



**New location:** The Solar Silicon Conference took place in Berlin for the first time. The number of participants dropped to 233 as opposed to 381 in the previous year.

Photos (2): Johannes Bernreuter

# Oversupply ahead

Those predicting a polysilicon glut are increasing in number – as too at the 9<sup>th</sup> Solar Silicon Conference held in Berlin in mid-April. Whether or not there is consolidation amongst the manufacturers will mainly depend on the turbulent development of the photovoltaics market.

**T**he price of polysilicon on the spot market has only been rising for a few months now, and established manufacturers and new entrants are already scrambling over each other again with announcements of new capacities. Martin Meyers, analyst at Photon Consulting, puts the sum just for plans announced in the first quarter of 2011 at 120,000 metric tons (MT) of growth within the next three years. Meyers stated this figure on April 12<sup>th</sup> in Berlin at the 9<sup>th</sup> Solar Silicon Conference, organised by Photon Europe GmbH. Many silicon purchasers are thus very relaxed about the supply situation: with 233 participants, as opposed to 381 the previous year, the conference once again experienced a decline in interest.

The panel of analysts on the podium estimated the volume of polysilicon production last year at 150,000 to 180,000 MT; for 2011 the forecasts ranged widely between 190,000 and 300,000 MT. Even if you take a middle value of 250,000 MT, the question is whether this volume will find enough takers. “The polysilicon industry will likely consolidate. Some smaller manufacturers might have difficulties to survive,” forecast Sunil Gupta, Head of Cleantech at Morgan Stanley in Singapore, who took part via video conference. The result will be that the five largest manufacturers will once again reach a market

share of 80 % in 2012 – according to Gupta this will be Hemlock Semiconductor Group (USA), Wacker Chemie AG (Germany), OCI Company Ltd. (South Korea), GCL-Poly Energy Holdings Ltd. (China) and REC Silicon Inc. (USA). Between 2006 and 2009 the share attained by the top five shrank from 85 % to 65 %.

Further developments will depend decisively on the growth of the photovoltaics industry, which already used four and a half times as much polysilicon for the manufacture of crystalline solar cells in 2010 as the semiconductor industry. The podium analysts forecast the capacity of newly installed solar systems at a considerable volume of between 23 and 28 GW this year, although the forecast for 2012 was pessimistic. The majority is calculating in a drop to approx. 22 GW, as capped or reduced promotion schemes in some European countries will not be sufficiently compensated for by new markets. “There is no second Germany in the wings,” said Meyers.

## Spot price for 2012 below 35 US\$/kg?

Only Jenny Chase, Head of Solar Research at Bloomberg New Energy Finance, didn't want to follow this estimation: “Price cuts will open up more



**Interesting insights: The 9<sup>th</sup> Solar Silicon Conference conveyed quite a bit of news about further developments in production technology.**

volumes,” she argued. Jim Stutelberg, Vice President of Marketing and Sales at Hemlock Semiconductor, who represented the market leader with a presentation at the conference after it had had a break of two years, was also confident: “Grid parity is closer than many realize,” he said: “We are more optimistic than some others.” Hemlock aims to expand its production capacities to over 90,000 MT by 2015/2016 and has recently founded an affiliated company in Singapore, probably in order to put up a new factory in Asia.

With a high and constant silicon quality as well as future production costs of between 20 and 25 US\$/kg, the large established manufacturers do not need to worry about overcapacities on the market. Things could become difficult for smaller suppliers, though. Analyst Meyers puts their fully loaded costs in 2012 at 45 to 55 US\$/kg, and the cash costs at 30 to 35 US\$/kg. According to Richard Winegarner, President of the consultancy Sage Concepts, who led the conference together with Anne Kreutzmann, Editor-in-Chief of Photon, such companies only have the following option if there is over-supply: “close down or cut prices to cash cost.”

Analyst Chase imagines the spot price will fall below 60 US\$/kg in 2011; Meyers even expects it to be “well below 35 US\$/kg” at the end of 2012, and Winegarner is confident that an older forecast of his that the spot price will drop to 30 US\$/kg in 2013 is still valid. Cost pressures on manufacturers will thus increase considerably, while customers can be happy about lower purchasing costs. One should still treat such forecasts cautiously, however, as the photovoltaics market has been good for a surprise on several occasions in the past. One year ago at the 8<sup>th</sup>

Solar Silicon Conference in Stuttgart (Sun & Wind Energy 6/2010, page 134), analyst Sunil Gupta forecast that the spot price would fall to 40 US\$/kg in 2011. Since November 2010 the price has been averaging between 70 and 80 US\$/kg, however; in China buyers have sometimes been paying over 100 US\$/kg. It remains to be seen whether and how fast the slightly less firm prices since early April turn into a continued downward trend.

## **Costs below 20 US\$/kg possible**

For the dominating process in the manufacture of polysilicon, the Siemens process, costs of 20 US\$/kg do not have to be an insurmountable hurdle for ever. The Chinese shooting star GCL-Poly is already approaching this figure, although Russ Hamilton, Vice President of Technology, said that 15 US\$/kg would be “a very big challenge.” In the Siemens process, silicon deposits from trichlorosilane in a reactor with a hydrogen atmosphere onto thin hyper-pure silicon rods, which are heated electrically to up to 1,150 °C.

