

PV manufacturing capacity expansion announcement plans and analysis for Q1 2017

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ABSTRACT

Our preliminary analysis of global solar PV manufacturing capacity expansion announcements in the first quarter of 2017 shows a strong rebound compared with the significantly subdued environment seen in the second half of 2016. A key driver over the period was plans announced by the majority of the 'Silicon Module Super League' (SMSL) members, which are profiled separately in this report.

Although capacity expansion announcements in January remained subdued and followed the low level of activity seen in the second half of 2016, February proved to be the third busiest month since 2014 and the strongest February in more than three years. March did not maintain that momentum but still posted

strong figures, the second highest March figures in more than three years.

As a result, the first quarter of 2017 was the third highest for capacity expansion announcements since the start of the PV industry's second major manufacturing expansion phase in 2014.

As previously noted, January 2017

capacity expansion plans remained subdued, indicating the potential for an end to the latest global expansion phase, after seven months of low activity, primarily due to fears of overcapacity and the fact that global module average shipment prices (ASPs) declined by around 25% in the second half of 2016.



Despite a slow start to the year, PV manufacturers have had a busy first quarter setting out new expansion plans.

Hamwha Q CELLS

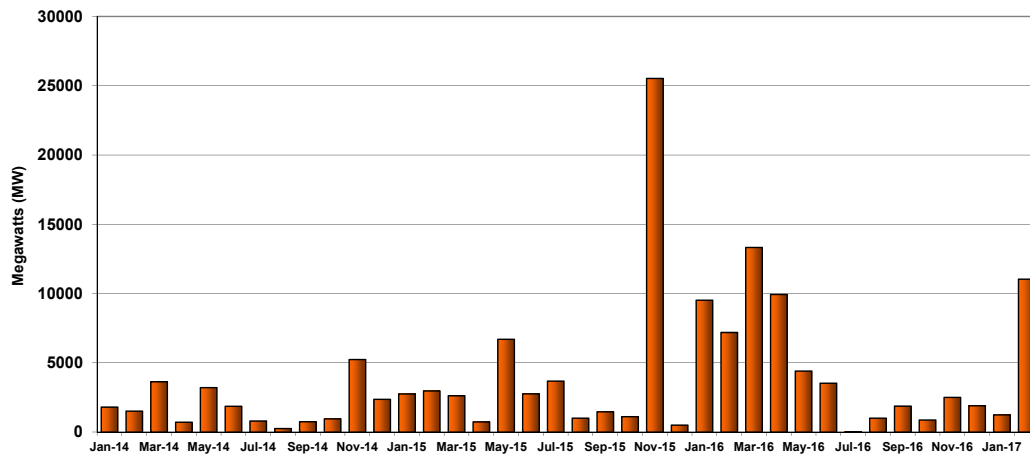


Figure 1. Combined total (c-Si cell, module & thin-film) expansion announcements by month (MW).

A total of 1,235MW of thin-film, solar cell and module assembly expansion plans were announced in January 2017. This included a total of around 370MW of thin-film announcements, 450MW of solar cell and 415MW of module assembly plans.

This low January total was boosted by rare CIGS thin-film plans from China and contrasts with 1,900MW of expansions announced in December 2016.

“The first quarter of 2017 was the third highest for capacity expansion announcements since the start of the PV industry’s second major manufacturing expansion phase in 2014”

February rebound

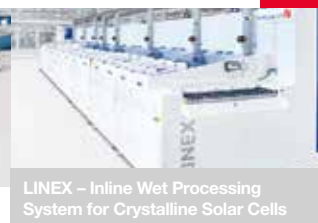
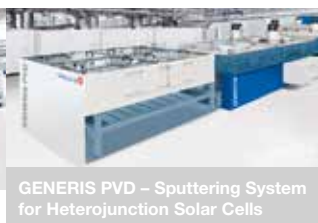
The significant rebound in capacity expansion plans in February 2017 led to a total of 11,040MW of announcements. This included 6,740MW of solar cell plans and 4,300MW of module assembly plans. Photovoltaics International’s preliminary review indicates no new capacity announcements were made in the thin-film sector or for integrated cell and

