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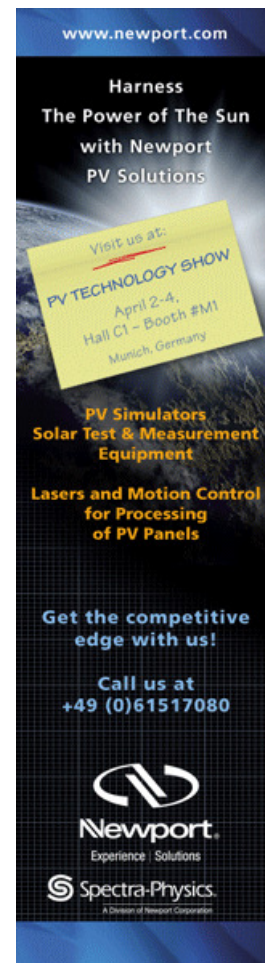
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## 2008 Photovoltaic trends: Innovative thin film technology and large-scale power plants; Gigawatt perspectives in the USA

by Rolf Hug  
20.05.2008

Large-scale solar plants for the generation of electricity in the megawatt category as well as new photovoltaic thin film technologies and products are conquering the world: in Europe, in the USA and also in Asia more and larger PV power plants are being built. Industrial manufacturers of solar cells and of solar module manufacturing systems right up to turn-key solar factories are growing in the global market. In particular, turn-key solutions for the manufacturing of thin film modules are in demand throughout the world. In the run-up to the Intersolar 2008, the 4. PV Industry Forum invites companies, suppliers and service providers of the solar sector to participate in a two-day specialised conference in Munich. The focus points of the event will be commercial solar power plants with megawatt capacities, as well as developments in plant erection and innovations in thin film processing. Another conference of the colourful supporting programme of the first Intersolar to be held in Munich will look into the solar potential of North America under the title of "Solar Gigawatts for the USA". Solarsserver, being the official media



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partner of both conferences, in the Solar Report 5/2008 focusses on current trends in the thin film photovoltaic market and spotlights the solar markets in North America.

## International progress of thin film modules

Material-efficient thin film technology that was continuously refined over the past years and now is able to produce layers of less than one micrometer, is gaining in importance side by side with crystalline solar technology, in spite of the somewhat more favourable situation on the silicon market: thin film modules are expected to reach a market share of up to 20 % in a few years. According to estimates by market researchers about 100 photovoltaic companies throughout the world are working on the production of thin film modules with various technologies and materials and find themselves in different stages of research and development right up to industrial series production.

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Left: Thin film photovoltaic power plant "Baar" (4,8 MW) of the company EPURON GmbH. Right: SunFab Technology Centre of Applied Materials. Sources: EPURON GmbH; Applied Materials

One noticeable trend is that in the past two years companies from the electronics industry (semi-conductors and plasma technology) have increasingly turned towards photovoltaics. In particular the US plant developer Applied Material and the Swiss Oerlikon Group have developed to offer potential manufacturers of thin film modules turn-key systems and to take over the extensive planning processes and the establishment of manufacturing lines for future producers. The Japanese solar cell manufacturer Sharp also turned to the promising future of thin film technology. Sharp, being the manufacturer of LCD panels, can resort to its extensive know-how of surface coating of glass and apply this to the production of thin film cells in the expansion of the production capacity of his Japanese factory Katsuragi. The Japanese manufacturers SANYO and Kaneka are also planning to expand their thin film capacities.

## Industrially manufactured thin film technology as a next step to enhancing the competitiveness of solar power

Even leading manufacturers of conventional solar cells on silicon basis are now scrambling for thin film, for example Q-Cells, the globally leading supplier of solar cells. Announcements by Applied Materials and other suppliers of turn-key plants regarding the possibility of a decrease in costs on a US dollar per watt peak encouraged a number of new participants to enter the market. Within only two years, for example, it is said that eight new solar factories have been built in Taiwan alone.

