



Photo: Solar Silicon

Low polysilicon prices are helping to drive solar's competitiveness and enhance margins, however this brings with it major challenges for suppliers.

2015 Poly and wafer rankings

PV manufacturing: Polysilicon manufacturers and wafer producers are facing wildly different fortunes. With polysilicon prices remaining low, the competitive landscape is in flux. But quality still counts. Wafer demand remains strong as wafer, cell and module capacities have not expanded in step. Christian Roselund reports.

The ongoing impacts of Chinese polysilicon tariffs, a related glut of poly on the market, and a shortage of multicrystalline wafers are all showing in the latest global polysilicon and wafer supplier rankings by IHS. These circumstances are crushing many of the leading Western poly makers, and may have temporarily brought Chinese wafer maker LDK back from the dead. Overall, Chinese companies are the big winners, and the question remains how long non-Chinese players can successfully negotiate these challenges.

Polysilicon: the top 5

In 2015, GCL, Wacker and OCI retained their dominant positions in global polysilicon production and supply. This is

particularly true of GCL, the top Chinese poly maker, which grew capacity to 86,000 metric tons (mt), at 85% capacity utilization in 2015. Fast-growing Xinjiang TBEA increased its capacities to 23,000 mt and managed 83% utilization.

Hemlock, the fourth-largest polysilicon maker, is suffering. According to estimates by IHS, the company ran at only 46% capacity utilization in 2015, while the other four leading producers all ran at 85-91%.

Hemlock formally abandoned a new poly production facility at the end of 2014, and such low utilization rates indicate that the company has partly stopped production at other facilities, including idling part of its production in Hemlock, Michigan.

The cause of Hemlock's woes is clear: It was unable to adjust to high Chinese duties on imported polysilicon. This has led the company to withdraw from the Chinese market, which represents the large majority of global poly demand. "About one third of their production is for the semiconductor industry," Johannes Bernreuter, head of Bernreuter Research, told **pv magazine**.

However semiconductor demand is a very small portion of the total market. Hemlock appears to be hanging on by strictly demanding compliance with existing long-term contracts, which can carry prices as much as twice as high as those on the spot market.

Hemlock's need to preserve its long-term contracts has impacts for cell and

module makers. A number of companies including Sharp have stated that they are burdened by the contracts, and SolarWorld is engaged in a high-stakes legal battle with Hemlock over allegations that it did not meet contractual requirements. "If Hemlock wins the case, it will endanger the survival of SolarWorld," warns Bernreuter.

But Hemlock is not the only polysilicon maker to be heavily impacted by Chinese tariffs. The sixth-largest producer in 2015, REC Silicon, announced in February that it would completely shut down its solar silicon production in the U.S. state of Washington due to Chinese tariffs, which was its only dedicated production for the solar market.

Conversely, the success of Wacker and OCI, the other two non-Chinese producers in the top six, comes down to their ability to avoid these duties. South Korea was able to negotiate polysilicon tariffs so low as to be a mere nuisance, which benefitted OCI. Meanwhile Wacker negotiated directly with the Chinese government for a minimum import price, similar to what the EU has imposed on Chinese PV modules.

Quality is an issue here, and it is not a coincidence that Chinese wafer makers took advantage of loopholes in these duties as long as possible. Wacker is able to supply higher quality poly than Chinese rivals, and as such its product remains in high demand in China even at higher prices. OCI has had even greater success in China. According to Chinese

customs data, January saw record Chinese polysilicon imports of over 12,000 mt, with roughly half of that coming from South Korea.

Polysilicon and prices

In addition to import duties, another issue that all polysilicon makers are facing is crushed prices. As of late February the average spot market price for polysilicon was still under \$14 per kilogram according to both PV Insights and EnergyTrend. These spot prices have been under \$15 per kilogram since last November, due to a huge volume of excess capacity.

These prices are mostly determined by market conditions in China, given that the nation hosts the overwhelming majority of ingot and wafer capacity. And the circumstances of this polysilicon oversupply is strongly linked to the trade war. Chinese poly makers planned for the supply of imported material to be cut off by duties, and began building substantial capacity. Instead, imports have never been fully curtailed, with OCI and Wacker evading high tariff levels. The result is a glut of poly on both the Chinese and global markets, as was explored in the December edition of **pv magazine**. This puts Western polysilicon makers in a doubly difficult position. First they have to cope with import tariffs, and even if they can overcome these the prices for which they can sell their products have largely collapsed.

