loans. For this reason, banks often set requirements for the content of project contracts, or place stricter demands on the use of cash flow (reduced profit distribution). At the same time they insist on top equipment quality to be confirmed by external experts (technical due diligence). It is not rare for two independent yield forecasts to be commissioned.

#### Quality criteria for solar funds

A working group from the German Solar Industry Association has developed quality criteria for solar funds. Although originally targeted at investors considering participation in a solar fund, the key quality criteria also provide suitable guidelines for project developers interested in sustainable, high-quality PV plant projects. The working group has also outlined a "voluntary commitment for yield assessors". This defines a minimum standard in order to enable a high level of acceptance for yield forecasts amongst financing banks.

Further information is available at [www.solarfonds-ratgeber.de](http://www.solarfonds-ratgeber.de).

#### Due diligence

To enable a project to be financially viable, thorough analysis, examination and assessment of the venture – also called due diligence – is necessary. This generally follows four steps.

##### Legal due diligence:

This step examines the legal basis of a project from purchase or rental of property to feeding in. Checks are made on the application to the utility as well as on the operating, maintenance and insurance contracts. Experienced project developers use standardized templates to exclude major risks.

##### Tax due diligence:

Experts check the tax aspects of a project, such as corporation income tax, trade tax and income tax, value added tax, tax on dividends, real property tax and land transfer tax, as well as taxes incurred during operation. Such an analysis includes tax incentives and depreciations.

##### Technical due diligence:

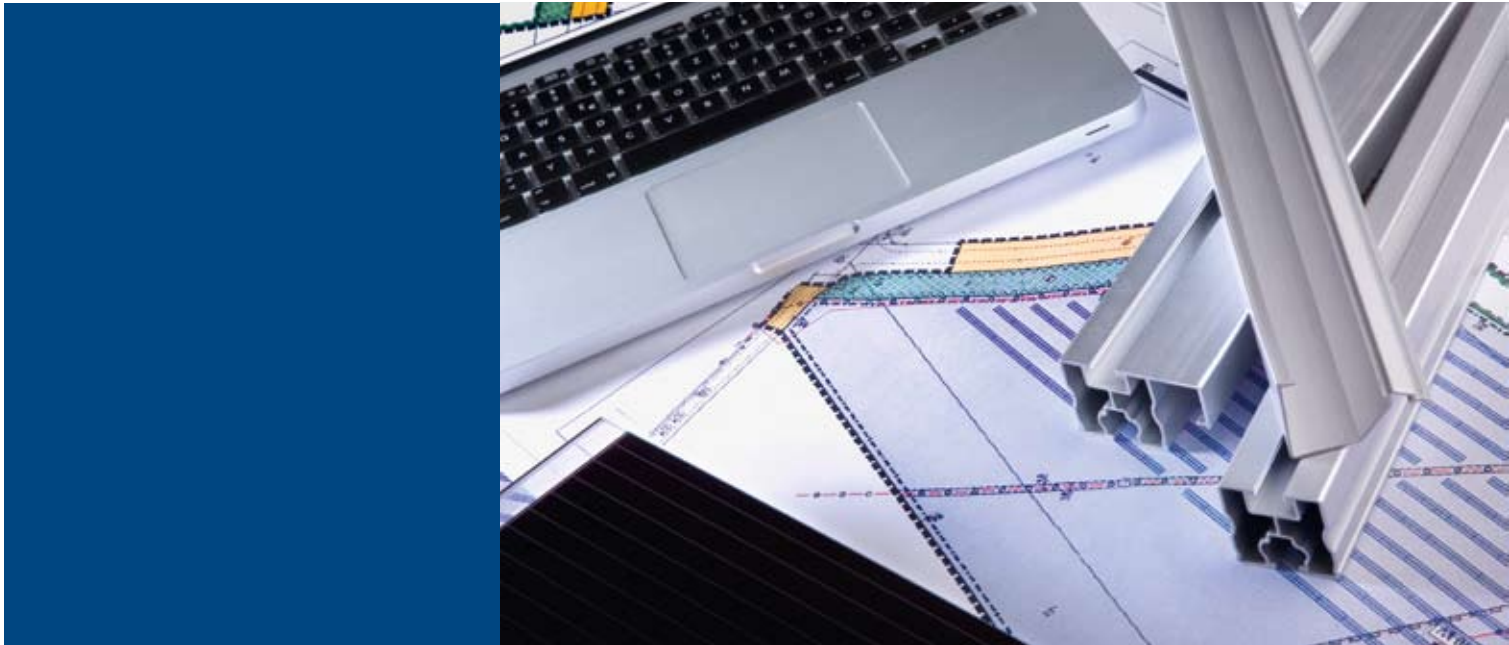
Independent engineers scrutinize the technical plant design. This includes: system planning (yield forecast, plant layout, inclination and alignment of modules, ground survey, distance from entry point, number of entry points, etc.), specification and selection of components, tenders and order placement, installation, technical quality management and building quality management, manufacturers' and installers' guarantees and warranties, creditworthiness of suppliers, theft and vandalism protection (fencing, CCTV), and the costs of maintenance and land management (for example pruning).

##### Financial due diligence:

The last phase before a loan is granted concerns financial aspects: required investments (capex), costs for the property and yields from any future sale, expected solar yield, costs for operation and maintenance (opex), reserves, insurance, costs for dismantling and recycling the plant after the end of its life span. The cash flow, taxes and debt services are used as a basis for evaluating profitability, which is the deciding factor in granting loans.



Ensuring technical and financial feasibility



Good and thorough preparation by experienced planners can make or break a large solar park project. Owing to the size of the project, neglecting small points may soon lead to large quantities of money being lost.

How to start a project – important questions

Assessment of yield and capacity

Which technology is necessary to achieve the highest possible yield? What is the module area required? It is possible that additional shading from new buildings or plant growth will occur at a later point in time?

Local support

Will the project be supported by representatives from local government and the local community? How can skeptics be won over?

Careful planning does not only concern the assessment of yields or capacity and building permissions. Local support and grid connection testing are also essential factors when starting a successful project.

Building permits, development plans and compliance testing

Has planning and building permission been granted? Does the land development plan permit the installation of a photovoltaic plant? Does the project conform to the national feed-in requirements?

Grid connection testing

Is a suitable grid connection terminal available on site? How long will it take to obtain grid-related information and to process the application?

Performance ratio

The ratio of actually generated power to the theoretical yield in a certain location is described by the performance ratio (PR). A good PR would be above 75 percent, very good plants achieve up to 80 or 85 percent. Based on the values for a one megawatt PV plant in the south of the United States (PPA: 0.2 US-\$/kWh, specific yield: 1,800 Wh/Wpeak, performance ratio 80 percent), a ten percent increase in performance ratio will earn an additional 850,000 US dollars over the course of 20 years.

Comparable calculations can be made for Germany. For instance, a PV power plant with a peak output of one megawatt, connected to the grid at the beginning of 2010 with a performance ratio of 75 percent, would produce 863 megawatt hours of electricity each year. If performance were to increase by ten percent to 82.5 percent, the same plant would furnish 949 megawatt hours. At a feed-in tariff of 0.2843 euros per kilowatt hour and a difference in performance of 86 megawatt hours, the operator will therefore lose out on 27,500 euros. Considering that the average plant will have a twenty year life span, total inexhausted solar yield will amount to 550,000 euros.



Logistics: transportation of inverter (left)  
PV plant monitoring (right)

Service and maintenance reduce downtimes and are crucial for guaranteeing maximum yields.



Expert opinion

Planning always starts with a survey to help determine what the solar yield, the foundations, the best modules, inverters and mounting technique will be. If a plant is built on former military ground or redeveloped industrial property, contamination from ammunition and hazardous substances must be thoroughly investigated. Ensuring that the property is safe has top priority. Yields from the PV plant must be able to cover the purchase price or the rent for the land.

Early involvement of utilities

Rough technical planning is followed by submitting the feed-in application to the local utility. This has the purpose of determining the location of the entry point and whether it will actually be possible to feed the projected yield into the grid. If there are several possible entry points, the most cost-efficient point will be selected – no matter which part of the costs must be paid for by the plant investor, and which by the utility. The basic principle is: Grid connection costs must be borne by the investor, grid development costs by the utility. The utility also sets specific parameters for keeping the grid stable when

power is fed in (power factor cos (Phi), short circuit current). To enable the utility to process applications as quickly as possible, they should be involved in the project as early as is feasible.

A word on logistics

Solar parks are complex building sites covering a large surface area. Transport logistics for modules alone requires careful planning. Crystalline modules, for example, are delivered in containers of 100 kilowatts each. A 25 megawatt solar park thus requires 250 containers which can only be moved with the help of a crane. Just-in-time delivery is vital to avoid costs for idle periods. The handling of frameless modules in particular calls for extreme care so as to avoid breakage or damage.

Operation – what else needs doing?

The operation of a solar park also necessitates great care. First of all, the smooth running of the plant must be ensured to avoid any interruptions. A sophisticated plant monitoring system will document operation, providing the basis for quarterly reports to investors and helping to identify the causes of any shortfalls. Faults at the entry point or the inverter are

particularly critical, and engineers must respond quickly to minimize any yield losses. Since modern inverters provide remote monitoring options, faults do not always require a trip to the site.

PV plants in the megawatt range also require regular checks by staff. Regular visual checks, on-site thermographic monitoring, remote monitoring of strings and inverters as well as the evaluation and storage of data are indispensable. Operation and maintenance costs account for between three and five percent of the solar yield. If well planned and performed, they can help increase yields by up to 15 percent.

Ground-mounted systems need to be protected from theft and vandalism, the minimum requirements being a fence with climb-over protection and a secured access gate. Video monitoring and microwave or infrared sensor barriers with alarms via cable or radio complete a security concept. Of course, costs and benefits must be weighed up against each other in each individual case.



## An interview with Stephan Hansen, Board Director European Photovoltaic Industry Association (EPIA)



In its SET For 2020 report, EPIA outlines the European PV market. What does the report say about large scale PV, i.e. systems that go from 200 kWp to many megawatts? Are there any European countries in which these systems play a significant role, compared to the rest of Europe and the world?

Stephen Hansen (SH): Large scale PV is supported in all feed-in tariff laws in the core markets in Europe. In order to meet the 2020 objectives and the renewable energy objectives beyond 2020 we will need to take advantage of all the all options we have. The share of central PV power plants versus distributed roof installations will be decided at local level.

**To what extent will these systems help photovoltaics to become a mainstream energy source in Europe by 2020?**

SH: Utility scale PV power plants are the most cost effective PV installations, and Europe is a clear leader in this area thanks to the competence that was developed over the last few years.

**Large systems break with the decentralized scenario that is generally associated with photovoltaic power. Isn't there a danger that a further growth of large systems will diminish the importance of smaller systems, which have been the backbone of the industry until now?**

SH: No, we clearly need both; decentralized installations where consumption is mainly at the point of production and central PV power plants to satisfy industrial consumer needs. Particularly the concept of combining renewable energy sources to create “hybrid power plants” is one of the future. Wind and solar are complementary resources, and together with biomass will be able to provide base load on multiple levels, for industrial customers, regional supply and on a larger scale.

**Large PV systems also challenge the electricity system as, for example, investments in grids become necessary. What further obstacles have to be overcome?**

SH: The integration of renewable energies in general requires new thinking with regard to grid management. We see this with wind and we will see this with PV as well. We will need to think about future technologies, such as smart grids and storage, combining renewable energies as mentioned above.

**How can politics further stimulate the increase of large PV systems in Europe?**

SH: The feed-in laws that we have in Europe are the most successful political instruments for the introduction of photovoltaics, until we are able to compete with other generation assets. This process will be a gradual one, but it will start in a few years. It is important that the regulatory framework provides a level of confidence to enable investments, and that it takes into consideration the well established and proven cost reduction capabilities of the industry. Important aspects besides the tariffs are access to the grid and generally



Left: 6 MW solar park in Darro, Spain, with two-axis tracking system  
Below: 5.6 MW PV power plant in Wörstadt, Germany



transparent and lean administrative processes, from obtaining permits through to commissioning. This security and transparency is, at the same time, a key factor in the financing of PV systems. As EPIA, we actively support this by working closely with the other associations in implementing our photovoltaic vision for Europe, SET for 2020, and sharing best practices.

### The strength of a single photovoltaic voice

With over 200 member companies drawn from across the entire solar electricity sector, EPIA is the world's largest solar photovoltaic industry association and represents around 95 percent of the European PV industry and 80 percent of the worldwide photovoltaic industry. EPIA members are present throughout the whole value-chain: from silicon, cells and module production to systems development.

EPIA represents the interests of its member companies at national, international and global level. Its mission is to deliver a distinct and valuable service driven by the strength of a single photovoltaic voice.

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◀ 1 MW power plant in Alquerida (Spain)  
with two-axis tracking system





Companies





# Services and products

Page  
Company

		system integrators / project developer / turnkey solutions	inverter / inverter systems	crystalline module manufacturing	thin film manufacturing	receiver (CSP)	tracking systems	mounting systems	IT solutions	insurance broker	certifier
32	AEG Power Solutions		●								
33	applied international informatics								●		
34	BISOL	○		●			○				
35	Bosch Solar Energy	●		○	○						
36	Changzhou EGing			●							
37	Danfoss Solar Inverters		●								
38	DEGERenergie						●				
39	Diehl Ako		●								
40	Ecostream	●									
41	Elettronica Santerno		●								
42	Emerson   Control Techniques		●				○				
43	EnBW Erneuerbare Energien	●									
44	EXOSUN	○					●				
45	First Solar				●						
46	Fronius International		●								
47	Gehrlicher Solar	●						○			
48	Habdank PV-Montagesysteme							●			
49	IBC Solar Group	●	○				○	○			
50	KACO new energy		●								
51	Lti REEnergy		●								
52	M+ W Group	●									
53	Q-Cells	●		○	○						
54	Perfect Energy			●							
56	REC			●							
58	Satcon Technology Corporation		●								
59	Scheuten Solar	○		●							
60	Schneider Electric	●	●								
62	Schott Solar			●	○	○					
63	Sinosol	●									
64	Siemens	○	●			○					
66	SMA Solar Technology		●						○		
67	Solarfun Power			●							
68	Solon	●		○			○				
70	Trina Solar			●							
71	Trust									●	
72	TÜV Rheinland										●
73	Upsolar			●							
74	United Solar Ovonic				●						
75	Solar Integrated	●									
76	Welser Profile						●	○			
77	Würth Solar	●									

Key: ● main business areas ○ further business areas



Turn to AEG Power Solutions for high-value solar power generating products and services



Solar farm

AEG Power Solutions –  
Competence Center Warstein-Belecke



Solar Inverter Protect PV.250

For decades, customers in the most demanding industrial sectors, from oil, gas and petrochemicals to power generation and utilities, have turned to AEG Power Solutions for reliable applications. Now, customers in the field of renewable energy can benefit from the same AEG expertise and quality. The new solar inverter product line launched in 2009 spearheads the AEG Power Solutions expansion into global renewable energy markets.