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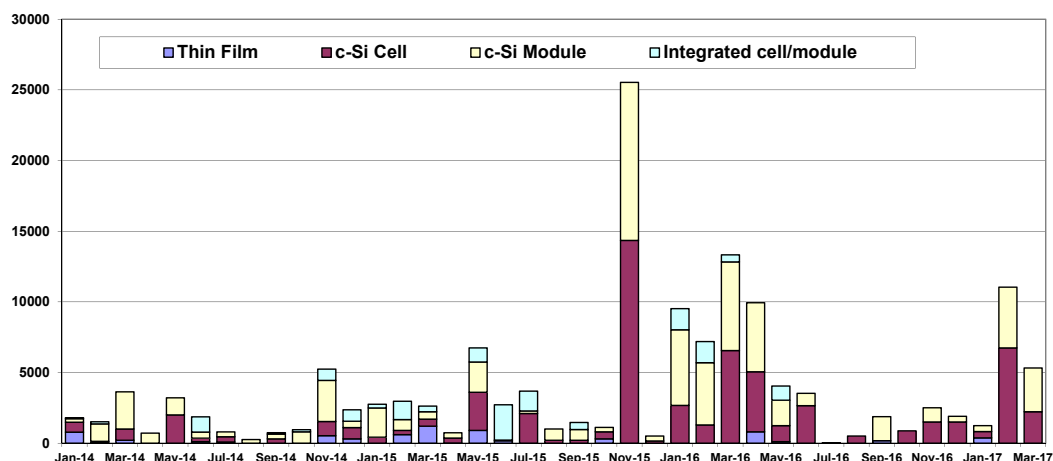


Figure 2. Capacity expansion announcements by product type monthly since January 2014 (MW).

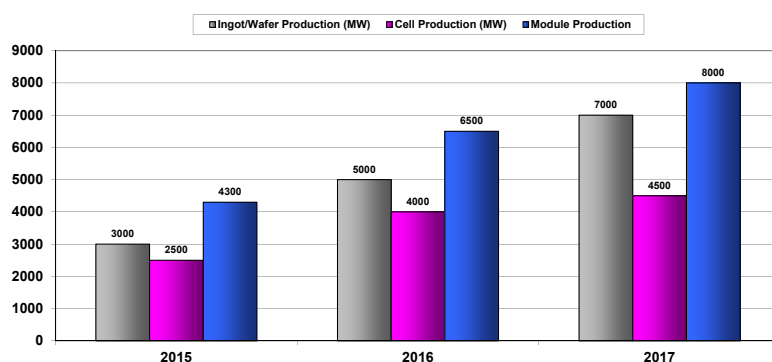


Figure 3. JinkoSolar manufacturing capacity in 2017 (MW).

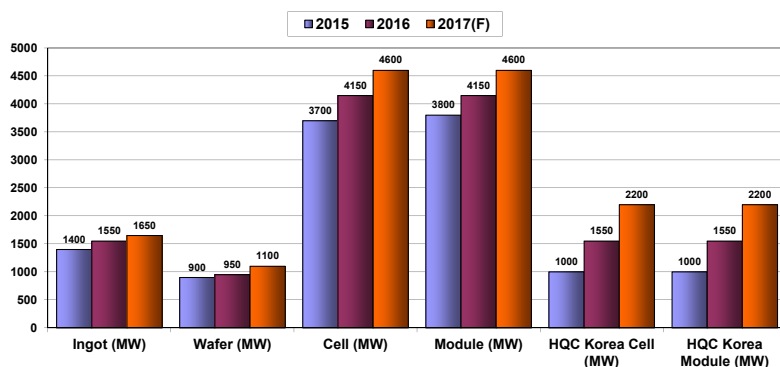


Figure 4. Hanwha Q CELLS manufacturing capacity expansions (MW).

module manufacturing plants.

There were two key trends at play. Firstly, several large announcements

were actually phased expansions over specified and non-specified time frames.

