The creation of large-scale photovoltaic power plants: the move to thin-film modules

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ABSTRACT

Every day, mankind consumes as much energy as it took the earth 1,370 years to store. The International Energy Agency estimates that by the year 2030, worldwide electricity consumption will have increased annually by approximately 2.4%. City Solar AG is seeking to increase renewable energy stocks through grid-connected solar power utilities. As one of the leading producers of large-scale photovoltaic plants, City Solar is uniquely placed to give us a better understanding of how these plants are put together.

Reserves of fossil fuels cannot cover our energy needs in the long term. Furthermore, price increases must be expected. It will be increasingly necessary to exploit deposits that are more difficult to mine, or that must be transported over longer distances. A worst-case scenario shows an increase in the number of political or even violent conflicts over control of remaining resources.

A world that uses solar energy solves important, central questions for mankind: less air pollution, less climate-changing CO_2, fewer political and violent conflicts over fossil fuels and a multitude of new, permanent work places.

City Solar is making great strides in delivering cost-effective power to the masses through their ambitious and aggressive power-plant building projects. To date, City Solar has connected to the grid projects with capacity of more than 81MW, including a 20MW installation in Beneixama (Spain), one of the world's largest photovoltaic power plants.

The resources and skills required to get a successful solar power plant up and running include securing the site, development and site management, excavation and foundation work, sourcing and testing solar modules, assembly of support frames and solar modules, installation of electrical equipment and ongoing technical operations management. Solar power plants produce approximately 410MWp worldwide, the majority of which are currently ground-mounted installations.

In order to install a power plant with a nominal power of 1MWp, an area of some 20,000 to 25,000m^2 is needed, depending on the site. The solar modules are mounted on metal supports, the heights of which vary between 1.8 and 2.5 metres. To avoid shading, a distance must be maintained between the rows of supports. Depending on the geographical degree of latitude, the incline of the site and the height of the supports, this distance is between 5 and 10 metres.

City Solar develops and constructs solar power plants independent of any manufacturer. With a proven track record of 21 installations in Germany and Spain using modern, top quality technology from producers of renown, they are able to achieve optimum operational availability for their power plants. This is vital to create high and continuous electricity yields with low operating costs and attractive returns for owners.

Figure 1. A Siemens engineer installing modules at a City Solar facility.

Grid Sub-Application	1997 MWp	2002 MWp	2007 MWp	2012 Conservative MWp	2012 Accelerated MWp	CAGR 1997-2002	CAGR 2002-2007	CAGR 2007-2012 Conserv.	CAGR 2007-2012 ACC.
Grid-Residential	28.5	296.4	856.5	3936.5	6904.5	60%	24%	36%	52%
Grid-Commercial	7.0	32.5	1519.6	6150.8	10788.3	36%	116%	32%	48%
Grid-Utility	**3.5**	**9.5**	**386.8**	**2214.3**	**3883.8**	**22%**	**110%**	**42%**	**59%**
Total Grid	39.1	338.3	2762.9	12301.6	21576.7	54%	52%	35%	51%
Total Demand	114.1	504.9	3073.0	12844.0	22142.9	35%	44%	33%	48%
Grid % Total	34%	67%	90%	96%	97%				

(Courtesy of Paula Mints, Principal Analyst, Navigant Consulting, Inc. PV Services Program).

Table 1. Grid connected forecast.

Figure 2. The Solar Park in Beneixama, Spain. In an area of 500,000m^2, 30 million kilowatt hours of clean energy are produced annually.

Without the financial support of government tariffs and the move by large utilities into the solar space, it is clear that the solar power plant market would not be growing at the triple digit growth it has enjoyed over the past five years. The recent Southern California Edison rooftops project is a great example of a large-scale energy provider jumping head-first into the solar energy market. In March 2008, SoCal Edison announced an ambitious project designed to generate 250MWp upon completion in five years. Funded partially by national and state government grants, this project will introduce a new scale for power generation projects.