Building on its proven track record in supplying utilities and grid operators with reliable, fully compliant solutions, the new AEG Power Solutions PV.250 solar inverter provides superior availability and efficiency for utility-size PV megawatt installations. An innovative FPGA circuit ensures the flexible, precise and rapid control needed to meet virtually all national grid standards. For larger installations, a follow-on version, the PV.500, will be available shortly.

In addition to the solar inverter itself, AEG Power Solutions offers a completely integrated solution, the TKS-C 500 container solution, which includes metering and monitoring components as well as communications infrastructure. The single

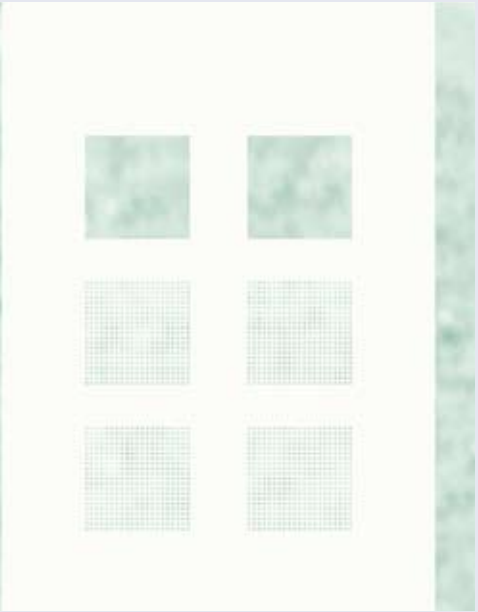
source solution ensures smooth PV power plant operations, in close cooperation with the grid operator.

Designed for utility-scale PV megawatt power plants, the TKS-C 500 solution includes a pair of PV.250 solar inverters along with a medium-voltage transformer and switchgear, plus advanced combiner boxes in the PV array field. The core units are fully integrated via communication and monitoring components to ensure that status updates, essential for the PV plant operator, are always available.

With facilities across Europe, the Middle East, Asia, China and North America, AEG Power Solutions is on hand for collaboration with all potential partners, including EPC, consultants, operators and investors.

Backed by decades of field experience, AEG Power Solutions has built its worldwide service reputation by constantly exceeding customer expectations – throughout product lifespan. AEG Power Solutions service starts right from the beginning. For solar plants, this means customers can rely on AEG for service and support over the entire life cycle of the plant.

SPEED solar sheds light on all your business processes



Customized SAP ERP solutions  
for the solar industry

ai informatics is a provider of complete IT solutions and has been a reliable partner for companies in the manufacturing industry for more than 30 years. ai informatics specializes in guiding customers through all phases of the IT application and infrastructure lifecycle: from design and implementation to application support and operations in the ai informatics data center.

With SPEED solar, ai informatics has brought to market the first qualified SAP business all-in-one solution for the solar industry. This pre-configured and integrated software package is designed to meet the specific requirements of companies in the solar and photovoltaic industry. It can be used anywhere in the world, and is both scalable and future-proof.

SPEED Solar is, however, more than just SAP software that supports your value-added processes. ai informatics can offer SPEED Solar as a highly customized solution for all your specific needs with best practice templates, effective project management, and implementation at a fixed price.

- SPEED Solar can be customized, particularly for the following tasks:
- Variable end products, stochastic production
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To see the full range of our professional services or get in touch with us, visit [www.aiinformatics.com](http://www.aiinformatics.com).

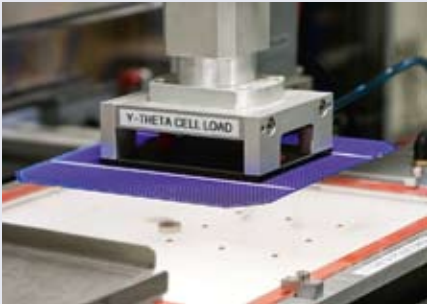
We look forward to talking to you!

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Founded 1975  
150 employees





Premium power from the sun!



Above right: State-of-the art technology  
Below right: Quality control at each step of the production process



10-year product warranty

BISOL, d.o.o.  
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Slovenia  
Phone: +386 (0)3 703 2250  
Fax: +386 (0)3 703 2263  
info@bisol.com  
www.bisol.com  
Founded 2006  
140 employees

**BISOL is an innovative and customer oriented producer of high quality mono- and multicrystalline silicon photovoltaic modules, designed for both commercial and residential applications and suitable for grid connected and stand-alone systems.**

Headquartered in Slovenia, BISOL finds its place predominantly in diverse international markets. The company started a representative office in Belgium and continues to expand its international activities by opening local offices in France and Italy.

BISOL products are a result of intensive research and development efforts, manufactured in a state-of-the-art automated production environment and comply with the principal international standards IEC 61215, Ed.2 and IEC 61730. Components and materials used in production originate from well established suppliers, are pre-certified, tested and meet the highest quality standards. Due to the strict quality control at each step of the production process, BISOL is able to offer its customers a 10-year product warranty.

BISOL photovoltaic modules are known for their long-term electrical stability, and for

delivering an excellent power output and energy yield in low as well as in high irradiation areas. This performance is achieved through a very high shunt resistance, pre-sorting according to  $P_{MPP}$  and  $I_{MPP}$  (leveraging out module mismatch losses), a lowest NOCT of just 44 °C, negligible Yellowing Index of EVA foil, TÜV certified lowest 20-year equivalent degradation of just 0.5 % of the 5 % permitted lowest module capacitance C (for highly repeatable I-V curve and lowest mismatch losses) and whole spectrum highly transparent glass, among other detailed features that demonstrate the professional in-house expertise of BISOL's personnel.

BISOL was one of the first companies worldwide to successfully implement three bus-bar and back-contact solar cells, and is strongly positioned as a glass-glass photovoltaic module manufacturer thanks to its VISTA collection.

BISOL's strategic goal is to support the extremely fast growth of the company, further expand its international activities and to continue to provide the market with a premium quality product that satisfies even the most demanding customers.



New power stations to be built worldwide



Top: Quality control of Bosch Solar Energy thin-film modules at the Erfurt production site.

Bottom: In Erfurt, Germany, 21,898 thin-film solar modules generate about 1,788,000 kWh of "green" electricity per year.

Right: The solar power plant on top of the Bosch parking structure covers the annual energy needs of around 250 four-person households.



**Bosch Solar Energy AG stands for the Solar Energy division of the Bosch Group and, together with its subsidiaries, is a leading provider of silicon-based photovoltaic products with a consistent focus on product quality. From small-scale plants for single-family homes to finished large-scale photovoltaic projects – Bosch Solar Energy offers high-quality solar cells and modules for photovoltaic power generation. With its highly-efficient crystalline and thin-film products, Bosch Solar Energy focuses very deliberately on the sustainable and environmentally friendly form of silicon-based solar power generation.**

At the end of 2009, Bosch Solar Energy commissioned four solar power plants in Germany. One of them is a 955 kWp rooftop photovoltaic plant on the Bosch parking structure at New Trade Fair Centre, Stuttgart, Germany. 4,247 monocrystalline solar modules extending over an area of about 7,000 m<sup>2</sup> generate around 870,000 kWh of "green" electricity per year. This covers the annual energy needs of around 250 four-person households.

The three other power plants, two of them in Thuringia and one in Saxony, have a combined capacity of 8.75 MWp and can generate an output of around 8 million kWh a year. This covers the annual energy need of about 2,200 four-person households.

In 2010, Bosch Solar Energy plans to expand its activities in the PV projects segment on an international level. "Bosch has the international networks required to push photovoltaics ahead around the world. In the long term, we want to make photovoltaics a competitive technology in the energy mix and contribute to protecting the climate", said Peter Schneidewind, Executive Vice President of Sales at Bosch Solar Energy AG. As a full provider of photovoltaic technologies, Bosch Solar Energy contributes its expertise in the production of high-end solar cells and modules. Moreover, the Bosch subsidiary assumes responsibility for the technical side of operations, from planning to turn-key construction of large-scale systems.

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Founded 1997  
Approximately 1,400 employees (Dec. 2009)



Cell production



**EGing Photovoltaic Technology is a globally leading vertically integrated solar PV company. It was founded in 2003 as a manufacturer of silicon ingots and has achieved fast growth since, with its production capacity set to reach 500 MW by the end of 2010 across the complete value chain of ingot, wafer, cell and module.**

In its persistent pursuit of quality and operation excellence, EGing technology and its manufacturing staff are committed to delivering products of outstanding performance. EGing has developed, and will continue to develop, a diversified range of products to provide customers with a broader range of solar energy solutions. EGing has established close partnerships with leading equipment suppliers, R&D institutes, universities and silicon producers to build up strong R&D capabilities that provide advanced technology and expertise for the production of high power and high efficiency solar PV modules.

As a photovoltaic product manufacturer, EGing provides highly efficient and stable performance photovoltaic modules for all types of photovoltaic projects, including ground-mounted systems, roof-mounted systems and BIPV. EGing modules are sold to Germany, Italy, Spain, Czech Republic, Korea and in emerging markets such as Australia and South Africa.

EGing has subsidiaries in Europe and North America, with offices located in Frankfurt and Orange Country, California.

Wafer production



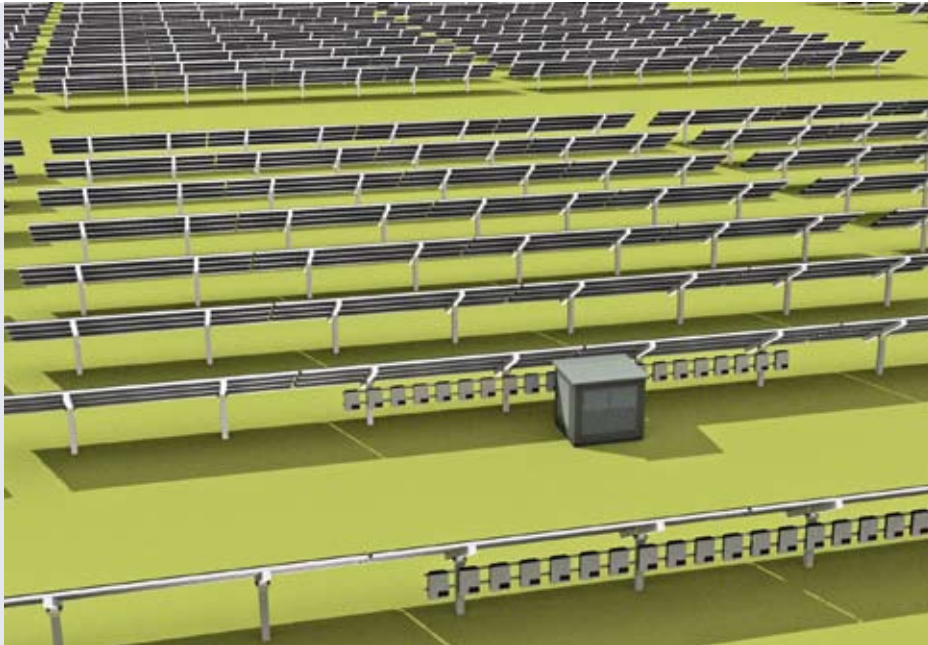
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www.egingpv.com  
Founded 2003  
2008 Sales Revenue: 300 million €  
3,500 employees

## Danfoss Solar Inverters recommends string inverters for PV power plants

The modular nature of a PV plant makes string inverters a perfect element in the system.



The TripleLynx inverter has class leading efficiency, three phase output and 1000V DC input.



**Danfoss Solar Inverters presents the newest advantages in string inverter technology, and recommends string inverters for large PV plants. Using string inverters such as the 98 % efficiency, three phase, 1000V TripleLynx inverter from Danfoss can save costs and provide higher yield.**

### Save 10 % by using TripleLynx

The inherent modular nature of PV modules means that a PV plant of any size is modular. Therefore, it is common sense to look at alternative ways to structure a PV plant than conventional ones. By using the inverter as a modular element in the plant, the built-in functionalities of the inverter can take over many of the additional functions that are needed when choosing a central inverter station. By using inverters that can handle 1000 V input, junction boxes and distribution boxes can be omitted, as the DC cables are laid directly from the string of modules to the inverter. Installations can be realised at a cost which is 10 % lower than installations based on central inverters.

### Increase yield

In addition to the cost savings, higher energy yields can be reached due to lower

cable losses without extra cabling efforts. To achieve the best value for money solution, up to 1 % yield losses in the DC cabling of PV plants are generally accepted. Using string inverters, 0.3 % DC cabling yield losses and 0.1 % AC cabling yield losses are achievable at the same cost. Individual MPP tracking for every string, which is a major advantage of string inverters, enables maximum energy yield per string. If the rows of modules per PV substructure are connected to their own MPP tracker, the risks of losses due to shading are greatly reduced.

### Additional benefits

String inverters have the benefit of being a commercially available standard component. This enables a local installer or plant supervisor with no special training to carry out an inverter exchange if required. Therefore, the service contracts required with central inverters are not necessary for string inverters.

### More information

Further information on the benefits of string inverters in power plants is found on our dedicated website. Here you can also download a concept paper and a film on the subject: [www.stringinverters.com](http://www.stringinverters.com)

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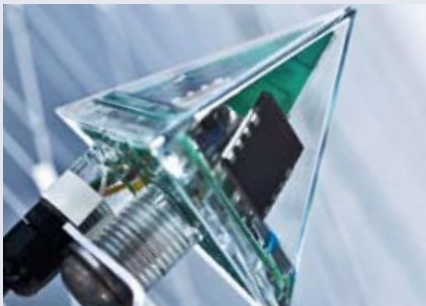


Intelligence increases energy yield



With its solar tracking modules on the roof, DEGERenergie's headquarters building produces about 300 percent more energy than it needs.

Solar park in Spain: up to 46 percent increase in energy yield using DEGERenergie tracking systems.



The patented DEGERconector control module was awarded the Invention Award of the German state of Baden-Württemberg in 2001.

About ten years ago, Artur Deger founded his company DEGERenergie. Today, DEGERenergie is the world market leader in the field of tracking systems for solar units, because Artur Deger's intelligent technology increases the energy yield of photovoltaic plants by up to 46 percent.