A key announcement was that US

manufacturer SunPower had signed a new joint venture partnership in China to produce both solar cells (p-type mono PERC) and modules for its P-Series technology with its existing China-based supply chain partners Dongfang Electric Company (DEC) and Tianjin Zhonghuan Semiconductor (TZS); that proposal included a manufacturing capacity expansion from 1.1GW to 5GW.

The second key trend was the start of expansion plan updates from 'Silicon Module Super League' (SMSL) members. JinkoSolar was the first SMSL to announce plans to expand in-house solar cell production by 500MW in 2017 and module assembly capacity by 1,500MW.

Also of note in February was the confirmation that Panasonic would take over the formerly SolarCity now Tesla facility in Buffalo, New York State, previously known as Riverbend, now dubbed 'Gigafactory 2'.

However, as the 1GW facility plans had been announced back in June 2014 it does not count as a new announcement from a capacity perspective and is not included in the preliminary new announcements for February.

Perhaps more important is that it seems increasingly possible that Panasonic's expected US\$250 million investment in Gigafactory 2 is only related to module assembly and not HIT solar cell production. This would change the status of the facility from being the largest integrated production plant in the US to being the largest module assembly plant, should it be ramped at some time in the future to 1GW-plus of module capacity only.

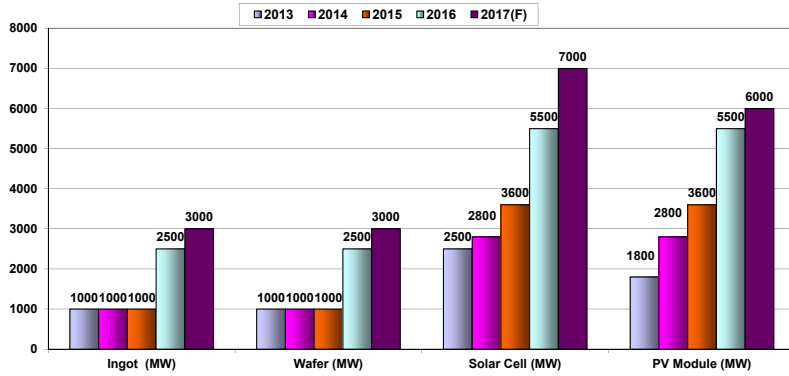


Figure 5. JA Solar in-house manufacturing capacity (MW).

March still strong

Preliminary figures for March 2017 indicate that a total of 5,320MW of new capacity expansion plans were announced. Following on from February, only solar cell and module assembly expansions were announced. This included 2,220MW of solar cell plans and 3,100MW of module assembly plans.

Momentum in capacity expansions was sustained primarily by three SMSL members (Hanwha Q CELLS, JA Solar

and Canadian Solar) reporting on plans for 2017 as part of their fourth-quarter and full-year financial results.

SMSL update

The Silicon Module Super League (SMSL) is our table of the top-ranking module suppliers that collectively are driving many of the trends shaping the market. In the latest quarter they once again played a prominent role.

JinkoSolar

Leading SMSL member JinkoSolar said that it would be expanding in-house ingot/wafer, solar cell and module assembly capacity this year.

The company expects to expand in-house ingot/wafer production from 5GW at the end of 2016 to 7GW by the end of 2017. Around 1GW of the wafer expansion will be monocrystalline based.

The company is still limiting in-house solar cell capacity expansions, adding only 500MW in 2017 to take nameplate capacity from 4GW at the end of 2016 to 4.5GW by the end of 2017.

However, the company noted that it is further migrating cell capacity to PERC technology, having reached 1.4GW of in-house PERC capacity in 2016. The company plans to have reached 2GW of PERC capacity by the end of 2017. JinkoSolar is planning to expand module assembly capacity by 1,500MW, reaching 8GW in 2017.

Hanwha Q CELLS

Caption for fig 4, in here Figure 4. Hanwha Q CELLS manufacturing capacity expansions (MW).

Hanwha Q CELLS and Hanwha Q CELLS Korea are adding a combined 1.2GW of p-type multi/mono PERC

KUKA



Automation in the energy sector

The photovoltaics and battery production are famous growth topics of the energy technology. Especially in the field of e-mobility, the demand for energy storage is of paramount importance. KUKA is aware of these challenges and supports you in your production along the entire value chain.