Applied Materials as well as Oerlikon Solar boast a number of international clients. And both manufacturers of PV solutions are rapidly expanding: for example, at the beginning of 2008 Applied Materials took over Baccini S.p.A., a leading manufacturer of fully automated metallisation and test systems for manufacturing crystalline silicon. "This acquisition is an important step towards our goal of becoming the leading plant equipper in the solar industry", said Mike Splinter, president and

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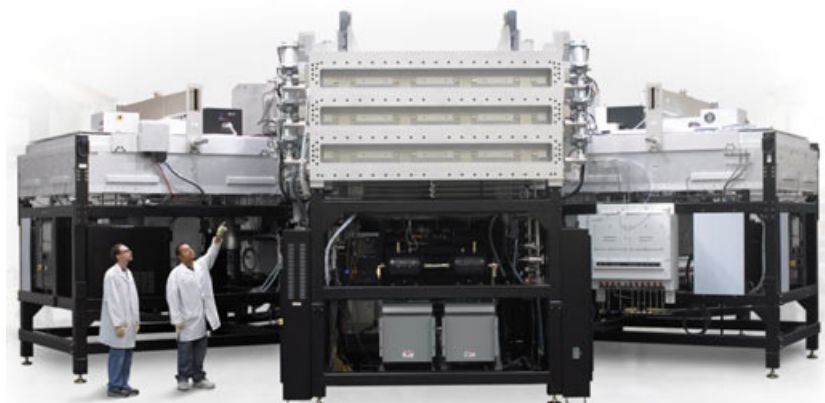
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chief executive officer of Applied Materials. The company's target is not only to lower the manufacturing costs of thin film modules and modules of crystalline silicon, but also to reduce the amount of silicon used in grams-per-watt of energy generated and thus to contribute to an improved competitiveness of solar power in comparison to conventionally generated electricity.



New dimensions in photovoltaic production: system of the manufacturer Applied Materials for plasma-enhanced chemical vapour deposition, PECVD, for the manufacturing of solar cells. Source: Applied Materials.

### **Integrated production systems are the international trend**

Applied Materials has among its clients the Chinese XinAo Group, Brilliant 234 – a 100% subsidiary of the solar cell manufacturer Q-Cell – and “Malibu”, a joint operation of Schüco and E.ON. With a fully integrated production plant of Applied Materials, Maliubu strives to improve the cost-benefit ratio by integrating PV modules into the building facades. The investor Good Energies (Amsterdam) and Norsun AS (Oslo) also want to enter this market: by establishing Sunfilm AG they established a joint operation with its head offices in the Saxonian town of Großröhrsdorf. On a manufacturing line from Applied Materials Sunfilm will be manufacturing tandem thin film photovoltaic modules on glass carrier materials of 5.7 m<sup>2</sup>. On 15.05.2008 Sunfilm announced that it would be erecting a second production line with Applied Materials technology and would be commissioning this line in about a year. With this expansion Sunfilm wishes to achieve an overall capacity of 102 MW. According to Applied Materials, a total of eight manufacturing lines with an overall capacity of 350 MW are currently being built, half of which have already been installed. At the beginning of 2008 another production line contract with a volume of one gigawatt was concluded.

Applied Materials introduced its production line for thin film solar modules for the first time in September 2007 under the name of “Applied SunFab”. The substrates used are four times the size of the largest thin film carriers currently used. “The Applied SunFab Line is setting new industrial benchmarks that can be used by clients worldwide to increase production capacities of solar modules and at the same time to achieve the lowest manufacturing costs per watt,” Applied Materials emphasised during its presentation on the SunFab during the 22. Photovoltaic Conference and Exhibition in Milan. The production line is suitable for solar cells with single as well as tandem junctions and can annually produce a sufficient number of modules for an output of up to 75 MW.



Applied SunFab production line (left) uses substrates that are four times the size of the modules currently used. A glimpse of future production of Sunfilm AG (right). Sources: AMAT; Sunfilm

On the basis of the advantages presented by the carriers of 5,7 m<sup>2</sup> the companies XinAo and Sunfilm want to lower manufacturing as well as assembly costs. "The use of these large substrates will accelerate the development of cost-efficient solutions to generate clean, renewable energies," said Franz Janker, executive vice-president of Applied Materials upon signing the contract with the Chinese XinAo Group.