The idea is as simple as it is ingenious: Photovoltaic modules that are always aligned to the position of the sun will yield more energy than rigidly installed modules. So why not develop a system that allows solar modules to automatically follow the course of the sun? Today, DEGERenergie has more than 30,000 of its systems installed in 38 countries. The reason for this is simple: DEGERtrakers increase energy yield by up to 46 percent. One crucial step on the road to attaining the world's top position was the invention and patenting of the DEGERconector control module. The core of the intelligent control module was awarded the Invention Award of the German state of Baden-Württemberg in 2001. The DEGERconector constantly measures the intensity and angle of incidental light beams and aligns the connected solar module accordingly. In doing so, it not only

takes into consideration the radiation of the sun, but also the light that is reflected by snow, for instance, or diffuse radiation that permeates clouds. This enables the solar module to always absorb the highest possible amount of energy. Artur Deger, DEGERenergie's CEO: "Solar energy systems that track using the DEGERconector sensor module therefore achieve the fastest 'Return on Investment'. They attain at the highest yields worldwide and offer the most economical cost-benefit ratio." His statement is based on many years of experience and yield comparisons in collaboration with many of his company's customers in widely diverse regions around the globe. The most commonly installed DEGERenergie systems are the DEGERtraker 5000NT and DEGERtraker 7000NT – dual-axis tracking systems for professional power generation. Among others, the Spanish companies AS Solar and Picanda Solar operate solar parks using these DEGERtraker systems. In Germany, both the operators Consolaris, which runs a one-megawatt park near Edertal, and Solarworld, with two 1.5 megawatt parks in Bavaria, rely on DEGERenergie's 7000NT models.

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340 at suppliers of DEGERenergie

Tradition & Innovation – Economical solutions for long term operations



Above: Flexible – the PLATINUM TL large is equipped with 3 MPP trackers that work independently.

Right: Diehl AKO Stiftung & Co. KG, headquarters and manufacturing plant for PLATINUM inverters.



Diehl AKO, an enterprise of the Diehl group, is a producer of PLATINUM-Photovoltaic products. In addition to transformer and transformerless inverters, Diehl AKO offers monitoring, remote control systems and a Solar Portal.

Diehl AKO, an enterprise of the Diehl group, sets standards for the development of innovative photovoltaic products by means

of innovation and high-tech production in Germany. A tradition stretching back over more than one hundred years coupled with the safety of a production volume of over 20,000 electronics a day in Germany alone form the basis for outstanding inverter technology at the highest level of proficiency (conversion efficiency 98 percent; photon test 02/09: excellent A+).

Manufacturing technology using an unprecedented six-step test technique guarantees the highest quality and reliability that makes Diehl AKO your reliable long-term partner on the photovoltaics market. Thus, the guarantee for all PLATINUM inverters can be extended for 20 years beyond the 5 year warranty. All PLATINUM inverters bear the mark "Made in Germany", have CE conformity and comply with the respective standards.

PLATINUM inverters are distributed by Matrix Power Systems GmbH, the sales organization of Diehl AKO, which was founded in order to effectively meet the special requirements of the photovoltaics market.

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AKO founded 1945, Diehl AKO since 1994  
2,700 employees worldwide



Your partner for turnkey solar systems



Left: Solar power plant, Moorenweis, Bavaria  
Below: The future of solar energy



Solar power plant, Froschham, Bavaria

**Ecostream is the specialist in the integrated implementation of highly-efficient photovoltaic solutions for companies, investors and project developers. The company's portfolio includes turnkey rooftop installations as well as large free-standing parks and rooftop lease agreements. We take care of all the steps which are required for a successful project:**

- Land purchase
- Project management and advisory services
- Site development
- Feasibility study and financing
- Facility planning and installation
- Maintenance and service

**Our thinking knows no boundaries**  
With more than 20 years of experience in the photovoltaic industry, a specialist team and well-developed partner network, Ecostream will act as the general contractor to ensure a smooth process – from site development and legal frameworks to the start-up of the facility.

In 2007, Ecostream built one of Europe's largest free-standing facilities in Murcia, Spain (more than 12 MW). In Germany, Ecostream has implemented the following free-standing projects: Heretsried (2 MW), Moorenweis (6 MW), Froschham (4 MW) and Vilgertshofen (4 MW). As a manufacturer-independent system provider, we use quality and optimally aligned components to ensure efficient operations and the success of your plant.

**Request: Land wanted for lease**  
If you own suitable land, you have an opportunity to lease it to us at attractive terms. We are looking for EEG-suitable land, starting at a size of 40,000 m<sup>2</sup>, which can be leased for a period of 20 years for the purpose of constructing and operating photovoltaic facilities. A corresponding land use plan, master plan or a building permit for the land should be in force or pending. We can offer a lucrative lease for a minimum term of 20 years.

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Active in Germany since 1999  
38 employees

Santerno: Qualified customer service and excellent products



Above: The new transformerless Sunway MXS for residential environments. It is available in 4 colours – red, blue, white, black.

Left: The photovoltaic plant in Fuente Alamo, Spain: 26 MW installed with Santerno inverters (160 Sunways TG 145 and 32 Sunways TG 385).



Elettronica Santerno's Headquarters in Imola, Italy

**"Since 1983, we have been supporting our customers and the highest-status design agencies and architectural offices during the design, planning and installation of photovoltaic plants, including monitoring, control and maintenance."**

In 1994, we installed our inverters in the 3 MWp photovoltaic plant station in Serre near Salerno, Campania, which is one of the sunniest regions in Europe. The power station in Serre was the largest in the world for 4 years. Since then, we have become the leading manufacturer of solar inverters in Italy in terms of MW installed.

Since 2006, Santerno has been part of the Carraro Group, an international leading company in the manufacture of power transmission systems.

Today Santerno has direct branches in Brazil, Russia, Spain and the United States and has commercial offices in Germany, India and China. Our customers' installations worldwide are serviced by highly qualified technicians.

Our growing investment in ever more advanced remote monitoring systems ensures optimum safety, reliability, accuracy and prompt service, thus reducing costs for maximum return on investment.

Control standards, quality assurance and a widespread network of qualified after-sales centers allow Santerno to offer contracts for extended guarantees and production reliability of up to 20 years.

We offer a complete range of solar inverters with power ratings from 2 kWp to 770 kWp. Our solar inverters are all compliant with the technical regulations and the standards in force worldwide: They all meet the strict LVRT (Low Voltage Ride Through) requirements as well as the control requirements of SMART grids.

Our Sunway Stations, ranging from 620 kWp to 1540 kWp, have shown to be very simple and quick to install and ensure optimum benefits in terms of performance, reliability and O&M promptness.

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Founded 1970  
Approximately 150 employees



Utility scale photovoltaic inverters to 1,760 kWp



Control Techniques' 12,000 square meter inverter manufacturing facility



Control Techniques 880 kWp SPV inverter

10 mission critical reasons for selecting Control Techniques

**1. The resources to deliver on our promises**  
Control Techniques is a part of Emerson, a Fortune 500 company with outstanding bankability in the eyes of the financial community.

**2. Designed for long life**  
Control Techniques uses standard mass produced inverter modules that are used in both industrial and PV applications. The modules are based on a mature design that is proven to be robust.

**3. Higher efficiency, more of the time**  
Control Techniques PV Inverters are efficient, and because of our unique modular inverter solution, we switch on sooner and off later, efficiently generating more energy with lower irradiance levels than single inverter solutions.

**4. Energized to meet your deadlines**  
Control Techniques understands the time pressures associated with PV plant installations; our project management teams work tirelessly to ensure you meet your start up deadlines.

**5. Tolerant to faults**  
Control Techniques inverters are fault tolerant: In the event that an inverter module trips, the inactive module is isolated so that the system can continue generating. System redundancy can also be specified for critical applications.

**6. Wherever you are, so are we**  
Control Techniques employs more than 1,500 people, the majority of whom are located within engineering centers around the World, focussed on project engineering and support for our energy conversion products.

**7. As much or as little as you need**  
Control Techniques can provide as much or as little of the PV inverter system as you need, from a single Inverter to a complete solution incorporating string connection boxes, transformer, shelter, medium voltage switch and SCADA .

**8. Complete peace of mind**  
Extended warranties and service contracts for up to 20 years are available to ensure the highest energy yield is maintained over the lifetime of the plant.

**9. Ready for PV industry growth**  
Control Techniques is geared up to mass-produce standard modules with high availability to support the growth of the PV industry.

**10. In service around the world**  
Control Techniques systems are already installed in over 30 large scale PV power plants around the world.

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Sunny prospects



Solar installation on the roof of EnBW logistics center

Solar park in Leibertingen



**Energy in abundance: The sun is the biggest source of energy on earth. It supplies more light and warmth than the human race could ever need. EnBW has been involved in the field of solar energy for a long time and supports its development.**

The sun gives life, lets plants grow and fruit ripen. It supplies light and warmth which can be converted into electricity. Photovoltaics use the photosynthesis effect of light and convert the rays of the sun directly into electrical current. The solar-thermal production of electricity works differently: It pools the radiation heat in solar collectors in order to heat water. The water steam turns turbines which produce electricity in a conventional way. However, the heat can also be used directly for providing warm water in households.

The dependence of solar energy on the number of hours of sunshine makes it difficult to calculate. This is why our reserves are combined with other production technologies in order to guarantee a continuous supply of electricity.

EnBW constructed its first photovoltaic system in 1984. The company operates 35 plants in Baden-Württemberg and will continue to invest even more in profitable systems. Within the "Solar BürgerAktiv" program, EnBW has been supporting the financing and construction of roof systems and solar parks together with local authorities since 2003. The number has risen considerably in the past years.

EnBW's first large solar park in Leibertingen (county of Sigmaringen) on a site measuring 7.3 ha supplies around 2.1 MW of electricity each year. This allows around 800 households to be supplied with electricity and 1,200 tonnes of CO<sub>2</sub> to be saved.

**EnBW – harvesting sunlight:**

- EnBW operates 35 photovoltaic systems with a total output of 3.4 MW.
- The largest solar park in Leibertingen has an overall output of around 2.1 MW.
- More than 16,000 private and local authority operated photovoltaic systems are connected to the EnBW network in Baden-Württemberg.

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Founded 2009  
100 employees





Focus on EXOSUN's solar solutions  
for a high performance investment guaranteed 20 years

Montesquieu solar plant – the first photovoltaic plant in France equipped with trackers. Engineering and construction by EXOSUN.

EXOTRACK 2-axis before grid-connection. Designed, developed and installed by EXOSUN.



Gabardan solar park under construction – 2 MWp equipped with trackers. Engineering and construction by EXOSUN.

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Founded 2007  
60 employees



Exosun delivers large scale ground-mounted photovoltaic power plants equipped with its patented solar trackers. From system design and engineering through to construction, Exosun controls the entire building process of its power plants. Highly competitive in terms of price, quality, and yield, Exosun offers all the technical and environmental qualities necessary to create the best solutions for large scale solar projects.

Exosun's mission: Lower the cost of the solar kilowatt with a technologically superior product. "EXOTRACK" – Exosun's patented range of solar trackers – allow photovoltaic panels to follow the course of the sun to generate up to 40 percent more energy than a fixed-tilt system. The 2-axis and 1-axis trackers are designed to respect the biotope, and with their low height they have the feature of blending in with their environment. Also designed for minimal ground occupation, EXOTRACKs have a high performance ratio per hectare and are equipped with a backtracking program for shadow correction. Exosun's solar plants are guaranteed a high ROI, rapid installation, up to 99 percent system availability and a life expectancy beyond 20 years.

A pioneer in France for solar trackers, Exosun designed, developed and built the first power plant equipped with this innovative solar technology. Located in the South West of France, next to Exosun's headquarters, the Montesquieu Solar Plant showed a record production of 1584 kWh/kWp. Also located in the South West of France is the Gabardan solar park, the biggest photovoltaic project in Europe, for which Exosun supplied the first section of 2 MW equipped with 2-axis trackers (November 2009). Strongly involved in R&D for concentrated photovoltaics, Exosun is part of many experimental projects. One of the completed projects, CENSOL PV, located in the Pyrénées Orientales, is a pilot for low CPV using the 2-axis EXOTRACK. The construction of a project which focuses on high CPV is scheduled for the end of 2010. Founded in June 2007 by Frédéric Conchy, Jean-Noël de Charentenay, and Dominique Rochier, Exosun is today 60 employees strong and already has a foot in the American and Persian Gulf markets. With four solar plants under its belt, as well as hundreds of MW's worth of projects underway in France and abroad, Exosun is well on its way to achieving its objective of installed capacity for 2010 and beyond.



Sustainable power on a global scale



Above: Phoenix Solar's 5.6 MW solar plant in Hasborn, Germany powered by First Solar modules

Above right: Worker producing modules in First Solar's state-of-the-art manufacturing facility, Frankfurt (Oder), Germany

Below right: First Solar's Frankfurt (Oder) solar module recycling facility



First Solar, Inc. is a world leader in the manufacture of photovoltaic (PV) solar modules focused on creating value-driven, renewable energy solutions that protect and enhance the environment. In addition to global module sales, First Solar also offers a complete range of system development services for the North American market.

Solar installations using First Solar's thin film CdTe modules have higher annual energy yields and performance ratios than traditional crystalline silicon systems. This is because they work more efficiently in low, indirect, and diffuse light conditions and have less temperature-related loss due to a lower temperature coefficient. These two advantages allow First Solar systems to produce more energy than competing systems with the same power rating.

First Solar also offers fully-integrated solar plant system services providing project development, engineering, procurement, and construction (EPC), operations and maintenance (O&M), and project financing. Project development involves overseeing processes such as site evaluation and permitting. EPC facilitates solar plant design and engineering, procuring materials, and

construction. O&M covers such system services as equipment, compliance issues, monitoring, and day-to-day operations. Project financing, when needed, is available globally.

First Solar systems span the globe, ranging from a few megawatts (MW) to multiple gigawatts (GW). In 2009, First Solar continued to expand its reach by signing 1.5 GW (AC) of power purchase agreements worldwide and building 50 MW of utility scale projects in North America. In collaboration with juwi Solar, First Solar celebrated the commissioning of the 53 MW Lieberose solar plant built on former military training grounds in Turnow, Germany. In Asia, First Solar entered China with a memorandum of understanding for a 2 GW solar plant in Ordos City.

First Solar's systems operate with no water, air emissions, or waste stream. On a life cycle basis, they boast the smallest carbon footprint and the fastest energy payback time of any PV technology. In addition, First Solar has set the benchmark for product life cycle management with the industry's first prefunded, comprehensive collection and recycling program for solar modules.

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Founded 1999  
Over 4,500 employees





High-quality inverters for grid-connected solar power systems

Left: Fronius CL – the identical power modules create a redundant system. A well-thought out concept for high reliability.

Right: Fronius IG Plus 150 – three phases in a device for mega-systems with a power output of 12 kW.



Front view of the logistics and production center at Sattledt, Austria.



Since 1992, Fronius International GmbH has been developing and producing inverters for grid-connected solar power systems from 1 kW to 60 kW and components for professional system monitoring. High standards for research & development and consistent quality management guarantee high performance and reliability for all devices. Fronius also offers reliability of supply, product warranties from 5 to 20 years, and professional support. Fronius International GmbH is headquartered in Austria, and is represented in all major photovoltaic markets by sales and service subsidiaries.