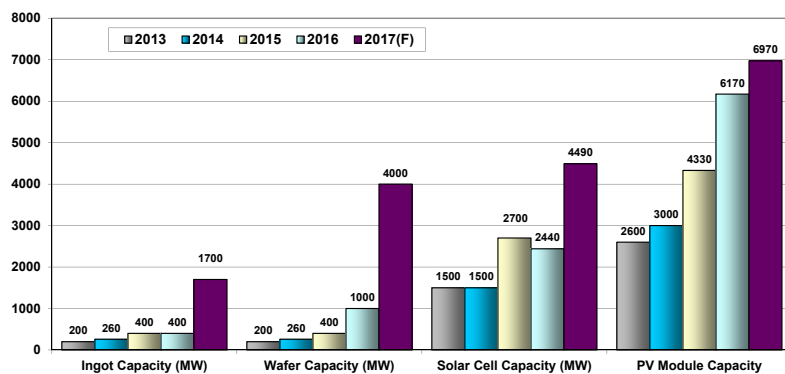


Figure 6. Canadian Solar manufacturing capacity expansions (MW).

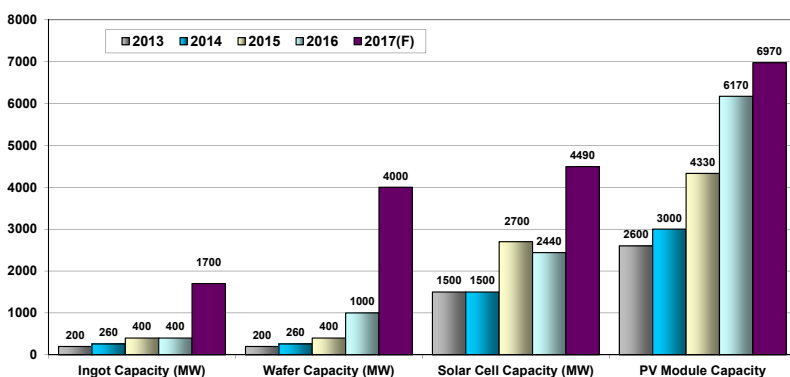


Figure 7. LONGi PV manufacturing capacity goals (MW).

capacity in 2017, including 500MW via PERC upgrades and more mono migration at its facilities in Malaysia and South Korea.

Hanwha Q CELLS also announced plans for an integrated (wafer/cell/module) p-type multi/mono PERC plant in Turkey with a nameplate capacity of 500MW as part of local content rules for developing PV power plants in the country. However, the establishment of plant could be several years away as it seeks government approvals.

JA Solar

JA Solar is continuing to expand manufacturing capacity in 2017 after guiding total shipments to be in the range of 6GW to 6.5GW, up from 5.2GW in 2016.

JA Solar exited 2016 with an in-house annual ingot/wafer manufacturing capacity of 2.5GW, up from 1GW in 2015. In-house solar cell capacity reached 5.5GW, up from 3.6GW at the end of 2015, and in-house PV module capacity also reached 5.5GW at the end of 2016, up from 3.6GW.

The company guided further in-house expansions in 2017, which would mean adding 500MW of ingot/wafer production to reach 3GW and

1.5GW of solar cell capacity to reach an in-house production level of 7GW by the end of 2017.

However, in-house PV module capacity expansions include only a 500MW increase to 6GW by the end of 2017. Management noted in a recent earnings call that its OEM partnership in Vietnam provided an additional 1GW of module assembly capacity to achieve a balanced cell and module nameplate capacity of 7GW in 2017.

JA Solar's 1.2GW Malaysian solar cell facility, which had predominantly produced p-type multi cells, will shift around two thirds of capacity to p-type mono-PERC cells in 2017, according to the company. This equates to a shift of around 800MW of p-type multi-PERC cell production to p-type mono-PERC.