AT A GLANCE

- GCL, Wacker and OCI retain strong polysilicon market share while Hemlock suffers.
- Chinese polysilicon duties continue to impact the market.
- Spot market price for polysilicon remained under \$14 per kilogram at the start of 2016.
- Multicrystalline wafer manufacturers are operating at high utilization rates and enjoy robust demand.
- Longi and other mono-wafer makers are clearly anticipating a rise in demand.

Good times for wafer makers

While polysilicon makers are suffering from intense competition and oversupply, multicrystalline wafer makers are experiencing very different circumstances, which shows in the rankings. According to IHS, China's GCL-Poly and Taiwan's Green Energy Technology (GET), the first and sixth-largest wafer makers, both ran at over 96% capacity utilization during 2015.

GCL-Poly and GET are good indicators of the multi-wafer space, as they are some of the largest multi-wafer makers who produce primarily for third-party sales, as opposed to their own consumption. Due to low poly prices and stabilization and even slight improvements in multi-wafer prices, accompanied by very high factory utilizations, such multi-wafer makers are seeing improved profitability.

Photo: Wacker Chemie



Production efficiencies, such as the recycling of gas at Wacker's Nünchritz site in Germany, allows the company to compete with Asian producers.

Photo: Longi Silicon Materials



Longi expects mono wafer demand to increase as it continues to push down costs.

Conversely, the fourth and fifth-largest wafer makers, JinkoSolar and Yingli, are primarily PV cell and module makers who have built substantial wafer capacity to serve their own integrated production. Jinko jumped several places to grow larger than Yingli in both wafer capacity and output rankings, due to changing circumstances in the module sales of the two companies. Jinko has grown its presence in the module end market, and Yingli has fallen from its former leading position.

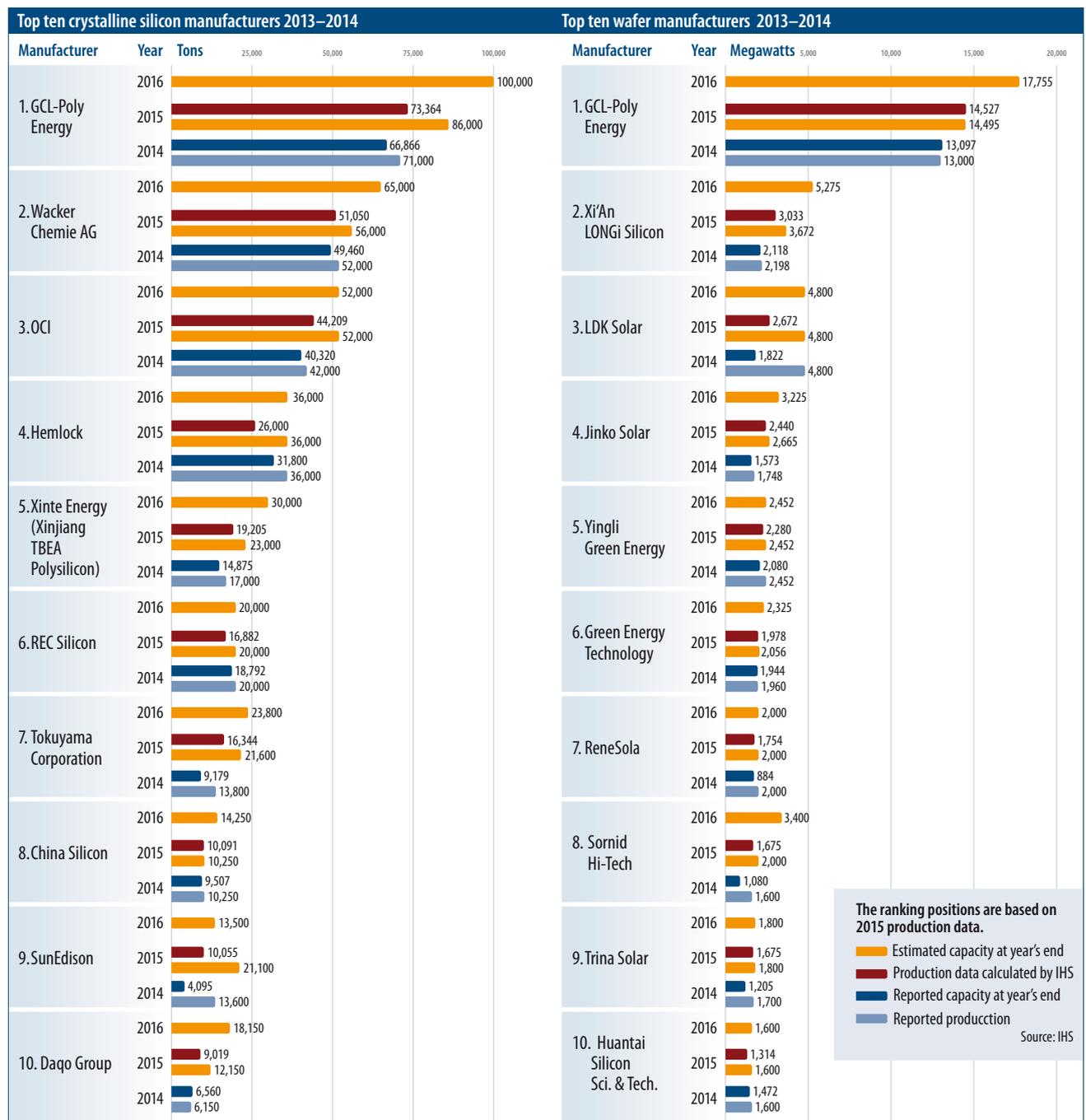
Perhaps the most interesting wafer maker in 2015 was LDK Solar, which returned to third place in production following bankruptcies, restructur-