Central inverter with Fronius MIX™ concept: Fronius CL

For solar power plants of up to several hundred kilowatts, Fronius offers the Fronius CL: An inverter series with a power of 36 kW to 60 kW that combines high-yield power electronics with a unique system design of up to 15 identical power modules with the MIX™ concept. The advantages of the modular design are maximum earnings in the partial load range, high reliability, longer lifetime, easy service, and thus investment security for the operator.

Alternative to a large inverter: Fronius IG Plus

The Fronius IG Plus provides an alternative to central inverters for large PV systems. The devices are suitable for installations in which inverters are placed separately near the solar modules (e.g., on a mounting bracket or a building wall) or near the grid connection point. The Fronius IG Plus also works with the MIX™ concept, which means that several power modules share the work here too according to their operating hours. The inverter therefore stays in operation and ensures earnings even if a power module is defective.

Extensive service network

Fronius has its own technical support service available in six languages.

System monitoring – Fronius DATCOM

Professional system monitoring is becoming increasingly indispensable for larger solar systems. With the Fronius DATCOM system, complete system monitoring can be set up: from comprehensive data recording and analysis to data display and remote monitoring.

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Founded 1945  
Turnover 370 million €  
More than 2,600 employees (2008)



gehrtec NUBBEL – The professional cable feeder for PV systems enables fast, convenient and effective DC cabling.

gehrtec BASE-FS is a substructure for free-standing installation.



Our headquarters in Munich



As an international system integrator, Gehrlicher Solar plans, constructs, finances and maintains PV plants in Europe and the USA.

Our Head Office is based in Dornach near Munich. We also have branch offices in Neustadt near Coburg, Spain, Italy, Greece, France, the USA, the Czech Republic and Slovakia. Currently, over 200 employees worldwide work for the Gehrlicher Group. Our strengths lie in designing, constructing and maintaining PV systems – from rooftops to multi-megawatt power plants – everything from one source.

As a wholesaler we offer solar modules and inverters from leading manufacturers as well as our own gehrtec-products (from mounting systems to cabling), which have become an inherent part of numerous PV installations – also of those from other market participants. The Gehrlicher Group is consequently optimizing existing photovoltaic developments. Thanks to comprehensive expertise, innovative ideas, the use of carefully selected materials and constant quality control, gehrtec products meet the highest standards and are proven to have an above-average service life.

Thanks to existing contacts with leading manufacturers, we are constantly extending our product portfolio with new, innovative developments. In the thin-film technology market in particular, which is experiencing above average growth, we are always close to the market as a “first mover” owing to the experience we gain with our technology test field (PV-Enlargement – Munich Fair), which is unique in Europe.

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Founded 1994  
More than 200 employees



Complete solutions for ground-mounted PV-systems



Project in Almeria, Spain

System FA, cost/time-efficient. The professional solution for ground-mounted PV-systems



Over 350 MWp planned, produced and mounted

With expertise from over 80 years of experience in steel and metal construction, HABDANK has been very successfully developing and selling patented mounting systems for photovoltaic power plants for ground-mounted operation since 2004.

Under the brand pv-mounting systems, the company from Göppingen, operating since 2009 under the name of HABDANK PV-Montagesysteme GmbH & Co. KG, has planned, produced and mounted systems with an output of over 350 MWp.

HABDANK combines all processes, from the planning and production of system components to the installation of mounting systems on site, all from one source. Your advantage: The highest level of expertise, planning reliability and cost-effectiveness.

Based on project-related planning, HABDANK produces module-independent PV mounting systems for outdoor power plants and undertakes their installation, from the establishment of foundations, (by means of driving and drilling, if necessary) to the insertion of the modules.

HABDANK works to schedule and in an economic way, even on the most problematic of foundations (with regard to soil properties and gradient).

Experiences gained in implementing various large-scale projects are the basis for the constant improvement of our range of products and services and the development of innovations. Furthermore, constant dialogue with customers and external experts provides HABDANK with valuable insights. To better understand the specific static loads of a photovoltaic large-scale system, for example, HABDANK exchanged experiences with a highly renowned engineering firm and together performed a wind tunnel trial to test the design against wind loads.

HABDANK consistently integrates the results from this trial into the further development of new system components and thereby further optimizes the static load bearing capacity of the PV mounting systems.

Habdank pv-mounting systems – for solid solutions.

Sunny outlook for your photovoltaic business

At the “Neue Messe Stuttgart” trade fair center, IBC SOLAR installed one of the largest solar roof systems in the world.

Long-term tests on IBC SOLAR’s own test plant.



IBC SOLAR Flasher – A flash aimed at the module simulates solar irradiation

**IBC SOLAR stands for 28 years of PV expertise. Based in Bad Staffelstein (Germany), the company has years of experience in international markets. As a global player, the company is represented by affiliates in the Netherlands, France, Italy, Spain, Greece, Malaysia and the United States as well as by a branch in Prague.**

Since the physicist Udo Möhrstedt founded the company in 1982, IBC SOLAR has realized more than 100,000 PV systems with a total capacity of over 800 megawatts. The scope of these systems ranges from large photovoltaic power stations and solar farms feeding power into the grid to systems designed for off-grid power supply. They are used for supplying electricity to private residences as well as to hospitals in Africa, schools in Southeast Asia, radio towers in South America, or the oil rigs of major energy corporations. Today, IBC SOLAR employs a staff numbering over 300, most of whom are based in Germany.

The IBC SOLAR sales system is based on two pillars. The company supplies its customers with modules, inverters and other PV component parts produced by established manufacturers. In addition to the

trading business, IBC SOLAR implements turnkey large-scale projects all over Europe, from the concept phase through to the connection to the public grid. These large-scale projects include planning and realization, extensive advisory services comprising consulting for funding and finance as well as subsequent monitoring of the systems and after sales support.

In order to guarantee the highest quality standards, IBC SOLAR obtains all system components from reputable manufacturers and defines strict product guidelines. Test and quality controls are not only pre-specified, but also audited by IBC SOLAR engineers in the factories of the suppliers. Using an in-house flash test, the company’s experts continuously inspect the nominal output of the modules. Similarly, a climatic chamber allows the life cycle of modules and component parts to be examined in long-term tests (damp heat test).

Additionally, IBC SOLAR permanently tests its components on a 3,000 m² test plant. Using this test equipment, IBC SOLAR is able to ensure that all component parts stand up to the promises of the manufacturers.

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Founded 1982  
Consolidated turnover 2008: 800 million €  
Approximately 300 employees worldwide



**Reliable and efficient inverters for solar parks and the world of renewable energies**

Right: The new KACO headquarters also house the state-of-the-art manufacturing plant for central inverters.

Below: KACO also offers central inverters from 25 to 33 kW. The 986 kW plant in Sanarica, Italy, is equipped with the Powador 33000xi.



The Powador XP350-HV TL: A trio of them is available as a ready-to-use megawatt station.

**KACO new energy is at home in the world of renewable energies. KACO's innovations range from inverters for block heating stations, fuel cells and concentrator modules to solar water treatment systems and systems for supplying power to electric vehicles. KACO is one of the world's largest manufacturers of solar inverters – from string inverters for single family homes to central inverters for solar parks. The central inverters of the Powador XP series were designed especially for use in large megawatt systems.**

The Powador XP100-HV and the Powador XP350-HV TL are highly efficient and reliable. They guarantee the kinds of high returns that investors expect. Our unique power electronics control increases the switching efficiency of the power transistors: Depending on the input power, one of several pulse-width modulation methods is used. The internal power supply and the cooling system are designed redundantly. In the case of a failure, a second system takes over. The error tracing function reports errors immediately and sends diagrams that allow the operator to locate the problem quickly. In addition to the three-year warranty, custom main-

tenance contracts offer further guarantee. The inverters are designed to generate a maximum of 110 kW and 385 kW, respectively. For the Powador XP100-HV, the MPP range spans from 450 to 800 volts. For the Powador XP350-HV TL this range is extended to 830 volts. The maximum input voltage is 950 or 1,000 volts, respectively and the maximum input current is 235 or 856 amperes, respectively. The Powador XP100-HV comes with a transformer and is ready for immediate use. The Powador XP350-HV TL is delivered without a transformer; it can be chosen on a project-by-project basis, allowing for maximum flexibility in system planning. Devices for different power classes are currently being developed. KACO also offers a ready-to-use megawatt station, which consists of three Powador XP350-HV TL units encased in a concrete structure and includes a medium voltage transformer. The Powador XP series is predestined for international use. The convenient touch screen allows the user to select preset country-specific grid parameters which can easily be adjusted to new standards, for example, thanks to the digital control. Because KACO new energy is at home all over the world.

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info@kaco-newenergy.de  
www.kaco-newenergy.de  
Founded 1998 / 99  
More than 400 employees

**The best possible plant efficiency – with PVmaster inverters from LTi**

Reference – The PV park in Veitsbronn, Germany, delivering 761 kWp

The PVmaster series of large-scale inverters is available in the 33 kW to 1 MW power range and various topologies.



Reference – The Solarpark Radelstetten at the Swabian Alb delivering 1.1 MWp is built on a former ammunition depot of the German Federal Armed Forces.

**For over ten years, renewable energies have been an established area of focus at LTi REEnergy GmbH. Based in Unna, Germany, the company is part of the LTi Group and develops components and systems for the photovoltaics, biomass, and wind power sectors.**

Obtaining the best possible efficiency for your PV park lies close to our heart: Our PVmaster series of large-scale inverters for large and medium sized PV installations provides the basis for the efficient conversion of generator power. In addition, you can utilize our expertise to optimize your plant efficiency. Simply contact our engineers at our branches in Europe, India, China, and the USA.

The PVmaster large-scale inverter is available for ac power outputs ranging from 33 kW to 1 MW and is compatible with all the usual crystalline and thin film modules. At your request we can deliver your PVmaster as an indoor or outdoor variant: As either a robust enclosure or ready assembled PVmaster station including low and medium voltage switchgear. Depending on the module type and environment, we can recommend the most efficient

topology for your PV installation, in constant pursuit of our objective to obtain the best possible overall efficiency. Via our web portal [www.pvmaster.de](http://www.pvmaster.de) you can comfortably view both the current and archived performance and yield curves for your PV park from anywhere in the world. In addition, our optional services range from extended service agreements to full plant monitoring, i.e. an all inclusive package for the entire lifecycle of your PV park.

Our experience has been drawn from many megawatt projects in Europe. Our customers appreciate not only the reliable and efficient PVmaster, but above all the expertise of our engineers and our expert supervision of all project phases.

With nearly forty years of experience, the globally operating LTi Group ranks among the pioneers of electrical inverter technology. This medium sized family enterprise develops and manufactures products for its three core competences of renewable energies, drive technology, and microsystems technology/electronics/sensor systems. Its inverter solutions based on quality technologies have placed the LTi Group in a leading role within selected segments.

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Fax: +49 (0)2303 779-397  
pvmaster@lt-i.com  
www.lt-i.com  
Founded 1971 (LTi Group)  
Turnover 170 million € (2008, LTi Group)  
1,000 employees (2008, LTi Group)



Large scale PV free standing installations



Large scale PV industrial roof top installation

**The M+W Group offers overall life cycle services for high-tech production plants and infrastructural facilities, including complementary services and modernization engineering worldwide. The client base includes leading enterprises in the fields of electronics, photovoltaics, pharmaceuticals and chemicals industries, automotive and information technology as well as research institutions and universities.**

**Our services for turn-key large scale PV power plants**

The average demand for energy generation per person is increasing, with a corresponding increase in the use of solar energy with photovoltaics. M+W Group offers consulting, design, construction, project management and operation for turn-key large scale PV power plants worldwide. Our scope of services covers the planning, technical setup and operation for turn-key large scale PV power plants with c-Si or thin film technology.

**Planning and realization of turn-key large scale PV Power plants**

Short project times and quality together with maximum deadline and budget compliance are our watchwords for you. We design and construct turn-key, cost-efficient large scale PV power plants for you.

As a globally established company, we are able to support you anywhere in the world with our extensive range of services and our long-term experience:

- Superior project management skills for large scale PV power plants
- Single point responsibility
- Global sourcing and component selection
- Optimization of technical and economical selection
- Total project life cycle management

Working together with M+W Group gives you the maximum possible security of having a strong and reliable partner who offers you future-oriented solutions.

M+W Group  
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Fax: +49 (0)711 8804-1393  
pvinfo@mwgroup.net  
www.mwgroup.net  
Founded 1912  
Turnover 1,74 billion €  
4,500 employees

**SOLAR POWER PLANTS FROM THE EXPERTS**  
**Reliable and quick to build – with high-quality components**



Above: Large, highly efficient solar plants – planned and constructed within a few months.

Above right: Q-Cells – the systems specialists with high engineering excellence

Below right: After grid connection, operation & maintenance services are provided



**Q-Cells offers its partners throughout the world a full range of services from project development and financing to the building and operation of large-scale photovoltaic arrays. By both working with well-known component manufacturers and supplying internally produced solar cells, Q-Cells' clients are assured quality, reliability and fast delivery throughout the whole value creation process. The company has branches in Berlin, Rome, Lyon, Madrid and San Francisco. And it has also launched a number of joint ventures with prestigious partners. Q-Cells – an integrated photovoltaic company – is one of the leading producers of solar cells and thin-film panels and is the largest system integrator worldwide\*.**

Q-Cells is working to harness the shared vision of permanently reducing the costs of photovoltaics and building up solar power as the energy source of the future. Among those to profit will be Q-Cells' partners, who are now being offered increasingly attractive opportunities to enter the world of power generation through photovoltaics.

Q-Cells offers its services in all phases of power plant projects. Regardless of whether municipal, institutional or private investors are involved, by choosing Q-Cells clients benefit from one-stop solutions and enjoy the full reliability and efficiency resulting from its technical and commercial expertise.

Reliable, risk-free yields and durability are ensured by the use of quality, multi-system products designed to coordinate with one another, some of which are produced at Q-Cells' own facilities. Standardized components make for efficiency and minimize the costs of large arrays, which explains the above-average financial performance of Q-Cells projects.

Q-Cells also offers full servicing and maintenance contracts throughout the entire service life of PV systems. By doing so, Q-Cells' partners can be confident of complete support and look forward to optimum returns.