Canadian solar

Canadian Solar is placing a major bet on pushing ahead with the migration to p-type multi PERC cell technology using diamond-wire saw (DWS) and 'Black Silicon' texturing under its 'ONYX' label, instead of increasing p-type mono PERC capacity as many companies are.

The company noted that its in-house

ingot capacity, which stood at a mere 400MW at the end of 2016, would be ramped to 1,700MW by the end of 2017. In-house wafer capacity would also be significantly expanded from 1,000MW in 2016 to 4,000MW by the end of this year. Wafer capacity is expected to reach 2,000MW by the end of June 2017.

These specific expansions would enable Canadian Solar to benefit from a PERC transition, providing higher efficiency cells and modules, while reducing silicon kerf losses and manufacturing cost by avoiding the use of slurries with DWS technology.

With respect to its solar cell manufacturing capacity, which stood at 2,440MW at the end of 2016, Canadian Solar said that it had restored production at two cell lines totalling 240MW at its Funing cell facility in China, which was completely destroyed by a tornado in 2016. An additional 480MW of cell capacity will be ramped in March 2017, while a further 720MW will come on stream in June 2017, providing a combined 1,440MW of p-type multi-PERC cell capacity.

Canadian Solar also noted that its newest 850MW solar cell plant in Southeast Asia was completed in February 2017, with production starting to ramp in March 2017.

As a result, total in-house cell manufacturing capacity is expected to reach 4,490MW by 30 June 2017. The company noted in an SEC filing that this level of nameplate capacity would remain through to the end of 2017. With the completed ramp of its Southeast Asia plant, and without further expansions at its Funing facility, Canadian Solar's in-house cell capacity would stand at approximately 4,730MW.

Having given PV module shipment guidance for 2017, Canadian Solar expects shipments to be between 6.5GW and 7GW this year. Therefore, the company is expanding in-house module assembly capacity from 6,170MW at the end of 2016 to 6,970MW by the end of June 2017.

Combined, SMSL members (JinkoSolar, Canadian Solar, JA Solar and Hanwha Q CELLS) have announced 3,700MW of solar cell expansions and 4,000MW of module assembly expansions for 2017.

With Trina Solar going private before being required to provide fourth-quarter and full-year financial results, the company has yet to make public any new expansion plans for 2017. However, indicative of intent, Trina Solar in January 2017 became a JV partner with LONGi Green Energy

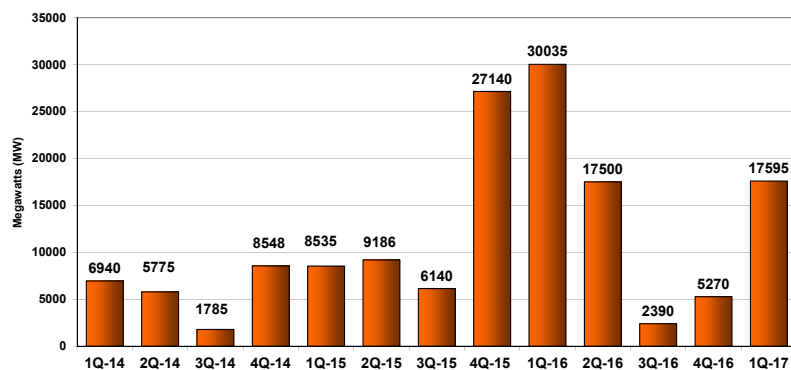


Figure 8. All manufacturing capacity expansion announcements (thin-film, cell, module, integrated) by quarter (MW).

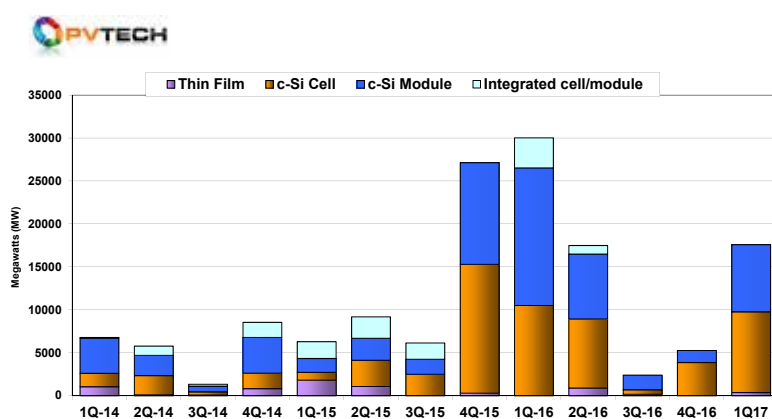


Figure 9. Capacity expansion announcements by product type quarterly (MW).