I caught up with Stephan Brust of City Solar, and asked him a few questions regarding the company's technology and plans for the future.

Who supplies you with the volume of modules required for your projects?

"We use multiple suppliers like Q-Cells, aleo solar, SOLON, Canadian Solar, EPV, and Suntech. They were selected based on long-term experience in the market, high quality, reliability, large capacities, price-performance ratio and, of course, the strength of their warranties. Quality is paramount to everything we do and so we cannot afford any risks when putting together a 20MWp installation."

Steffen Kammler, CEO of City Solar, commented: "We have selected EPV SOLAR as our commercial partner because of their reliable, low-cost amorphous silicon technology. We are confident that EPV SOLAR's PV modules will deliver exceptional performance and value for our customers."

What are the key criteria for selecting different brands of modules?

"We focus on characteristics such as efficiency rates, durability, ease of installation and how the modules work with different inverters. The modules need a max voltage of 1,000V. We only work together with manufacturers who are able to ensure warranty. Furthermore, the modules must fit to our mounting system. The most important advantages of our patented mounting system are its simple and quick assembly and its uncomplicated installation. This means a significant saving on material and time – savings of up to 50 percent. Particularly in the case of large-scale projects, these savings play an important role."

What are the characteristics of industrial strength inverters for solar power installations and how important are they to the running of a plant?

"They are very important for the running of a solar power plant. We work together with Siemens – in 2003, when our first power plant was built up at Saarbrücken's airport, Siemens was permanently involved in the construction. Siemens supplies invertors, transformers, substations, and takes care of the engineering as well as the electrical fittings. The example of our transformers demonstrates our strategy: we use dry-type transformers (Geafol), as, even though they are more expensive to buy than oil transformers, they do not need servicing, operate more efficiently and are environmentally friendly."

Is there anything particularly unique about the way you put together a plant?

"Yes. City Solar has an inbuilt facilty for research and development that works on cost reduction or efficiency improvement strategies throughout the supply chain. An example is our new tracker system that is 40% cheaper to make and has a 22% higher yield than other ground-mounted systems. Two projects in Spain's Albacete are using these systems; one 15MWp system in Mahora goes live in July 2008."

Location: Beneixama (Alicante Province)
Nominal power: 200 x 100kWp (20MWp)
Global radiation: 1,934kWh/m^2 per annum at module level
Ground area: Approx. 500,000m^2 (approx. 71 football pitches)
Solar modules: Approx. 100,000 pieces
Manufacturer: City Solar (PQ 200)
Module surface: Approx. 160,000m^2
Electricity production: Approx. 30,000,000kWh per annum (requirement of more than 12,000 average households)
CO_2 avoidance: Approx. 30,000 tons per annum (over 25 years: approx. 750,000 tons)
Completion date: August 2007

Location: Mahora (Province Albacete, Spain)
Nominal power: 15MWp (Tracker)
Global radiation: 2,311kWh/m^2 per annum at module level
Tracker: Approx. 7,000
Type: City Solar system
Ground area: Approx. 1,000,000m^2 (approx. 142 football pitches)
Solar modules: Approx. 70,000 pieces
Manufacturer: Canadian Solar, Inc.
Electricity production: Approx. 28,000,000kWh per annum (requirement of more than 11,200 average households)
CO_2 avoidance: Approx. 22,400 tons per annum (over 25 years: approx. 560,000 tons)
Completion date: July 2008

Location: Alconchel (Province Badajoz, Spain)
Nominal power: 10MWp
Global radiation: 1,937kWh/m^2 per annum at module level
Ground area: Approx. 250,000m^2 (approx. 35 football pitches)
Solar modules: Approx. 59,530 pieces
Manufacturer: Conergy AG
Electricity production: Approx. 15,500,000kWh per annum (requirement of more than 6,200 average households)
CO_2 avoidance: Approx. 12,400 tons per annum (over 25 years: approx. 310,000 tons)
Completion date: June 2008

Are thin-film modules an obvious choice over Si modules?