\*Source: PV Systems Integrators – An Analysis of the Competitive Environment, 2009 Edition

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q-cells@q-cells.com  
www.q-cells.com  
Founded 1999  
Turnover 550.3 million € (Sep. 2009)  
2,700 employees (Sep. 2009)



Always Striving for Absolute Perfection



1.2 MWp solar park in Kallmünz with PerfectEnergy modules.

Through the exceptionally high quality of its solar cells and modules, PerfectEnergy demonstrates its pursuit of absolute perfection. The company's products not only meet various international standards, they go far beyond them; because for the company, perfect energy does not just mean to provide green energy, but also optimum energy yield from photovoltaic installations. PerfectEnergy's product portfolio comprises both monocrystalline and polycrystalline modules, as well as complete system solutions.

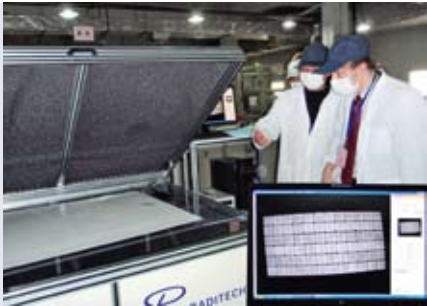
PerfectEnergy produces the solar cells for its modules in-house. Specific quality tests are integrated into both, solar cell and module production lines, such as resistance tests for wafers or electroluminescence tests for strings prior to lamination. The modules are certified according to safety class II and have passed the higher TÜV-Rheinland load tests under pressure and suction load of 5400 Pa. The EVA gel content test, for example, establishes how well the individual laminate layers of the module are cross-linked, thereby providing an indication of the production quality.

PerfectEnergy modules attained excellent, extraordinarily consistent results in a test conducted by the Photovoltaik-Institut Berlin. Furthermore, all solar modules are manufactured in strict accordance with IEC 61215, TÜV safety class II, IEC 61730 and UL 1703.

PerfectEnergy's ability to offer high-quality products at a reasonable price lies in effective, independent production methods and in appliances developed within the company. The high level of customer orientation and international involvement of the company result in the constant progression of independent research and development, executed by an in-house expert team with excellent connections to pertinent scientific institutions in China and abroad. Technical support and customer service also contribute to lasting product quality and customer satisfaction.

PerfectEnergy insures every individual module. The company has therefore taken out both a product quality guarantee and product liability insurance policy with Alltrust Insurance Brokers & Consultants Co. Ltd, Shanghai.

The electroluminescence check detects cell micro cracks, which are not visible to the naked eye.



The Company

PerfectEnergy (Shanghai) Co., Ltd develops and produces solar cells and modules. The company was founded in 2005 by Jack Li, who is also the president of the public holding company PerfectEnergy International, listed on the OTCBB under the symbol of PFGY.

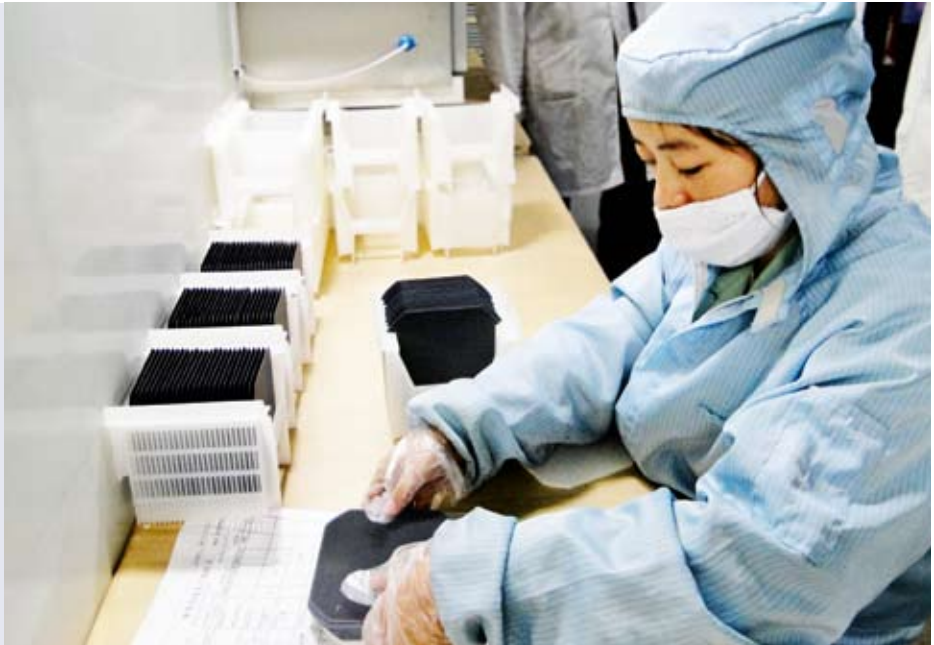


PerfectEnergy GmbH, based in Sankt Augustin near Cologne, Germany, is responsible for the sale of modules, technical support, customer service and warehousing in Europe. This subsidiary of PerfectEnergy International was founded in September 2007 by Margaret Xiaochun Haas, who is also the Vice General Manager of PerfectEnergy (Shanghai) Co., Ltd.

PerfectEnergy has provided several PV power plants with its modules, not only in Germany but also in Italy, France, Switzerland, Belgium, Slovenia and other European countries. Today, the company has over 300 employees and manufactures solar cells with a total output of 45 MW and modules with a total output of 60 MW each year. By the end of 2010, the total module output will stand at 100 MW.

Margaret Xiaochun Haas is the founder and director of PerfectEnergy GmbH.

Each wafer is checked carefully before going to the cell production.



Product Range

Solar Cells:

- Mono-crystalline 5" cells, diameter 150 mm, thickness 220 µm
- Mono-crystalline 5" small-corner-cells, diameter 165 mm, thickness 220 µm

Solar Modules:

- PEM-160/X-72M (72 mono crystalline cells, power output from 145 W to 180 W)
- PEM-180/X-72M SCC (72 mono crystalline small-corner-cells, power output from 180 W to 200 W)
- PEM-230/X-96M (96 mono crystalline cells, power output from 220 W to 240 W)
- PEM-230/X-60P (60 poly crystalline cells, power output from 210 to 230 W)

PerfectEnergy provides a five year product quality warranty, a ten year warranty for 90 % of the minimum rated power and a 25 year warranty for 80 % of the minimum rated power.





SMART ENERGY FOR A CLEANER FUTURE – POWERED BY REC



Above: Production of high-performance modules in accordance with strict quality standards

Right: Large PV power plant in Germany

Below: Silicon production in Moses Lake



**In a time when the world is eagerly seeking clean and renewable power sources, solar has emerged as a solution with tremendous opportunities worldwide. With uncompromising focus on quality, lowering costs and increasing efficiencies, REC is leading the way forward. By prioritizing research and development, quality, and strict adherence to environmental standards, we own every step in the value chain to ensure the products we create deliver sustainable value.**



REC - A GROWTH HISTORY

The company is one of the world's largest producers of silicon (REC Silicon) and wafers (REC Wafer) for solar applications, and of the fastest growing producers of solar cells and polycrystalline PV-panels (REC Solar). REC is also engaging in project development activities in selected segments of the market. Throughout REC there is continuous focus on technological innovation, lean production and universal reduction of unit costs. A major achievement in our commitment to reducing cost by innovation is REC's proprietary deposition technology – FBR. This technology will produce solar grade silicon at significantly lower cost than the traditional Siemens process. The energy savings in the silicon refining process will be up to 80-90 percent. REC is now in the final stages of implementing the FBR technology at our Moses Lake plant in Washington, USA.

REC Solar Germany is working with a international network of professional partners.

Silicon rods from REC Silicon



All cells are carefully checked

**REC Solar Germany's Partners**

Germany:

- EWES
- NEWI-SOLAR
- MHHsolartechnik
- soleg
- Wagner & Co

Czech Republic:

- ETL
- soleg

Austria:

- ENERGIEBIG

Switzerland:

- REC Solar AG

Headquartered in Oslo, Norway, our production facilities include the silicon materials plants in Moses Lake, Washington and Butte, Montana in the USA. The wafer production sites are located in Glomfjord and Herøya, both in Norway. Cells production is in Narvik, Norway and solar modules are produced at a manufacturing plant in Glava, Sweden. A new fully integrated wafer, cell and module manufacturing complex is under construction in Singapore. This new expansion project, which will cost approximately 1,5 billion euros will more than double REC's current production capacity. The new plant is due to be commissioned in the first quarter of 2010.

REC Solar has sales offices in the key solar energy markets in Europe, the USA and Asia. In these areas, REC works very closely together with experienced, reliable business partners. Market channels are either the distribution part or projects. The sales office network of REC Solar Germany is spread across the whole of Germany, Austria, Switzerland and Eastern Europe. According to our policy of quality throughout the whole production line, we also place very strong emphasis on the selection of our business partners.

REC STANDARDS

REC's culture is driven by our history as a company that is focused on innovating for value in solar technology. We set ourselves challenging targets in this area – and consistently achieve them. That success is rooted in our belief that inspired individuals, working in concert, can achieve the impossible. This philosophy is brought to life at REC through our focus on a set of core values which are called "REC-ID".

RESPONSIBILITY

REC people are committed to providing smart energy for a cleaner future. We deliver on our promise by acting with discipline, professionalism and honesty. Safety always comes first.

ENTHUSIASM

With excitement and optimism, we strive for rapid growth and great performance. We are strongly engaged in, and proud of, our business.

COMMITMENT

We maintain a deep sense of ownership that keeps us focused on our mission and vision. We are determined to reduce costs, while pursuing and realizing growth opportunities. We recognize that quality and customer satisfaction are critical to our long-term success.

INNOVATION

We believe the future holds unlimited opportunities. Our open minds, imagination and curiosity prompt us to explore new ideas. We constantly identify and create smarter solutions and process improvements.

DRIVE

Our pioneering mindset drives us to proactively seek new opportunities and ambitious goals. Inspired by the challenge of making solar competitive, we attack new challenges with dynamism and boldness.

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Fax: +49 (0)89 4423859-99  
muenchen@recgroup.com  
www.recgroup.com  
Founded 1996  
Approximately 3,000 employees worldwide





Satcon's PowerGate Plus is available in 12 models with power ratings ranging from 30 kW to 1 MW and sets the standard for performance, reliability and efficiency for large scale solar power conditioning.

Satcon Solstice is an optimized, utility scale solar solution that offers the benefits of both the large scale central inverter and the localized micro inverter, increasing energy harvest by 5-12 percent while reducing 20-25 percent of balance of system costs.



Satcon Prism is a fully customizable one megawatt medium voltage platform optimized for utility scale solar PV installations, complete with factory integrated step-up transformers, switchgear, and electronics.



**Satcon Technology Corporation (NASDAQ: SATC) is a leading clean energy technology provider of large-scale, utility grade power solutions for the renewable and distributed energy markets. For over 24 years, Satcon has designed and delivered power control solutions that enable utility businesses and energy companies to convert clean energy into efficient and reliable power. Satcon's photovoltaic, stationary fuel cells, and energy storage solutions have delivered millions of grid connected kilowatt (kW) hours of energy across some of the world's largest installations, and have enabled the utility grade market to leverage renewables as a primary energy source.**

Satcon PowerGate Plus solar PV inverters boost system power production and maximize the overall profitability of commercial and utility-scale solar PV systems through a combination of system intelligence, advanced command and control capabilities, industrial-grade engineering, and total lifecycle performance optimization. All Satcon solutions are built on a foundation of the world's most field-tested and the proven PowerGate inverters, which

recently eclipsed 450 MW of total units installed globally, including over 250 MW of the PowerGate 500 kW unit alone.

Founded in 1985 by a group of engineers from MIT and the Charles Stark Draper Laboratory, Satcon is built on a foundation of world class technical expertise. In addition to offering the widest range of utility scale power ratings, the company is responsible for a number of industry-firsts, including the first single-cabinet PV inverter, the first high-efficiency power conditioning system for commercial PV inverters, and the first 1 MW PV inverter.

Satcon has received more than 150 Small Business Innovation Research (SBIR) awards for technical excellence and innovation from the Department of Energy, the Department of Defense, and NASA. The company has obtained 61 patents, 9 applications and 37 patents on non-exclusive, royalty-free licenses for non-automotive applications.

Satcon became a publicly traded company on the NASDAQ in 1992. For more information please visit [www.satcon.com](http://www.satcon.com).

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[www.satcon.com](http://www.satcon.com)  
Founded 1986  
260 employees



Powerful PV solutions



Solar field  
Specchiano, Italy

Greenfever solar field  
Veurne, Belgium



Roof system  
Molino Cassillo, Italy

**Scheuten Solar is part of the Scheuten Group: An international company with a staff of more than 1,800 providing total solutions in the field of glass and solar energy systems. Scheuten Solar – with its headquarters in the Netherlands – is a global player in the fields of solar technology, manufacturing, project development and realization. By managing the critical stages of the solar value chain, we guarantee the quality and performance of our products and projects.**

Scheuten Solar encompasses the whole PV spectrum, from high output PV modules to aesthetic BIPV solutions. We guarantee a 25 year power output warranty and our performance guarantee is one of the best available. Scheuten Solar owns and operates a 200 MW fully automated production facility for PV modules in Gelsenkirchen (Germany); with the most modern module production line in Europe. The production facility for our BIPV solutions is located in Venlo (The Netherlands). Scheuten Solar offers powerful PV solutions for every purpose.

Scheuten Solar has all the knowledge, experience and commitment to develop, build and operate PV projects from start to end:

**Project development**

Scheuten Solar develops projects in Europe and America. With experience in different countries, well established international bank relations and a network of reliable investors, the main focus is on solar fields and large roof systems. Our project development department is able to develop large scale projects in detail whilst taking into account financial, legal and technical aspects. Our strength lies in applying best practices in our central organization combined with local presence. Our goal is to realize PV power plants which are an attractive investment for our partners.

**Project realization**

Scheuten Solar realizes large PV systems in Europe and America. Scheuten Solar has the knowledge, technology and experience to ensure the success of any PV project. We are locally present in all significant solar energy markets and our quality is evident from prestigious BIPV projects and major turnkey solar power plants in Belgium, Germany, Spain, Italy and Greece.

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[www.scheutensolar.com](http://www.scheutensolar.com)  
Scheuten founded 1950  
Scheuten Solar founded 2000  
Approximately 1,800 employees



The global specialist in energy management



Headquarters of Schneider Electric in France

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Phone: +33 (0)141 297000  
Fax: +33 (0)141 297100  
[renewableenergy@schneider-electric.com](mailto:renewableenergy@schneider-electric.com)  
[www.schneider-electric.com](http://www.schneider-electric.com)  
Founded 1836  
114,000 employees

The history of Schneider Electric

Schneider Electric, founded in 1836, has transformed itself into the global specialist in energy management. From its roots in the iron and steel industry, heavy machinery, and ship building, it moved into electricity and automation management. In the late 20th century, the Schneider Group shifted its focus to the electrical industry by breaking away from its non-strategic activities, and was strengthened through its acquisitions of Telemecanique in 1988, Square D in 1991 and Merlin Gerin in 1992. In 1999, the development of installations, systems and control was bolstered with the acquisition of Lixel, Europe's number two in electrical distribution. In May of the same year, the company was renamed Schneider Electric to more clearly emphasize its expertise in the electrical field.