Oerlikon Solar is also rapidly expanding its global presence. With clients that are already commercially manufacturing and other companies that are finding themselves in ramp up, as well as with over 300 000 solar modules produced, Oerlikon Solar had a solid foundation on which to build in the rapidly growing market of thin film production systems. The company in April already announced a doubling of the production capacity of its plant in Trübbach (Switzerland). In September 2007 Oerlikon Solar introduced its micromorph tandem cell in the market. This latest development stage offers a significantly higher degree of efficiency in comparison to its amorphous solar cell predecessors and would further expand the conversion rate in the double-digit range and would thus enhance technological advantages.



"Micromorph tandem is an important element in the reduction of production costs of solar energy and in achieving grid parity in the short term. This will allow this environmentally friendly technology to become an economically feasible alternative to conventional energy production. The target is to achieve grid parity by 2010," the company stated.

Photo: Oerlikon Solar TCO system for the manufacturing of thin film silicon modules. Source: Oerlikon Solar

### **ersol and SCHOTT co-operating in the field of thin film cells, Inventux starting up in Berlin and CMC already producing in Taiwan**

ersol Thin Film GmbH (Erfurt), a subsidiary of ersol Solar Energy AG, is already producing together with Oerlikon plants and has delivered its first modules in January 2008 already. In addition, ersol entered into a cooperation agreement with SCHOTT Solar GmbH (Alzenau) to jointly further the development of micromorphous technology for thin film solar cells. Both companies intend bundling their resources in research and development in order to attain a marketable product more rapidly and thus to achieve a leading market position in micro-crystalline photovoltaics.



The Mainz-based technology group SCHOTT is working together with ersol in developing thin film technology and is investing approx. 60 m euro in its Jena plant to establish a manufacturing site for thin film solar modules of its subsidiary SCHOTT Solar GmbH.

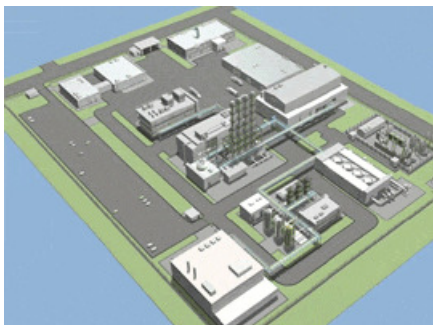
Photo: SCHOTT Solar small-scale manufacturing for thin film technology in Putzbrunn near Munich. Source: SCHOTT

The company Inventuz Technologies AG that was established in spring 2007 has chosen its future production site and head offices to be located in Berlin. Inventuz is planning to invest about 49 m euro in a production site for solar modules. From autumn 2008 annually about 275 000 solar modules with a total output of 33 MW are to be produced. In the manufacturing process the raw material silicon is to be applied as silan gas 100 times thinner than in conventional crystalline technology. The contractual partner for this manufacturing process is the Swiss company Oerlikon Solar.

CMC Magnetics Corp. is to be the first client of Oerlikon Solar stepping up its production in Asia. The 40 MW turn-key production line was transferred from Trübbach (Switzerland) to Taiwan over the past months, was then assembled and adjusted in order to commence its pilot operation on 17.04.2008. The final commencement of production is planned for the second half of 2008.

### **Successful German manufacturers of photovoltaic production equipment: medium-sized companies are becoming global players**

Even German medium-sized companies are actively contributing when it comes to exploring new markets for PV production plants. For example, centrotherm photovoltaics AG (Blaubeuren near Ulm) and the plant manufacturer Roth & Rau AG (Hohenstein-Ernstthal) are developing from medium-sized companies to worldwide suppliers of production technology. centrotherm photovoltaics AG, provider of technology and services for manufacturers of solar cells and solar silicon, established a subsidiary in Taiwan and is currently building a new thin film research centre with a pilot production site for so-called CIGS lines. CIGS (copper indium gallium selenide) is currently the thin film technology with the highest degree of efficiency. In research this is currently stated to be at 19.9%.



