

# PV manufacturing capacity expansion announcements hit new records

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## Abstract

PV manufacturing capacity expansion announcements in 2019 were a stark contrast to 2018, when major policy changes in China impacted the upstream supply chain. This paper looks in detail at not only a significant recovery in capacity expansions throughout the year but also new trends in the capacity scale of announcements and a marked shift in wafer sizes and cell technology. 2019 was also notable for the dominance of Chinese manufacturers announcing new expansions, specifically in China. This was made at the expense of further globalization and a collapse in new announcements in Europe, South East Asia and North America, despite strong downstream PV installation growth. Finally, the paper details an unprecedented level of solar industry capacity expansion plans that were announced in just the first quarter of 2020, easily surpassing any total annual plans in the history of the industry.

## 2019 analysis by quarter

### Q1 2019: solar cells dominate

With the collapse in capacity expansion announcements in the second half of 2018, primarily due to the lack of activity in China, which plummeted to a staggering 40MW, the first quarter of 2019 set a new course for much of the year. The first quarter was dominated by high-efficiency mono cell plans that totalled 10,200MW in January. This was in contrast to the lack of any new solar cell expansions announced in the third quarter of 2018, and only a global total of 590MW being announced in the fourth quarter of 2018 (Fig. 1).

Only one major solar cell expansion plan, however, was announced in January, while the other was for 200MW of mono passivated emitter rear cell (PERC) capacity, via Taiwan-based Tainergy Tech shifting reduced total capacity from China and Taiwan to a new plant in Vietnam with a nameplate capacity of 650MW.

The major announcement in the quarter came from Jolywood (Suzhou) Sunwatt Co. The company has an annual output of 2.1GW of n-type mono tunnel oxide passivated contact (TOPCon) technology, initially developed at Fraunhofer ISE. Jolywood has launched TOPCon modules with seven busbars and incorporating high-efficiency half-cut cells, with power outputs of 440Wp and above. TOPCon cell conversion efficiencies had reached 23.36% by mid-

2019. In January 2019, the company announced plans to establish a strategic partnership with Huajun Industrial, part of the Huajun Group, to expand cell capacity by a further 10GW in Quzhou, China.

In February 2019, total cell capacity expansions announced totalled 6,370MW, but from just three companies. The most significant announcement was plans by China-based PV manufacturer GS-Solar to break ground a 5GW manufacturing base in Jinjiang City. The first phase of the project is expected to be 2GW of heterojunction (HJ) solar cells with an RMB5bn (US\$732m) investment. GS-Solar is targeting 25% cell conversion efficiencies in the new production plant.

News soon followed that Panasonic was transferring a 90% stake in its heterojunction intrinsic layer (HIT) solar cell technology and its plant in Malaysia to GS-Solar as part of a wider collaboration on HIT production expansion and R&D. GS-Solar would become the principal owner and operator of Panasonic's Malaysia plant, while a new company will be formed in Japan with GS-Solar undertaking all HIT R&D activities, which will entail Panasonic's existing R&D activities being separated from the group.

Solar Module Super League (SMSL) member LONGi Solar, which appears strongly in new capacity expansions in 2019, kicked off the year with plans for a 1,259MW mono PERC expansion at its facility in Malaysia.

Rounding-up cell announcements in February was a joint venture between European companies SoliTek and Valoe to expand production of HJ cells by 60MW at a facility in Vilnius, Lithuania, with plans to double capacity to 120MW in the future.

In March 2019, a total of 5,550MW of new solar cell capacity expansions were announced. Again, only three companies accounted for the total. Major SMSLs JinkoSolar and Canadian Solar announced solar cell expansions of 3,000MW and 1,550MW, respectively, at the time of announcing fourth quarter 2018 and full-year financial results. However, the key news came from Turkish industrial and PV project developer EkoRE, which held a groundbreaking ceremony on 11 March 2019 for the world's first vertically integrated HJ technology cell/module factory in Turkey, with an expected nameplate capacity of 1,000MW.

The vertically integrated HJ technology plant will be the first in the world to integrate n-type

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monocrystalline ingot and wafer production through to assembled solar modules at one manufacturing site. EkoRE said that the n-type Czochralski crystal pulling factory would have an initial nameplate capacity of 2GW, while the cell and module capacity would initially be 1GW each. The company is collaborating with HJ equipment and technology specialist Meyer Burger.

Total solar cell capacity expansion plans in the first quarter of 2019 totalled 22,120MW (Fig. 2).