From 2000 through 2009, Schneider Electric entered into a phase of organic growth and began positioning itself in new market segments: UPS (uninterruptible power supply), movement control, building automation and security and renewable energy through the acquisitions of APC, Clipsal, TAC, Pelco, Xantrex Technology and more. As a global specialist in energy manage-

ment with operations in more than 100 countries, Schneider Electric offers integrated solutions across multiple market segments, including leadership positions in energy and infrastructure, industrial processes, building automation, and data centers/networks, as well as a broad presence in residential applications. Focused on making energy safe, reliable, efficient, productive and green, the company's 114,000 employees achieved sales of more than \$25 billion in 2008, through an active commitment to help individuals and organizations "Make the most of their energy™."

Renewable energies

In October of 2008, with Schneider Electric's purchase of Xantrex Technology, a significant milestone was reached in the company's expansion into the renewable energy sector. Combining Xantrex's knowledge and expertise in renewable energies and Schneider Electric's depth of experience in energy management was critical for the future success of the organization in this field. The renewable energies business of Schneider Electric is focused on designing and developing renewable energy products and solutions and providing best-in-class, global customer service and technical support.



3 MW installation in Villanueva, Spain

Schneider Electric provides full solutions from panel DC output to grid connection.



Make the most of your energy

Schneider Electric provides full solutions from panel DC output to grid connection, including monitoring & supervision. In 2009, Schneider Electric introduced a customizable solution geared to photovoltaic (PV) power plants. The Schneider Electric PV Box is a pre-wired equipment package specifically designed to meet the growing demand of large scale grid-tied solar farms and large commercial rooftop solar installations. The PV Box is a complete solution for electrical distribution, automation, security, monitoring and control available from one vendor.

A PV Box typically consists of solar inverters, DC combiner boxes, step-up transformers and a medium voltage switch housed in a prefabricated building to allow quick field wiring from both the solar arrays and the utility grid connection point. Other items can be added to the package, including climate controls, security equipment, array string monitoring, SCADA monitoring equipment, and power metering, accompanied by operation and maintenance offerings.

With the PV Box, customers can significantly reduce total electrical installation costs and project cycle time. This product offers customers a reliable, complete solution from a company with over 100 years of experience in designing electrical distribution and control systems. In addition, because the PV Box enclosure provides a controlled environment for its components, it can be installed in a variety of climates, including harsh desert environments where many future large scale solar projects are planned.

For more information about Schneider Electric and renewable energy solutions, please visit [www.schneider-electric.com](http://www.schneider-electric.com).



24 MW installation in Ontario, Canada



Whatever the future holds



Europe's first 2 MW PV plant  
in Neustadt an der Weinstrasse,  
in operation since 2004.

Electrical quality control in thin-film manu-  
facturing. A raw ASI module is prepared  
for the tester. During this process, the  
electrical data of the module is captured.



Solar power plant in the desert with  
receiver tubes from SCHOTT Solar

**SCHOTT Solar is committed to leveraging  
the virtually inexhaustible potential of the  
sun as a renewable source of energy. To this  
end, the company manufactures photo-  
voltaic modules and receivers for solar  
power plants based on parabolic trough  
technology.**

**High quality standards from  
over 50 years of experience**

As a wholly-owned subsidiary of SCHOTT  
AG, a company with 125 years of techno-  
logical expertise, innovation that comes  
from conviction ranks among SCHOTT  
Solar's company maxims. The company's  
roots even go back as far as the late 1950s.  
Today, SCHOTT Solar ranks as one of the  
world's leading manufacturers and is the  
only vendor that combines both expertise  
in photovoltaics and know-how in receiver  
technology under one roof.

**Decades of reliable performance  
and high energy yields**

External institutes in Europe and US have  
certified SCHOTT Solar Modules as dis-  
playing an above average lifetime and very  
little degradation in performance. 25 year  
long-term tests conducted by Fraunhofer  
ISE Institute demonstrate extremely low

degradation of only 7 %. Long term data  
tracking by UL, TÜV, ISPRA and ENREL pro-  
vides proof of an above average perform-  
ance ratio.

**Product & service spectrum**

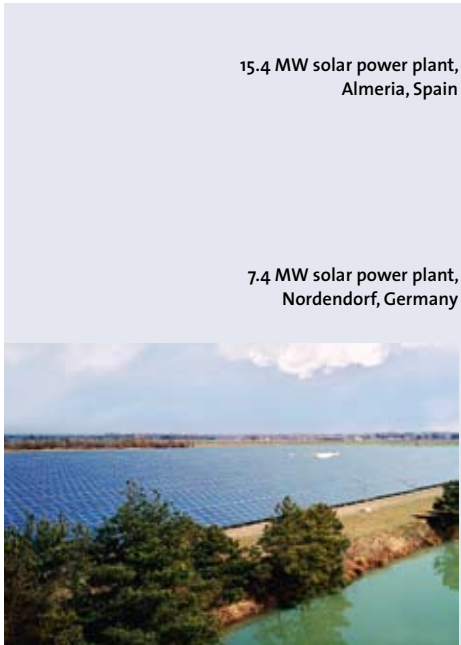
SCHOTT Solar covers all of the core compo-  
nents involved in generating photovoltaic  
electricity, from wafers, solar cells and  
crystalline modules to thin-film modules.  
Moreover, SCHOTT Solar is active in the  
project business with regard to the devel-  
opment, structuring and financing of PV  
projects. In addition, SCHOTT Solar is the  
market and technology leader in the  
development and commercialization of  
receivers for parabolic trough solar power  
plants.

**Outlook**

With international manufacturing sites,  
many years of advanced manufacturing  
expertise and experience, in addition to  
its global sales network and highly quali-  
fied employees, SCHOTT Solar considers  
itself to be well-positioned in the market-  
place. The company will undoubtedly also  
rank among leading players in the solar  
industry in the future.

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solar.sales@schottsolar.com  
www.schottsolar.com

NEW ENERGY FROM THE VERY START



15.4 MW solar power plant,  
Almeria, Spain

7.4 MW solar power plant,  
Nordendorf, Germany



1.0 MW solar power plant,  
Le Lauzet, France

Sinosol AG  
Wilhelm-Leuschner-Strasse 79  
60329 Frankfurt am Main  
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Phone: +49 (0)69 2440425-0  
Fax: +49 (0)69 2440425-15  
info@sinosol.com  
www.sinosol.com  
Founded 2006



The Sinosol Group is an international pro-  
ject developer and epc turn-key solution  
provider of solar parks, as well as a supplier  
of photovoltaic systems and solutions.  
With its extensive experience and long-  
standing expertise in engineering, pro-  
curement and the construction of numer-  
ous international PV projects, Sinosol  
projects have included a 15 MW park in  
Spain, a 1 MW thin film solar farm in France  
and recently a 7.4 MW park in Germany.  
Our business activities are divided into  
projects and wholesale branches. The  
projects business line provides institution-  
al investors such as investment compa-  
nies, banks, insurance companies, family  
offices, and utility companies with a  
complete range of services, from project  
development to turnkey construction and  
to the operation of solar farms.

**1 PROJECT AND SITE DEVELOPMENT**  
Sinosol performs all tasks involved in proj-  
ect and site development, authorization  
frameworks, site qualification, and the pre-  
paration of a sustainable financing model.  
We also negotiate the conclusion of the  
relevant purchase and lease agreements  
and obtain the required approvals from  
municipalities and energy suppliers.

**2 PLANNING, PROCUREMENT AND  
TURNKEY CONSTRUCTION**  
As an epc contractor, Sinosol assumes all  
the responsibilities required for plant  
construction. When outsourcing services,  
Sinosol carefully selects suppliers and  
subcontractors who help ensure the best  
project quality possible.

**3 OPERATIONAL MANAGEMENT**  
Solar power systems have a service life  
which spans several decades. Sinosol  
offers professional technical and com-  
mercial support throughout the entire  
service life and ensures that projects are  
successfully managed.

**4 WHOLESALE**  
The Sinosol Group's trading activities in-  
clude selling PV system components as  
well as complete systems to resellers, such  
as photovoltaic wholesalers, project de-  
velopers, procurement organizations, and  
utility companies, tailored to their demands.  
We round off our sales support with  
training courses, technical, planning and  
design support, as well as all services sur-  
rounding logistics and goods management.





We make the sun your source of energy.



SINVERT reference,  
France – La Réunion

**SINVERT inverters and  
components for PV plants**

**Top performance is in our nature**

Siemens AG is a global powerhouse in the areas of electronics and electrical engineering, operating in the industry, energy and healthcare sectors. For over 160 years, Siemens has stood for technical achievements, innovation, quality, reliability and internationality. Around 410,000 employees develop and manufacture products, design and install systems and plants, and offer customized solutions.

With 40 years of experience in the planning, installation and maintenance of photovoltaic power supplies for industrial applications, Siemens is one of the trendsetters in the field of photovoltaic technology and a reliable partner when it comes to offering solutions which make solar energy a key factor for success. The product portfolio ranges from individual components to turnkey systems. In fiscal 2009, Siemens achieved sales of 23 billion euros with the products and solutions of its environmental portfolio. This was an

increase of around eleven percent compared to the previous year. This included, for example, the economical SINVERT PV inverters with their add-on components – from plant monitoring to medium-voltage components – for medium and large-sized photovoltaic plants.

**SINVERT – Photovoltaic  
inverters from Siemens**

**Minimum total cost of ownership with  
maximum energy yield**

PV power plants with SINVERT inverters are verifiably the plants with the highest performance ratio values. With their high level of availability and optimized efficiency, SINVERT inverters provide a reliable basis for operating a photovoltaic plant efficiently throughout its entire life cycle. In short: SINVERT inverters enable the cost-effective infeed of solar irradiation into standard power grids. The registered trademark SINVERT stands for "Siemens" combined with "inverter" and can nowadays be found in the largest PV power plants in the world.

**Peak efficiency > 98 %**

In an endeavor to help their customers to gain competitive advantages and to ensure maximum plant yields, Siemens is continuously driving innovation and implementing it in its business philosophy. It is therefore only to be expected that SIEMENS PV inverters with their peak efficiency of > 98 % are available for a broad market spectrum (commercial and power plants).

SINVERT PVM inverters are available in the range from 10 kW to 20 kW for small to medium-sized plants in the "commercial" market segment. This three-phase inverter series of wall-mounted devices is characterized by its compact design, its robust nature and its long service life. These inverters are suitable for PV plants from 10 kW right up to the megawatt range.

SINVERT PVS inverters from 350 to 2,000 kW are available for medium to large photovoltaic plants in the "power plant" market segment. They can also be supplied as a PV container station including medium-voltage transformers and switchgear. Products from Siemens operate in the world's largest PV power plants.



**Sunny prospects for the future  
of your PV plant**

The functions and yield of the entire photovoltaic plant can be monitored and visualized in a user-friendly fashion using the SINVERT Webmonitor or SIMATIC WinCC industrial software. Remote real-time monitoring enables faults to be detected immediately; this functionality also enables configuration changes to be made remotely, thus minimizing the service costs for the customer. The software also provides comprehensive verification of all

occurrences and measurements, including for example current energy yield or data after the commissioning of the PV plant.

The free of charge SINVERT Select layout software is available for determining the optimum configuration for a PV plant. It calculates all feasible combinations for most of the PV modules available on the market together with Siemens inverters, and provides you with an easy means of analyzing and optimizing these calculated combinations.

In addition to professional hardware and software, the portfolio is rounded off by consultancy, studies and maintenance concepts.



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www.siemens.com/sinvert  
Founded 1836  
410,000 employees





Above: The world's largest inverter factory with a capacity of 4 gigawatts

Right: Assembly of the SMA Sunny Central inverters



**SMA Solar Technology AG**

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Founded 1981  
Turnover > 680 million € (in 2008)  
More than 4,500 employees

Created, evolved and driven by the vision of creating a sustainable, responsible solution for energy issues of the future. As technology and market leader, SMA Solar Technology AG has been contributing to the continuous growth of photovoltaics for almost 30 years. It is a force to be reckoned with in a sustainable power supply for the future. This is where SMA sets standards. SMA is the only manufacturer worldwide to offer solar inverters in all the relevant power classes. From kilowatts to megawatts, on-grid and off-grid, suitable for any module. With peak efficiencies of up to 98 percent, they ensure a higher energy yield and thus a higher return on investments. At this very moment, more than 400 development engineers at SMA are working to tap new efficiency potential for solar power plants, increase profitability for PV plant operators even further and continue to expand the total installed capacity of more than 6.5 gigawatts to date. For SMA, today's achievement is always the beginning of the next step forward. A claim which each and every one of the 4,500 employees strives daily to uphold. A further contributing factor in this is a corporate culture which encourages commitment, demands

performance and shares success. As a consequence, SMA has been awarded a number of international prizes such as the Great Place to Work Award. Today, SMA ranks among the five top employers of Europe's solar industry. In addition, the world market leader has an outstanding system competence which particularly benefits large-scale project clients. Numerous large-scale plants, such as the Turnow-Preilack energy park in the German state of Brandenburg (54 MWp) or the Solar Park "Realenga I" in Alicante, Spain (5.7 MWp) are exemplary evidence of this. Such projects benefit from SMA's experience and expertise from the initial planning stages right through to completion of the project. With country-specific competence. With cutting-edge technology. And with the conviction that together we can achieve more. **SMA employs more than 4,500 people. Its headquarters are located in Niestetal near Kassel, Germany. SMA also operates twelve international sales and service subsidiaries and one manufacturing facility spread across four continents. The company is listed in the Prime Standard index of the Frankfurt Stock Exchange. SMA achieved a turnover of over 680 million euros in 2008.**



**Trusted PV manufacturing partner**

11.5 MW of Solarfun Power modules at the Eldauren PV System in Badajoz Province, Spain. Installation by Grupo Isolux Corsan

Quality control at each and every step of Solarfun's vertically integrated manufacturing process



Solar energy powering Solarfun's manufacturing facilities

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**www.solarfun-power.com**  
**Founded 2004**  
**Over 5,000 employees worldwide**

**With 700 MW of annual capacity in place from April 2010, Solarfun Power is one of the world's largest module manufacturers. This position has been earned thanks to an ongoing commitment to growing and strengthening partnerships with local partners and installers. Consistently providing high quality solar modules, introducing innovating technologies and improving the long-term value of solar are the keystones of Solarfun Power's approach.**

**Expertise across the value chain**  
Solarfun Power is actively engaged in each stage of the photovoltaic production process: Ingot production, wafer slicing, cell processing, module manufacturing and service. Expertise in each of these areas allows the company to create and use technical feedback which is valuable for developing system wide improvements. Solarfun's Technical Center and in-house pilot production line enable the company to develop process sequences and smooth technology transfers to production lines, effectively bringing upstream innovations in efficiency and overall quality to market.