ing, and very low capacity utilization in 2013 and 2014. It is very difficult to know what is going on with LDK as the company was de-listed from the New York Stock Exchange in 2014 and has not filed financial reports in years. LDK appears to remain something of a zombie, on a financial lifeline from the Chinese government and with little capacity being added. Despite this, IHS reports that LDK managed a 56% capacity utilization in 2015, by far its best in years.

pv magazine has heard rumors that LDK may be taken over by GCL-Poly, but was unable to confirm any evidence of this. Regardless LDK did not increase

its wafer capacity from 2014 to 2015. IHS also does not anticipate any increase in LDK's production capacity in 2016, while its rivals are expanding rapidly.

The second-largest wafer maker in 2015 by output, Xi'an Longi, produces mono-crystalline silicon. Longi remained in third place by capacity during the year, but IHS predicts that the company will surpass LDK as the second-largest wafer maker by capacity in 2016. Despite lower capacity utilizations than multi-wafer makers and prices in the mono-wafer space which have fallen at times to the level of multicrystalline wafers, Longi continues to expand its production



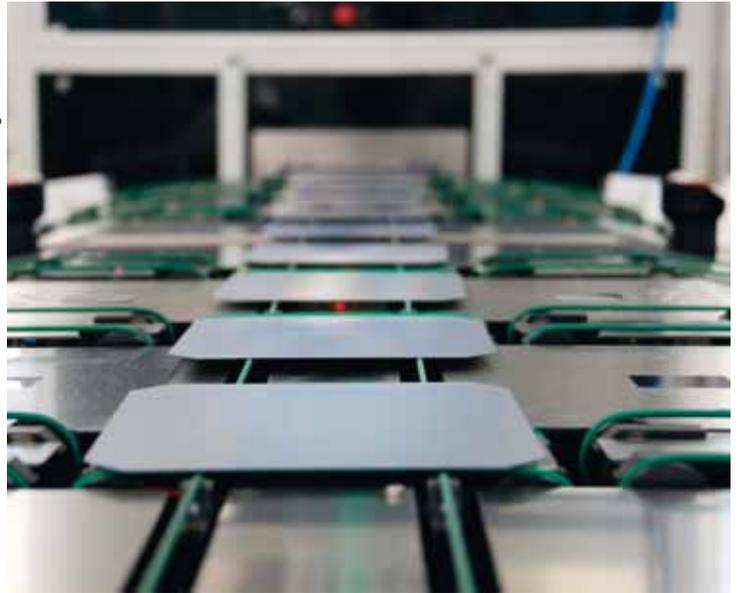
Graphic: pv magazine/Harald Schütt

Photo: MEI Wet Processing



Quality counts with polysilicon supply and Chinese PV manufacturers continue to source large quantities from outside of China.