There were no new dedicated module assembly capacity expansion plans announced in January or February 2019. However, in March, Jiangsu Seraphim Solar System in partnership with Shanxi Lu'An Photovoltaics Technology Co. announced a 1,000MW advanced module assembly plant in Shanxi province, China, to produce half-cell, dual-glass half-cell and bifacial half-cell PV modules.

SMSL's JinkoSolar and Canadian Solar announced module assembly expansions of 5,000MW and 2,400MW, respectively at the same time as announcing solar cell expansions planned in 2019.

Total dedicated module assembly plans in the first quarter of 2019 totalled 7,500MW.

**Q2 2019: PERC cells dominate**

The second quarter of 2019 was notable for a few major PERC cell capacity announcements, led by SMSL member LONGi Solar. In April 2019, the company announced plans for a 5,000MW high-efficiency mono PERC cell plant to be built in Ningxia, China. This was accompanied by a 3,000MW cell plant to be located in Yinchuan, China. Also in April, Zhangjiakou HuanOu International (a subsidiary of Tianjin Zhonghuan Semiconductor) announced plans for a 500MW p-type mono PERC cell plant in Zhangjiakou, China.

However, the most notable plans were announced by REC Group, which planned to expand HJ cell and module capacity by 500MW at its Singapore manufacturing hub. Although cited as a 600MW expansion, REC Group had already established 100MW of HJ production in 2018. Meyer Burger is a strategic partner with REC Group.

Only one solar cell expansion was announced in May, which related to China-based Sunport Power adding 1GW of metal wrap-through (MWT) cell capacity in Xuzhou, China. There were no further solar cell expansion plans announced in June.

Second quarter of 2019 solar cell capacity expansion announcements totalled around 11,000MW.

As with the halving of new cell announcements in the second quarter of 2019, compared with the first quarter, PV module assembly plans also subdued.

In April, along with Zhangjiakou HuanOu International's planned 500MW cell plant, a module assembly plant of the same capacity was also announced. Also notable in April, was the 500MW fully automated module assembly plant planned by AE Solar in Kutaisi, Georgia.

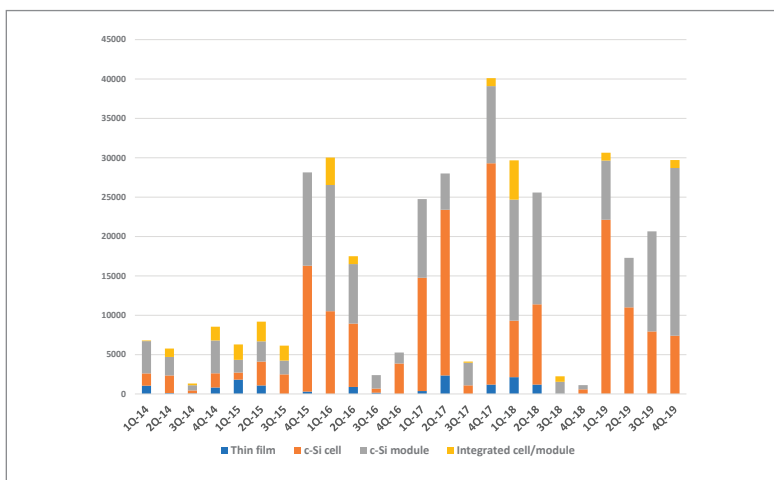


Figure 1. Total quarterly capacity expansion announcements by product type 2014–2019 (MW).

May followed a similar trend with Sunport Power's matching 1,000MW MWT module assembly expansion and Philadelphia Solar planning to add 280MW of module assembly in the Al Qastal Industrial Area, Amman, Jordan. The only announcement in June 2019 was LONGi Solar's plans for a 5,000MW module assembly plant in Taizhou New Energy Industrial Park, Taizhou City, Zhejiang Province, China.

Total module assembly capacity expansion plans in the second quarter of 2019 reached 6,285MW.

**Q3 2019: heterojunction dominates**

Total capacity expansions in Q3 2019 were higher than in the second quarter, with major plans being announced for new HJ cell and module assembly plants, primarily in China, in the third quarter.

A total of over 7,500MW of new HJ solar cell plants were announced in July 2019 by three companies: Jiangsu Akcome Science & Technology Co, Risen Energy and an unidentified customer of Meyer Burger in North America. Akcome plans a 5,000MW HJ plant in Changxing, Zhejiang province, China, while Risen Energy is planning a 2,500MW HJ plant in Ninghai, Hejiang province, China. Few details have been reported by Meyer Burger, other than the signing of a US\$100m heterojunction equipment order.