Left: Model of a turn-key solar silicon factory of the company centrotherm photovoltaics. Right: Solar cell coating system SiNA\_L by Roth & Rau

The photovoltaic production site manufacturer Roth & Rau opened a new manufacturing site with additional capacities for its core product, the anti-reflex coating systems of the SiNA series. Furthermore, a manufacturing site for the production of thin film technology plants is being established. Currently Roth & Rau is the international leader in providing anti-reflex coating systems and fully automated t

Which of the new thin film technologies and production technologies will become established internationally not only depends on the quality and costs of the plants, a report of the Solarstrom magazine PHOTON emphasises. Because the development of thin film production could take a similar course as that of information technology. It is a known fact, that there the operating system with the fastest gain in market share won the race – and not necessarily the best operating system, Photon quotes Gerd Lippold, the technology expert of City Solar AG. The worldwide race for thin film technology of the future remains open. The winner, however, has already been established.

### First Solar at the top of thin film producers

The rapid ascent of First Solar – a manufacturer of thin film solar cells on the basis of cadmium telleride – is clear evidence of the ever-increasing importance of thin film technology. With a production of 200 MW in the year 2007, the company gained fifth position in the world ranking list of solar cell manufacturers. No other thin film producer was anywhere near the production figures of this US company that also has a factory in Frankfurt/Oder. The modules of the profitable thin film manufacturer are preferably used in large-scale plants of the megawatt category. For example, by COLEXON Energy AG, that is establishing the world's largest thin film roof system with an output of 4.6 MWp in Hassleben (Brandenburg); or in the future photovoltaic plant that is to be the largest of its kind, the energy park "Waldpolenz" (40 MW), in which the Mainz-based juwi group installed about 550 000 solar modules from First Solar that were mainly produced in Frankfurt/Oder. A total of 15 MW thin film modules from First Solar were installed by EPURON GmbH (Hamburg) during the course of last year. In Baar, EPURON connected another thin film park to the public grid in December 2007. The 4.8 MW project is among the Top Ten of the world's largest thin film plants. For EPURON it was the fifth solar plant that was realised in Germany in 2007.



Left: First Solar thin film modules; Right: Solar park Baar. Sources: First Solar (left) EPURON GmbH

### Large-scale solar power plants in Europe, the USA and Asia

80% of all large-scale commercial photovoltaic power plants (regarding their output) are located in Europe which thus internationally holds the first position. Positions two and three are held by the USA and Asia. Within Europe the German market has proven to be very dynamic and is thus one of the few that has shown continued growth during the past ten years. Currently almost half of all high-performance photovoltaic plants in the world are operated in Germany. Solarsserver reported on these developments in January 2008 under the heading "Large-scale

photovoltaic plants: 100% average growth since 2005". These and other developments in the photovoltaics sector will form part of the programme of the PV Industry Forum to be held this year. On the basis of the importance that photovoltaics now hold for German and international energy markets, the event was extended from one to two days. Also the increasing number of visitors and the increasingly international nature of this event required it to be extended in 2008: whereas in 2007, 319 decision-takers and experts in the field utilised the opportunity to exchange ideas and further their knowledge, more than 400 international visitors are expected this year. "The enthusiasm with which the field welcomed the conference over the past years has shown us that this platform for exchange is gaining in significance for the sector. With an extension of the PV Industry Forum we are hoping to meet this demand," Horst Dufner from Solar Promotion underlines, co-organiser of the PV Industry Forum.

### **"Solar Gigawatts for North America": Is the Northern American market ready for a boom?**

Only 5% of the world population live in North America. However, they use 26% of the entire energy produced worldwide for which they annually pay over 450 billion US\$. But particularly the USA also have enormous potential of renewable energies, from the very windy plains of North Dakota to the Mojave Desert, an area that stretches from California to Arizona and is among the regions with the highest solar radiation in the world. Photovoltaics, solar thermal power plants, solar thermics, solar air-conditioning and solar construction in North America are the topics of the transatlantic symposium "Solar Gigawatts for North America". For the first time, this event, organised by Solar Promotion GmbH and the consulting company eclareon GmbH, informs about market developments and opportunities as well as about political framework conditions.