"Absolutely. Recently, we entered into a long-term solar module supply agreement with EPV Solar, Inc., a leading thin-film solar module manufacturer and photovoltaic systems provider headquartered in New Jersey, USA. The framework agreement allows us to purchase 250MW of amorphous silicon modules over a period of five years. We use EPV modules to further execute our profitable growth strategy in Europe. A first 2MW project with EPV modules will be realized in Germany by the end of 2008."

What is next for City Solar?

"At the moment we are in the final phase of the big 15MWp Tracker project in Mahora (Spain), which will be finished in July. Moreover, we realized another two big ground-level power plants in Spain (7.5MWp in Yecla and 10MWp in Alconchel). So currently, City Solar has connected to the grid projects with capacity of more than 81MWp. Further markets are Italy and Greece: in Italy, we will build two projects by the end of this year; Greece will start in 2009."

With City Solar moving into thin-film modules and large players like juwi already using CdTe thin-film modules from First Solar, it seems clear that the future of the power generation segment of the solar industry will become increasingly about scale.

Outlook for Solar power generation

In Spain, more power was installed during the first six months of 2008 than in the entire 12 months of 2007. 2008 has also marked a milestone with the first MW PV plants being put into service in Greece and the Czech Republic.

The average growth rate for large PV installations over the past two years has been 100%. Significant growth is expected

in the use of thin-film technologies and the French, Greek and Italian market sizes for power generation. The remainder of 2008 and the first half of 2009 will form another vital step in the adoption of solar power for energy generation.

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Figures for the size of the power generation market are drawn from data provided by Denis Lenardic at www.pvresources.com. All information based on statistics of approximately 1150 PV plants with 200KWp or greater capacity.

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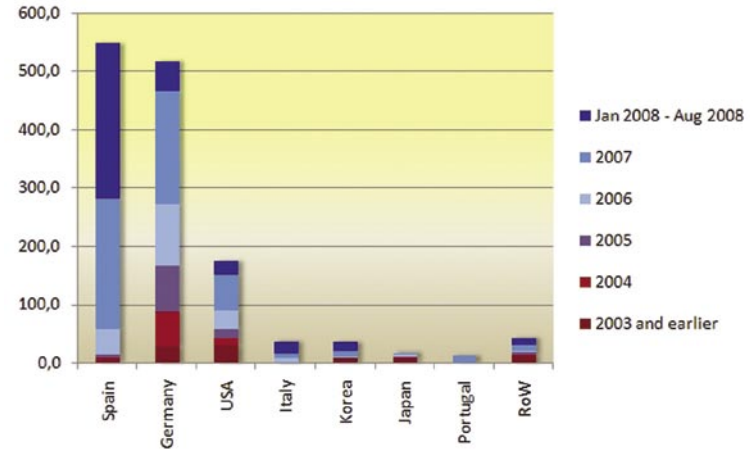

Courtesy of Denis Lenardic, www.pvresources.com.

Figure 3. Cumulative installed power by region.

Crystalline silicon technology

- Crystalline silicon cells are made from thin slices cut from a single crystal of silicon (monocrystalline) or from a block of silicon crystals (polycrystalline).
- Efficiency ranges between 12% and 17%. This is the most common technology representing about 90% of the market today.
- Cost of running power plants with crystalline technology: 73% modules, 27% BOS (DC-Cables, engineering, substructure, installation, inverters).

Thin-film technology

- Thin-film modules are constructed by depositing extremely thin layers of photosensitive materials onto a low-cost backing such as glass, stainless steel or plastic.
- Thin-film manufacturing processes result in lower production costs compared to the more material-intensive crystalline technology, a price advantage that is currently counterbalanced by substantially lower efficiency rates (from 5% to 13%).
- Cost of running power plants with thin-film technology: 52% modules, 48% BOS (DC-Cables, engineering, substructure, installation, inverters).

Competing technologies for PV power generation.