Technology's previously announced 5GW monocrystalline silicon ingot pulling production plant in Lijiang City, Yunnan Province, China.

LONGi

New SMSL member in 2017 is LONGi Green Energy Technology, which has become the leading fully integrated, high-efficiency monocrystalline module manufacturer in recent years.

LONGi has come a long way very quickly. Annual revenue in 2013, which came solely from selling mono c-Si wafers, was around US\$330 million but skyrocketed to approximately US\$1.67 billion in 2016, almost a 94% increase over the previous year, which had itself generated a revenue growth of around 61%.

The significant increase was due to aggressive capacity expansions at the ingot/wafer, cell and module segments that were perfectly timed with China's downstream end-market growth that resulted in 34.54GW being installed in the country in 2016.

With intense expansion activity in the polysilicon, ingot and wafer

segments supported by several key partnerships, LONGi also plans to expand in the solar cell and module segments, including through overseas production.

Having reached around 2.5GW of cell capacity and 5GW of module capacity in 2016, LONGi Solar is expected to add a further 1.5GW of cell capacity in 2017. This is comprised of ongoing expansions at its 2GW nameplate mono-PERC cell facility in Taizhou, China, and establishment of a 500MW solar cell and module facility in India.

LONGi's vertically integrated ingot/wafer/cell/module facility in Kuching, Malaysia, includes around 500MW of dedicated cell and module production. At the end of 2017, LONGi expects to have approximately 4GW of mono cell production capacity in-house and 6.5GW of in-house module assembly capacity.

LONGi had around 800MW of domestic mono-PERC cell production in 2016, achieving average cell conversion efficiencies of 21%. This is likely to be expanded to around 1.4GW in 2017, with 300MW from

its Malaysian facility providing total mono-PERC cell capacity of around 1.7GW. Average cell conversion efficiencies are expected to reach 21.3% in 2017.

By the end of 2018, LONGi expects mono-PERC cell capacity to reach around 5GW, with domestic capacity at 4.5GW and overseas mono-PERC cell capacity at 500MW.

Should module shipments in 2017 be in the range of 4.3GW to 4.5GW, as guided by LONGi, then the company would become a new member of the SMSL, having achieved shipments of 2.34GW in 2016.

Surprise strong quarter

Preliminary total global PV manufacturing capacity expansion announcements in the first quarter of 2017 were 17,595MW, which just beat the second quarter of 2016, when total expansion plans topped 17,500MW.

The first quarter included 370MW of thin-film announcements, 9,140MW of solar cell and 7,815MW of module assembly. No integrated plant announcements were recorded for the quarter.

The quarter was also notable for a number of possible module assembly expansions, although these lacked meaningful information.

Almost all of the solar cell expansions were for high-efficiency upgrades such as p-type multi PERC, p-type mono PERC, n-type mono heterojunction and bifacial cells. Indeed, 2,100MW was attributed to n-type mono IBC/bifacial cells, due to confirmations to *Photovoltaics International* that Jolywood (Suzhou) Sunwatt had started construction of a new cell production plant in February.

On a geographical basis, China expansions dominated, followed by South Korea and the Philippines. Expansions were also announced in India, Malaysia, Taiwan, Germany, Italy and US.

Conclusion

Although capacity expansion announcements in the second half of 2016 proved subdued, annual updates by SMSL members and some top 15-ranked PV manufacturers resulted in a rebound in the first quarter of 2017. Linked to this recovery was the migration to high-efficiency solar cells whether in new-build lines or upgrades. However, the rebound was also driven by some speculative long-range phased expansion plans, mainly related to modules.