**Responsibility**  
Delivering clean, renewable energy around the world is just the beginning of Solarfun's commitment to corporate responsibility. Solarfun cell and module manufacturing processes are fully ISO 14001 certified, and this commitment is being extended upstream to turn the full value chain "green". Solar energy and solar lighting are used throughout Solarfun's manufacturing facilities to further reduce the facility's carbon footprint, and Solarfun is an active member of PV CYCLE, supporting end-of-life module recycling.

**Worldwide strength, local service**  
Solarfun Power offers convenient local support to clients and project investors via local offices and service teams around the world. Since 2007, Solarfun Power Deutschland GmbH has been serving companies in Germany and across Europe, and will continue to build on this in 2010 and beyond.



**Clean power: customized and ready for use –  
SOLON Power Plants.**

SOLON developed a special solution for a project in the mountainous terrain of Moclinejo, east of Malaga, to securely anchor the 7 MW plant to the steeply sloped ground.



Right: Since 2005, SOLON has installed projects throughout the world with a total capacity of over 180 MW.

Below: The 12 MW solar power plant Gut Erlasee was equipped with a dual axis tracking SOLON Mover system that allows for an additional 40 % yield due to optimal alignment with the sun.



This urban solar power station on the site of a public transportation company in Seville makes intelligent use of a previously sealed area twice over by combining proceeds from feed-in tariffs and weather protection.



**SOLON SE is one of the largest manufacturers of solar modules in Europe as well as a supplier of solar power system technology for large-scale rooftop and greenfield installations. For more than a decade now, we have been developing trendsetting projects across the globe through our subsidiaries in Germany, Switzerland, Austria, Italy and the US. Worldwide, the SOLON group employs approximately 900 staff.**

The foundation of our global success story in power plant construction is the development of the SOLON Mover in 2003. This pioneering achievement in the field of double axis tracking systems allows for additional yields of up to 40 percent compared to fixed systems with equal power ratings. In 2005, SOLON constructed the solar park Gut Erlasee using this system, which was the world's largest photovoltaic plant at that time with 12 MW and 1,500 SOLON Movers. Worldwide, the projects realized with this product amount to a capacity of over 90 MW to date.

**From the unique SOLON Mover to the diverse power plant portfolio**  
Based on our many years of international experience, SOLON is one of the premier solar power plant EPC providers in the world. From planning and construction to commissioning and maintenance, we always use state-of-the-art technology and the most current safety standards. With over 180 MW of power plants installed around the world, we provide a unique combination of PV power plant expertise and unsurpassed experience in designing and manufacturing PV modules. Today, our power plant portfolio includes fixed tilt, single and dual axis tracking PV power plant systems with large SOLON modules, as well as custom solutions for individual customer needs. All of our systems and their essential components are precisely tailored to one another.

As a manufacturer and general contractor of solar systems, we can ensure the quality of the entire power plant up to grid feed-in point, irrespective of whether a frame, a module, an inverter or a medium-voltage component is concerned. No matter how extreme or challenging the conditions, whether facing the requirements of a complex site or a unique roof mount, SOLON develops the optimal solution: Our PV power plants are individually tailored to the geographical location, particularities of the construction site and the needs of our customers. And our systems are continuously being developed and optimized.

**SOLON Power Plants – the reasons for decade-long profitability**

- Optimal solutions for every location and all requirements
- Highest quality for long-term high yields
- SOLON PV systems with components optimally tailored to one another
- Innovative solar power plant technologies
- Quality from one source for comprehensive guarantees
- Utmost security (delivery, financing, technology and implementation)
- Internationally proven and standardized PV systems



Above: The tracking system SOLON Single Axis allows for an additional yield of up to 25 % compared to fixed installations.

Below: SOLON manufactures solar modules at its own manufacturing sites in Germany, Italy and the USA.

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Founded 1997  
900 employees

**SOLON Power Plants – business portfolio**

**1. Project Development**

- Own and third party projects
- Acquisition of suitable locations and authorization procedure
- Yield simulations and preliminary system design and engineering
- Project financing

**2. Planning and Construction**

- Solar power plant design
- Support and management of permit application processes
- Plant construction inclusive of all required components as an integrated general contractor
- Turnkey delivery

**3. Operation and Service**

- Commercial and technical operation management, including system monitoring, maintenance, inspection and servicing, spare parts service and training of service personnel

As prime contractor SOLON can provide all the steps required in power plant business: From planning and construction to the commissioning, maintenance and service of your solar power plant, we are your reliable partner.



5 MW installation in Fustiñana, Spain, by Proinso



26 MW installation in Fuente Álamo, Spain, by GA Solar

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Trina Solar is a leading manufacturer of photovoltaic (PV) modules with more than 12 years of experience in the solar energy business. Trina Solar manufactures and commercializes a wide variety of mono and multicrystalline PV modules, with power outputs ranging from 165 W to 290 W. Listed in the New York Stock Exchange (NYSE), Trina Solar is currently one of the few PV manufacturers who has developed a vertically integrated business model from the production of ingots, wafers and cells to the assembly of modules within one production site. This integrated value chain, together with the Trina Solar, in-house testing laboratory, helps ensure efficient quality controls and delivers high quality products to end customers. Trina Solar's modules provide reliable and environmentally friendly electric power for residential, commercial, industrial and public utility applications worldwide. With European headquarters in Zurich, offices in Munich, Madrid and Milan, among others, and a local sales force in key countries, Trina Solar has reached long-term commercial partnerships with the leading companies of the PV business in key countries such as Germany, Italy, Spain, Belgium, the Netherlands and France.

**Actively supplying modules for PV plants**  
As a leading PV module manufacturer, Trina Solar actively supplies mono and multicrystalline modules for demanding large PV plant projects worldwide. In Europe, for example, Trina Solar modules have been used in several projects carried out by Trina Solar's most important customers, such as:

- Fuente Álamo, in Murcia, Spain, a 26 MW plant installed by GA Solar (mainly using Trina Solar modules)
- Fustiñana, in Spain, a 5 MW plant installed by Proinso (42 % of which uses Trina Solar modules)
- In der Kultur, in Bavaria, Germany, a 3 MW plant installed by Scatec

**PV Modules designed specifically for utility-scale installation**  
The new TSM-PC14 module is the newest addition to Trina Solar's premium portfolio of multicrystalline modules. With power outputs ranging from 265 to 290 Watts, this module is designed specially for utility-scale installations. Along with the rest of Trina Solar's module portfolios, the PC14 provides the highest quality, power output and easy installation and handling.

TRUST in Solar – Information about TRUST AG



TRUST AG provides customized insurance and risk management concepts to all project phases.

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Founded 1999  
30 employees

**TRUST AG is one of the leading insurance brokers in the renewable energy sector. Since 1999, we have been active in developing and consulting insurance programs for companies driving renewable energy projects and producing renewable energies worldwide. Individual consulting and global presence enable our clients to have access to an effective network of enterprises and experts with sound experience in the field of risk insurance.**

Projects are commonly divided into several phases, such as planning, building and operation. General insurance coverage provides a risk minimization tool to management which applies to all project phases. Based on its long term experience in the renewable sector, TRUST AG provides customized concepts to ensure integrated coverage of all project phases. In addition to your project coverage, we provide qualified insurance services for your company.

During the design phase your company has to verify that all participating contractors have Professional Indemnity Insurance with sufficient liability coverage. This liability coverage should, as a minimum, cover the amount of the project being carried out.

Following the design phase, building starts with delivery of the first material on site and ends with the final acceptance or hand over of the project. Within this phase we offer you the following insurance policies:

- Principal Liability Insurance for the SPV (Special Purpose Vehicle)
- Transportation Insurance
- CAR/EAR Insurance
- ALoP Insurance

The building phase ends with the final acceptance or the handover of the completed project. Usually the project is handed over to the company that operates the plant. TRUST AG recommends and offers the following insurance policies for the operating company.

- Principal's Liability Insurance
- Electronic Equipment Insurance
- Machinery Loss of Profits Insurance
- Dismantling guarantee

If you would like to obtain more information about our company and products, please contact Christian Leers, Director of Sales & Marketing, TRUST AG.



**TÜV Rheinland – Your partner for quality  
and yield in photovoltaic power plants**



Thermographic pictures (failure  
detection, eg. contacting problems)



Test mark for qualified PV power plants,  
TUVdotCOM service in preparation (basis  
for the evaluation of bankability)



**The range of services offered by TÜV Rheinland to investors, system manufacturers and operators includes site evaluation and system inspection services as well as long-term monitoring services which aim to certify and confirm PV plant quality by means of a test mark. Its expert reports are required by banks, financial investors and insurance agencies as the basis for the evaluation of bankability, which is required for project funding and for the purpose of risk minimization.**

TÜV Rheinland has over 25 years of experience to look back on, and not only in the field of plant qualification. As the global market leader for PV-module certification, running six laboratories in Europe, Asia, and in the USA, TÜV Rheinland has the necessary expertise and capacity to test and certify PV modules and other components.

Every successful project relies on an optimized expert report of energy yield, based on site evaluation. Taking into consideration long-term irradiation data, selected plant configurations and further specifications, yield forecasts are compiled using simulation programs and shadowing analysis. TÜV Rheinland assists clients with

regard to tender procedures and evaluates offers before the plant's planning and construction phases. Construction supervision measures enable the prevention of failures and defects at an early stage to improve safety and service life times of the PV systems.

Acceptance testing of the plant examines conformity with the guaranteed electrical and mechanical characteristics. One important aspect is operator and system safety. The evaluation and assessment of PV system performance is realized through on-site monitoring combined with the laboratory testing of wisely selected random samples of solar modules. TÜV Rheinland also has suitable concepts for system monitoring, performance checks and evaluation in order to facilitate complete and consistent yield documentation. All measures are performed on the basis of a catalog of criteria and lead the issuing of a certificate and the test mark TUVdotCom.

During many years working in the PV power plant sector, TÜV Rheinland has performed acceptance tests of plants up to 50 MWp and has gained a multitude of references.

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Founded 1999  
150 employees

**Upsolar is a global company, specialized in design engineering  
and manufacturing of solar photovoltaic modules.**

Project realized by Izen NV in Maasmechelen  
in Belgium. With a total power output of  
1.15 MWp, the plant is located on a converted  
former mining waste site.

This project involves shade canopies,  
was realized by JMB, in France, and has a  
total output power of 800 kWp.



This project was realized in Portugal by  
Grupo Geneng using UP-M200P modules,  
and its total power output is 7 MWp.

**Upsolar's mission since the company's inception has been to provide the global PV market with an opportunity to purchase a "made in China" product of market leading quality at a competitive price. The company has since developed its focus on providing an excellent product, meeting all international quality standards while offering the most competitive prices available from a Chinese manufacturing base.**

Upsolar has negotiated agreements with China's largest manufacturing platforms in order to produce excellent quality modules, while maintaining very low CAP-X. This business model has enabled Upsolar to grow at a rate that would not be possible with the traditional business model adopted by most Chinese solar companies. Having developed relationships with toptier international suppliers, using high performance components and materials, Upsolar has developed a reputation as having one of the best quality-to-price ratios among PV module suppliers on the world market, further advancing its own product development capacity in order to expand the range of solar applications in different sectors. Upsolar's performance has been impressive, having shipped over 60 MW in 2008

and 95 MW in 2009, with sales of close to 150,000,000 euros annually. By investing in international recruitment, Upsolar intends to maintain close links with customers to develop mutual long-term partnerships. We take great pride in the quality of the Upsolar team, now more than 60 strong and growing, which includes several experienced members from the sector who have been attracted by the innovative capacity already shown at Upsolar.

The cornerstone of Upsolar's success has been the rigorous quality-control management protocol we have developed. Upsolar employees implement these online QC Management standards at all partner manufacturing facilities in collaboration with a 3rd party QC management provider, Bureau Veritas, helping Upsolar to continually improve upon these processes while conducting audits of all Upsolar products prior to shipment. Combined with our in-house R & D center, industry standard warranties, performance guarantee through innovative insurance coverage and international presence, Upsolar can guarantee its customer-base an extremely reliable PV module, providing protection from power-loss or supply-shortages.

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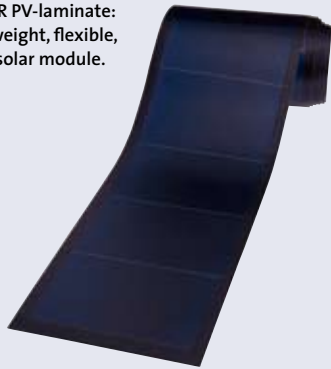


Discover the art of flexibility –  
**UNI-SOLAR® PV-laminates: adaptable, reliable, bankable**

Fiera di Roma: An innovative solar solution that adapts perfectly to the building architecture.



UNI-SOLAR PV-laminate:  
The lightweight, flexible,  
powerful solar module.



**United Solar is the world leader in lightweight, flexible solar modules, the second largest thin-film supplier worldwide and the longest established manufacturer of thin film solar products. Our proprietary roll-to-roll production process is ideal for mass production and allows us to scale capacity quickly according to demand. Today, our factories can produce more than 18 km of reliable and proven solar materials per day.**

As part of the ECD group research, innovation and ground breaking technological solutions are part of our DNA. Our advanced triple junction devices not only generate more electricity per m<sup>2</sup> than traditional amorphous silicon products but also capture all of the different wavelengths of light to convert all of the sunlight available and render a higher energy yield under real outdoor conditions.

When crystalline solar products are incorporated in a building envelope, their performance drops off rapidly. Our cadmium free amorphous silicon solar cells on the other hand have been specifically designed to work at higher temperatures, be resistant to shading, and be light weight

so that they can be mounted easily into or onto the building. Together with our building materials channel partners, we provide products for virtually every roof type, be it membrane, modified bitumen or metal.

Our products are tested and certified to comply with international certifications, are recognized to be fully eligible for higher building integrated feed in tariffs in France and Italy, and are already used to generate clean electricity in towns and cities across the globe from Dubai to Johannesburg, San Francisco to Seoul and Madrid to Munich. Blue chip companies such as Airbus, Coca-Cola, Volkswagen, General Motors and Lidl have selected the Uni-Solar solution to meet their building's solar needs.

Impressive large scale applications have been realized and are being planned with UNI-SOLAR PV-laminates around the world: A 12 MW installation on the GM-Opel plant in Zaragoza, Spain; a 5 MW installation on various buildings of the San Diego Unified School district; 25 MWs on commercial buildings in Italy; a 1 MW plant on a warehouse in Korea and even a 300 kWp installation on the Museum of Beijing.