If, for example, the heat from the cooling fluid in the reactor wall is recaptured, the energy consumption for deposition can be reduced from 60 to 35 kWh per kg of silicon, says Albrecht Mozer, Managing Director of the technology supplier Centrotherm Sitec GmbH. A further starting point for increasing efficiency was explained by Gladwyn De Vidts, Chief Strategy Officer at AEG Power Solutions BV: using high-frequency alternating current to heat the silicon rods leads to a more even temperature distribution between the rod core and the surface. This reduces the risk of cracks, makes thicker rods possible and thus results in a higher output.

The American trichlorosilane specialist LXE Solar has developed a variation of the Siemens process which promises to achieve production costs of just below 20 US\$/kg in a 5,000 MT polysilicon plant in China. LXE has already tested the individual steps at its development centre in Seattle, reported Mark Dassel, Vice President of Business and Strategic Development. The concept is to initially convert trichlorosilane to monosilane, which can be purified by distillation more easily than trichlorosilane due to its lower boiling point. Through a clever use of the off gases from the Siemens reactor, the monosilane is then reconverted to trichlorosilane, because silicon can be deposited with better yield from the latter than from monosilane.

The Spanish new entrant Siliken Chemicals also feeds trichlorosilane into its fluidized bed reactors in order to manufacture polysilicon granules. The parent company Siliken had originally announced the start of production already for the first quarter of 2009. Problems with the equipment delivered, however, meant that the company had to redo part of the distillation unit and make adjustments to the reactor design, reported Antonio Navarro, Chairman Office Director at Siliken. The first new reactor wasn't started up until the end of 2010. Navarro still stated an ambitious target, though: production costs should

come down massively from 35 US\$/kg at a capacity of 1,000 MT and electricity costs of 0.10 US\$/kWh this year to 20.90 US\$/kg in 2014 at a 10,000 MT plant obtaining electricity at 0.05 US\$/kWh. A decision on its location has not yet been made.

## Big plans for UMG silicon

The small group of manufacturers of upgraded metallurgical-grade (UMG) silicon is also confident of having good chances. As the photovoltaics market grew by approx. 140 % in 2010 they had no sales problems, although their material only has a purity of between 99.999 and 99.9999 % (5N to 6N). The Norwegian manufacturer Elkem Solar AS produced 2,200 MT last year at its 6,000 MT plant and sold 2,000 MT of this, said Torgeir Ulset, Vice President of Supply Chain and Sales. In China there is a strong trend to blend UMG silicon with conventional polysilicon, added Jun Shi, President of UMG technology supplier Propower Renewable Energy Co., Ltd. in Shanghai. Shi puts production costs for UMG silicon at under 15 US\$/kg.

Elkem, which has been taken over by the specialist chemicals corporation China National Bluestar (Group) Co., Ltd., is already looking for a low-cost site outside Norway for a second UMG silicon factory. The Californian solar cell manufacturer Calisolar Inc. has very big plans for its UMG subsidiary 6N Silicon Inc.: a 16,000 MT plant is to be built in an existing building in the US-state of Ohio, and is to begin making its first deliveries as early as July 2012.

Calisolar will continue its ingot, wafer and cell production in Sunnyvale, with a capacity of 75 MW, as a reference and development line. The average efficiency of the multicrystalline UMG cells there currently lies at 16.5 %; the best cells reach 17.7 %. Calisolar wants to sell the silicon from the new plant in Ohio together with a know-how package, so that the customers can also reach such efficiencies. The new strategic aim of the company is very clearly: "to become the global low-cost silicon producer."

*Johannes Bernreuter*

*The author is head of the market research firm Bernreuter Research as well as lead author of the market and technology report "The Who's Who of Solar Silicon Production."*

### **Further information:**

Bernreuter Research: [www.bernreuter.com](http://www.bernreuter.com)

Photon Consulting: [www.photonconsulting.com](http://www.photonconsulting.com)

Morgan Stanley: [www.morganstanley.com](http://www.morganstanley.com)

Bloomberg New Energy Finance: <http://bnef.com>

Sage Concepts: [www.sageconcepts.com](http://www.sageconcepts.com)

Hemlock Semiconductor: [www.hscpoly.com](http://www.hscpoly.com)

Wacker Chemie: [www.wacker.com](http://www.wacker.com)

OCI: [www.oci.co.kr/eng](http://www.oci.co.kr/eng)

GCL-Poly: [www.gcl-poly.com.hk](http://www.gcl-poly.com.hk)

REC: [www.recgroup.com](http://www.recgroup.com)

Centrotherm Sitec: [www.sitec.centrotherm.de](http://www.sitec.centrotherm.de)

AEG Power Solutions: [www.aegps.com](http://www.aegps.com)

LXE Solar: [www.lxesolar.net](http://www.lxesolar.net)

Siliken Chemicals: [www.siliken-chemicals.com](http://www.siliken-chemicals.com)

Elkem Solar: [www.elkem.com](http://www.elkem.com)

China National Bluestar: [www.china-bluestar.com/en](http://www.china-bluestar.com/en)

Propower: [www.pro-enertech.com](http://www.pro-enertech.com)

Calisolar: [www.calisolar.com](http://www.calisolar.com)

6N Silicon: [www.6nsilicon.com](http://www.6nsilicon.com)