Left: Open-space photovoltaics power plant with an output of 8.22 MW in Alamosa (Colorado). Source: Xcel Energy; Sun Edison LLC Right: Parabolic trough power plant "Nevada Solar One" in the Mojave Desert.

On 11 June the symposium will be discussing in Munich whether and how the ample available renewable energy sources can meet the demand and how the US market can develop in this direction, since the demand for renewable energy is rapidly growing. Currently, however, the continuation of tax credits that were granted to the end of 2008 is still at the centre of contentions. A new president will be elected in November. He could bring about a turn in energy affairs in the States and could awaken the "sleeping giant" solar energy in the USA.

### **Rethinking among US energy suppliers: solar power gaining in importance**

Renewable energies, and in particular solar energy, are becoming increasingly popular in the USA and are now subsidised at almost all levels. Some states have developed own solar programmes, new companies have been established and are working on innovative technologies. The solar power and solar thermal market is taking shape. Even large-scale energy suppliers – such as, for example, Southern California Edison (SCE) – are now looking towards photovoltaics. Other utilities are planning solar thermal power plants, for example Pacific Gas and Electric. And this is done on an enormous scale: SCE alone is

planning on investing about 550 m US\$ in solar power plants. With the largest photovoltaics project of the USA approximately 6 million square metres of roof surface are to become solar power plants. Week by week SCE wants to install solar modules with an output of one megawatt. At this exemplary speed photovoltaic systems are to be installed on roofs of commercial buildings to achieve an overall output of 250 MW.



John E. Bryson, president and CEO of Edison International wants to build solar power systems on enormous roofs. This SCE plan resulted from the progress of photovoltaics that significantly reduced the installation costs of solar power plants, says Bryson.

Source: Southern California Edison

SCE is convinced that its solar programme for commercial roof surfaces will drive numerous environmental initiatives in California, including the Million Solar Roofs Programme that subsidises PV projects up to 2017. The SCE initiative supports the programme of the federal state against climate change as well as the programme for renewable energies that stipulates that until 2010 about 10% of the energy demand is to be covered by regenerative sources.

### **California leads the American photovoltaics market**

The US photovoltaics market holds immense growth potential. California, leading in matters of solar power, has through its ambitious subsidising policies created the largest market in the USA in which in 2007 about 100 MW were installed. In comparison: in Germany just over one gigawatt was installed last year. With the Californian solar initiative and its solar roof programme, Governor Schwarzenegger wants to achieve about 3 000 MW by 2017 and will provide subsidisation to approximately 3.2 billion US\$. In New Jersey the government wants to move away from traditional subsidisation models and still wants to achieve a 22.5% share of renewable energies in its electricity mix by 2020. Other states such as New York, Arizona, Colorado, Connecticut and Massachusetts have their own subsidisation programmes.

### **Solar-thermal power plants in the desert as gigawatt electricity suppliers of the future**

But not only photovoltaics are considered as technology of the future in the USA, but also gigantic solar-thermal power plants are to cover the immense electricity demand of Americans. The big electricity suppliers in California have recently announced projects with a total output of over 2 000 MW. The current federal energy bill also envisages tax benefits for this kind of electricity generation, but the continuation of these is still uncertain. Although the gigawatt projects have been planned already, many years often pass before construction actually commences.

### **Solar heating and cooling still little developed, but new market is forming**

Classical solar thermics boomed in the USA in the early 1980s, but heating and cooling with solar thermics has long not established itself in spite of mostly ideal conditions. The solar thermal industry remained rather small and was mainly used for heating pools. But now solar thermics is said to have reached a turning point in North America, the organisers of Solar Gigawatt emphasise and report annual growth rates of 50%. How political support of solar thermics can be structured and what it can achieve, will also be discussed at the symposium.

**For further information:** <http://www.solar-gigawatts.de/> and <http://www.pvindustry.de/>

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