Focusing on lightweight, durable,  
powerful turnkey photovoltaic solutions



The Rodamco Equinoccio commercial center won the award "Best Photovoltaic Installation in the Community of Madrid for 2009".

Solar Integrated's solution solved leachate problems, produces clean energy and enhances the image of the Malagrotta landfill near Rome.

**Solar Integrated is a renowned pioneer and leader in commercial, industrial and institutional solar applications. As a global solar solutions provider, we combine various technologies to develop the best PV-system for every customer's specific needs, for utmost reliability, productivity, financial performance and environmental benefits.**

Founded in 2002 as a spin-off of Southern California Roofing, Solar Integrated is the roofing expert and draws on more than 80 years of experience in construction and project management. Combined with our unparalleled team of experienced engineers, designers and service technicians, Solar Integrated provides proven quality and dependable long-term performance.

Today, Solar Integrated is part of Energy Conversion Devices (ECD), to which United Solar also belongs – the world leader in the manufacture of lightweight, flexible solar modules and the second largest thin-film supplier in the world. Being part of ECD secures access to financial and technological resources, which allows us to

further develop Solar Integrated's business activities and strengthens our market position as a turnkey EPC contractor of MW-size photovoltaic installations.

While focusing on building integrated or building applied systems, Solar Integrated also offers innovative solutions for special applications, which demonstrate Solar Integrated's expertise with intricate projects, e.g. solar landfill closure systems for "new" unsettled landfills or slopes.

All product solutions developed by Solar Integrated are lightweight in comparison to related products, increasing the scope of building types available for solar energy generation. We focus on the use of materials and components that have proven their long lifetime and durability in other heavy-duty applications, such as automobiles.

Our combination of high-quality materials and innovative PV-technology renders high energy yields under real outdoor conditions, guaranteeing a stable return on investment.

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Turnover FY 2009: 316 million \$  
Approximately 1,500 employees worldwide

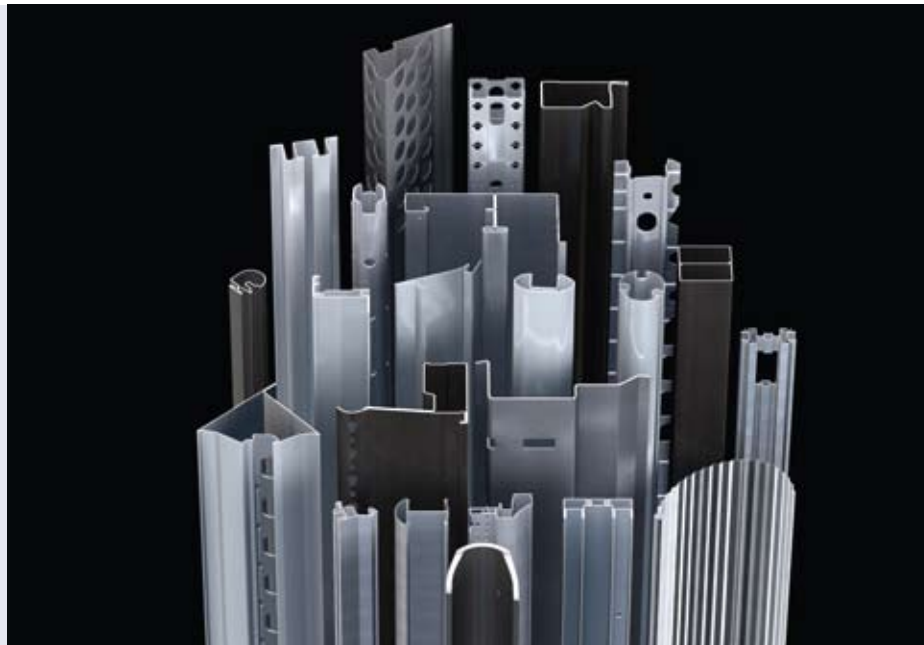
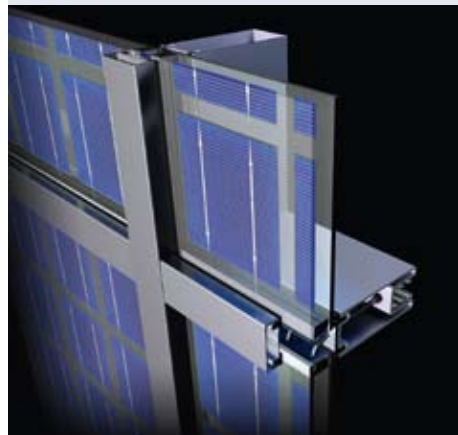
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Founded in 2002 (USA) / 2005 (Germany)  
Approx. 38 employees Europe-wide



## Customized realization of innovative PV-system solutions

Welser's special sections are optimally suited to meet the static requirements of PV systems.

Building integrated photovoltaics (BIPV):  
ISO hermetic with integrated cable duct



Tracker systems – just one of many PV applications for special sections made of steel.

### Rollformed special sections made of steel used for PV applications

For more than 50 years Welser Profile has used the cold roll forming process to manipulate flat coil made of steel, stainless steel and non-ferrous metals and transform it into open special sections, welded section tubes and complete section systems. This process engineering can be supplemented with a wide range of further processes such as laser cutting, bending and a variety of joining and adhesive techniques. In the business area of photovoltaics, Welser Profile manufactures bespoke sections and section systems for a wide variety of base constructions such as pylons, module mounting structures and longitudinal supports. These sections are predominantly made of steel and stainless steel, because this material is optimally suited to most of our customers' products.

### The reasons for this might derive from the following requirements:

- Increase of span width and optimized sections considering static demands
- Reduction of material usage by optimizing the material thickness used
- Simplification of manufacturing and assembly steps

- Adjustment to required basic conditions under consideration of ecology and economy

By using premium materials, accurate manufacturing techniques and active corrosion protection of slit edges, strip edges and punched out areas, Welser Profile can offer first-class and long-life sections in the field of solar technology. Further advantages include optimal pre-material availability and short lead times. Welser Profile can meet these criteria, even for major projects, thanks to its identical production sites in Austria and Germany and its proximity to Europe's most important pre-material suppliers. Welser Profile already manufactures a considerable amount of different section for specific projects and delivers them within the agreed time scale to the project location. RP-Technik Profilsysteme GmbH, a subsidiary of Welser Profile, offers revolutionary complete solutions in the field of building integrated photovoltaics (BIPV). Embedded in the steel façade system, RP Iso hermetic 60 N, with its large scale modules and use of the most varied kind of cell technology, allows new standards in aesthetics and design to be achieved.

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## Turnkey solar power plants – everything from a single source.

Würth Solar's largest project to date in Almeria (Spain)



Würth Solar: CIS large scale production since 2006



**Würth Solar has been producing CIS modules for more than ten years now (with large-scale production since 2006 in Schwäbisch Hall, Germany) and has been working intensively on the integration of components to yield tailored overall systems. Würth Solar covers the entire spectrum ranging from roof-mounted systems for residential buildings and commercial facilities, architecturally sophisticated facade solutions and other custom solutions, right through to turnkey solar power plants.**

Many examples of this type of power plant have already been built: Würth Solar has constructed ground-mounted projects with capacities of between 0.2 MWp and 10 MWp, mostly in Spain.

Würth Solar is able to provide an all-inclusive service as regards the erection of solar power plants: Each project is implemented by a project manager with international experience who works together with a local project team. In this way, professional project execution, the involvement of local companies and the efficient use of resources are all guaranteed.

Würth Solar's service portfolio is comprehensive and structured in a modular fashion. The focus here is on the most complex project area – that means the construction of the system – but all pre-construction and post-construction tasks are of course also included in our range of services. Project development in partnership with the client is one possible approach here. Prime importance is attached to all services affecting the safe and reliable operation of the system once it has been constructed.

The largest project completed to date was built in Almeria with a construction period of only three months; it has 10 MWp of installed capacity and occupies a ground area of around 25 hectares, approximately 8.5 hectares of which are covered with over 55,000 modules that employ CIS and silicon technology.

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Publishers



The engineering department  
generates up-to-the-minute knowledge



Solarpraxis' conferences:  
well-established and  
close to the market

**Solarpraxis is one of the leading knowledge service providers in the renewable energy sector. The Berlin-based company has been providing clients with expertise and professional services in the fields of engineering, conference organization and publishing for over 12 years.**

**Conferences**

Solarpraxis' conferences are valued industry platforms which offer decision makers in the renewable energy industry opportunities for targeted networking and information exchange. They are well-established, close to the market and customer-oriented. Using a combination of specialist presentations and topical panel discussions, they present practical knowledge relating to market development, financing and policies. Industry representatives are given the opportunity to share ideas, to follow and discuss the latest developments, and to meet representatives from politics, the press and the financial world.

Renowned well beyond Germany's borders, the Forum Solarpraxis is the oldest and most established of the Solarpraxis AG

events and celebrated its 10 year anniversary in 2009. Numerous other conferences are set to continue this success story, events in Spain and Italy among them.

**Engineering**

Are you a manufacturer, wholesaler, planner or specialist tradesman and are you looking for technical support in the photovoltaic, solar thermal, heat pump or pellet markets? The engineering department of Solarpraxis AG generates up-to-the-minute knowledge and processes it for your customers using a targeted and project-orientated approach, operating in such areas as expert opinion reports, training, technical hotlines, technical documentation and planning for solar installations:

**Expert opinion reports:** Reports and forecasts of yields • Profitability analyses • Market overviews • Product evaluations • Due diligence • Quality assurance for large scale PV systems

**Training:** Fundamental training • Expert seminars • Sales and motivation training • Workshops



**Expert hotline & customer service:** Tender cost estimation • Parts list compilation • Complaints handling • On-site customer service

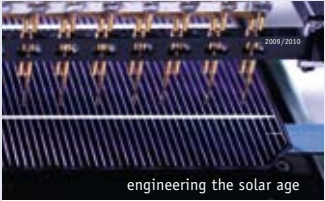
**Technical documentation:** Product documentation • Planning information • Assembly instructions • Checklists

**Planning for solar installations:** Preliminary planning • Planning for photovoltaic installations • Optimization of large-scale solar thermal power plants



B2B-magazines "photovoltaik"  
(with Alfons W. Gentner Verlag)  
and "pv magazine"

"engineering the solar age":  
one of many industry reports  
published by Solarpraxis AG



Suppliers for Photovoltaik | Maschinenbau und Antriebe der Photovoltaikindustrie



Generally in collaboration with the relevant technical associations, Solarpraxis AG and Sunbeam GmbH jointly publish image brochures for various sectors of the renewable energies industry. These provide companies with the opportunity to present their products and services. An editorial section sets out the essential facts and figures relating to each sector plus the latest technological and economic developments.

**Publishing**

Solarpraxis offers a comprehensive range of industry reports, magazines and specialist publications in the fields of renewable energy and energy efficiency. With expertly designed information from experienced professionals for experienced professionals, our publications appeal to planners, engineers, technicians and developers alike.

The monthly trade publication **pv magazine** is published in English and provides independent technology-oriented reports on the latest technological trends and market developments worldwide. **pv magazine** covers the entire technological, energy-related and political spectrum.

The magazine provides market surveys and tests of single components in partnership with the industry, and sheds light on developments toward achieving grid parity. The publication is targeted at decision-makers from all fields of international PV production and project planning.

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Founded 1998  
Turnover 4.8 million €  
45 employees



communications | new media | design



We combine professional communication services with expertise in technologies, markets and decision making processes.

Since 1998, Sunbeam has been providing sound market intelligence as well as excellent contacts with industry associations and media. Specializing in renewable energies and energy efficiency, Sunbeam offers technically oriented communication services which are perfectly tailored to the dynamic market environment.

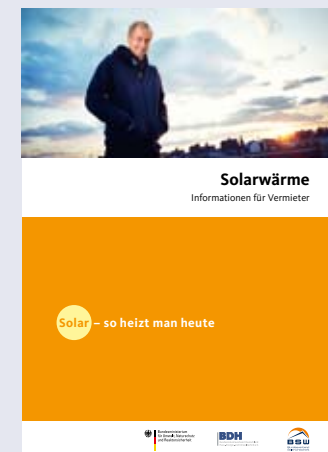
#### Communications

With over 10 years of experience in renewable energy, Sunbeam has acquired skills in all relevant technologies as well as an extensive media network in the field. Sunbeam has successfully conducted a variety of campaigns for governmental departments and offers a wide spectrum of services to corporate clients, ranging from PR concepts and consultancy to the comprehensive management of all press contacts.

#### New media

Sunbeam is one of the leading German agencies for information-oriented, barrier-free websites. The agency has won a prestigious BIENE award and ranks top in relevant listings for the content management system TYPO3. Two team members

Germany-wide information campaign "Solar – so heizt man heute" ("Heating Today with Solar Energy") for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.



are also the authors of renowned specialist books on the design and implementation of web presentations.

#### Design

We value visual communications as a key success factor in the renewable energy market. Sunbeam offers comprehensive expertise in presenting complex matters to technically oriented target groups. In our work for companies, associations and governmental departments we specialize in editorial design for periodical magazines, high quality brochures and extensive industry guides.

#### Added value

Sunbeam operates on all media channels connected to public relations, new media and design. Clients benefit from our experience both in the management of individual formats as well as the creation of integrated marketing solutions. Part of this cross media approach is our widely circulated newsletter ("PresseTrend") which provides concise daily summaries of Germany's press reports on solar, wind and bioenergy.

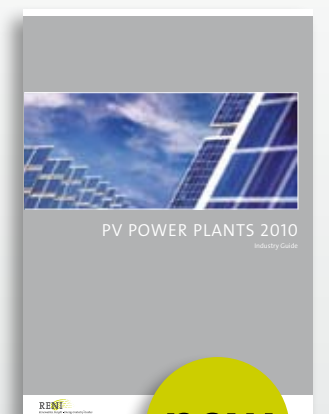
## Renewables Insight – Energy Industry Guides



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RENI | Renewables Insight brings the Solarpraxis and Sunbeam industry reports together under the umbrella of a single brand for 2010. An Industry Guide from the RENI | Renewables Insight is aimed at those working in the industry and finance, press, politics, public administration, education and research. The publications serve as a means of attracting investors and business decision makers, as a political instrument on a national and international level and also as an information source for journalists. [www.renewablesinsight.com](http://www.renewablesinsight.com)

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Falling technology prices and the rising costs of fossil fuels are making large solar parks increasingly attractive for investors. Plants in the three-digit megawatt peak range are being planned, and gigawatt peak plants are already being evaluated.

“PV Power Plants 2010” is the first industry guide to focus exclusively on utility-scale solar power plants, and targets system integrators, distributors, project developers, top planners and investors. Besides corporate portraits, it includes an overview of market conditions and developments in technology, and depicts crucial issues related to planning and financing.

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