Photo: Longi Silicon Materials



Mono wafer supply is less constrained than that of multicrystalline silicon wafers.

capacities. Longi and other mono-wafer makers are clearly anticipating a rise in demand for higher-efficiency modules based on monocrystalline silicon. In addition to adding to its wafer capacity Longi is aggressively expanding downstream, and plans to soak up much of its mono-wafer production in new cell and module factories.

Forward into 2016 and beyond

Despite significant oversupply, polysilicon capacity expansions continue. IHS predicts big capacity expansions at GCL-Poly, Wacker Chemie and TBEA Xinjiang, with GCL alone expected to put online 14,000 metric tons of annual capacity in 2016.

These expansions may seem insane given current market conditions, however it takes years to build new polysilicon production. This means that the expansions coming this year were planned years ago, and now producers can only stop them at substantial expense. If there is any good news for polysilicon makers, it is that some facilities are shutting down. REC Silicon is mostly out of the solar market, at least temporarily, and SunEdison has shut down its fluidized bed reactor (FBR) polysilicon plant in Texas. This is bringing down available capacity at least until new factories come online. So far this has not been sufficient to provide meaningful relief to oversupply conditions, which are expected to continue throughout 2016.

There are also implications for the technology mix. With the shutdown of SunEdison's legacy FBR plant, delays in new FBR facilities by GCL and SunEdison, and REC Silicon's Chinese joint venture still under development, FBR's market share is expected to stagnate in 2016.

Looking out to 2017, the situation is less clear. The polysilicon market will depend upon conditions in global PV module end-markets, which are hard to forecast two years out. Johannes Bernreuter warns that China may have problems with grid capacity, and multiple analysts are forecasting policy-related corrections in the U.S. and Japanese markets in 2017. If the year sees relatively flat end-market demand, conditions of oversupply and crushed margins could persist.

However, if demand outstrips new poly expansions in coming years this could mean a rebound for Hemlock Semiconductor. "The interesting question is what will happen with the solar customers of Hemlock once these long-term contracts expire," notes Bernreuter. "Hemlock could be lucky that their long-term contracts expire when the next shortage of polysilicon appears on the market." With the exception of LDK and Yingli, the largest wafer makers are also planning big capacity expansions in 2016, in many cases more ambitious than polysilicon expansions. GCL-Poly is planning a 22% increase in its wafer capacity in 2016, and GET is looking at a 13% expansion. Despite lower factory utilizations in

the mono wafer space, Longi is planning to expand its production capacities by a stunning 44% in 2016.

This may not completely alleviate supply concerns. GCL is expanding its PV module production even faster than its wafers, and this means that less of its production will be available to third parties. The company increased module output fivefold to 2.5 GW in 2015, and plans to reach 6 GW of capacity in 2016.

To fill this void, mid-sized Chinese wafer makers are rising in the rankings through ambitious expansions. Sornid Hi-Tech, the eighth-largest wafer maker in 2015, will have the third-largest capacity in 2016. In the big picture, the ongoing trend is that polysilicon and wafer manufacturing is increasingly concentrated in Asia. Mostly this means China, but there is still some wafer capacity in Taiwan and polysilicon production in South Korea.

Under its unilateral price agreement with the Chinese government, Wacker Chemie is the only Western producer that is successfully navigating this space. Wacker Chemie has new production coming online this year, but with the fall of REC and Hemlock it is now the only large Western supplier to thrive in China's polysilicon market. Wacker has decades of experience in polysilicon and healthy margins, but it cannot be a comfortable position to be the last big player outside of China. The walls are increasingly coming up. ♦

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