In August, Oxford PV confirmed its 250MW perovskite-on-silicon solar cell manufacturing line being added to its facility in Brandenburg an der Havel, Germany. No solar cell capacity expansions were announced in September.

Total solar cell capacity expansions announced in the third quarter of 2019 reached almost 8,000MW.

Along with Akcome's and Risen Energy's HJ cell announcements, equivalent capacity is planned for module assembly. Also of note in July was a further 5,000MW assembly plant announced by LONGi Solar, which would be located in the Xianyang High-tech Industrial Development Zone of Xianyang City, China.

There were no module assembly expansion plans announced in August and only one in September – a 500MW expansion confirmed by Waaree Energies

at its facility in Vapi, Gujarat, India bringing its total capacity to 2,000MW.

New module assembly capacity announced in the third quarter of 2019 reached a total of over 13,200MW.

**Q4 2019: module assembly dominates**

With module assembly capacity plans exceeding cell expansion plans in the third quarter of 2019, that trend continued in the fourth quarter, which witnessed an overall increase in module assembly capacity expansion figures above those in the second and third quarters.

October 2019 was dominated by one company. LONGi announced a 5,000MW mono PERC solar cell plant in Xi'an Xincheng City, China. No other solar cell expansions were announced in this month.

As in the previous month, November had only one company announcing solar cell expansions. Jinneng Clean Energy Technology (Jinergy) announced a 2,300MW mono PERC cell expansion, as well as a doubling of capacity of an existing HJ line to 200MW. The PERC expansion takes nameplate capacity to 4.5GW.

In December, no expansions were announced for solar cell expansions. However, Jiangsu Akcome Science & Technology Co announced a 1,000MW integrated HJT cell and module project.

In the fourth quarter of 2019, total solar cell expansion announcements topped 7,400MW.

LONGi Solar was also the only company to announce a further 10,000MW of new module assembly plants in October. The company is planning a 5,000MW assembly plant, dubbed Luzhou Phase II, in Zhangzhou, China. The second 5,000MW assembly plant is to be built in Xianyang High-tech Industrial Development Zone, Xianyang, China.

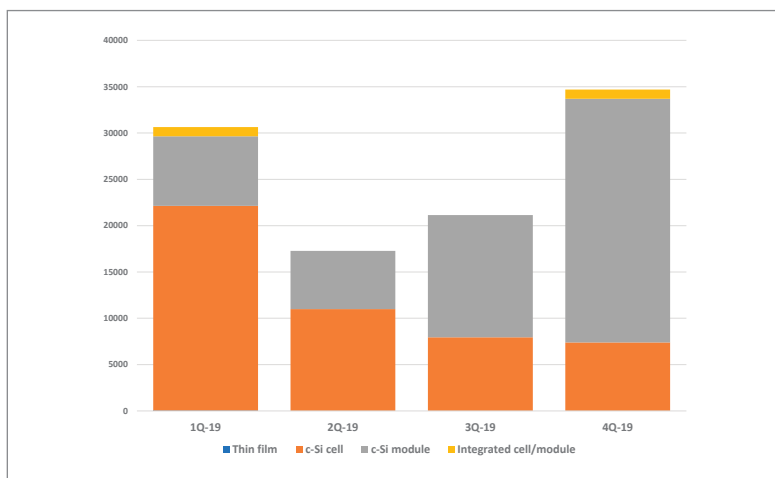
Module assembly also dominated new capacity announcements in November, as over 6,000MW was announced from four companies. Because of stronger demand than expected, SMSL members JinkoSolar and Canadian Solar announced module assembly expansion plans of 1,000MW and 2,000MW, respectively. Included in the November figures was Jinergy's 2,300MW assembly expansion to go along with the mono PERC cell expansion. Finally, India-based Vikram Solar proposed increasing module assembly by 1,000MW should Indian government policies support the expansion. The expansion would almost double module capacity.

Wuxi Suntech, on the last day of the year, announced a new 5GW high-efficiency, large-area wafer, fully automated module assembly plant in the Yangzhou Economic and Technological Development Zone, Jiangsu province, that would be operational in 2020.

In the fourth quarter of 2019, announced module assembly expansion plans totalled 26,300MW.

**2019 geographical review**

With a major pick-up in capacity expansion plans



**Figure 2. Quarterly capacity expansion announcements by product type in 2019 (MW).**

**“With module assembly capacity plans exceeding cell expansion plans in the third quarter of 2019, that trend continued in the fourth quarter.”**

in 2019, compared with 2018, driven by almost complete shutdown in future planning from Chinese manufacturers, the geographical capacity expansion map looks completely different to that seen in 2018 (Fig. 3).

In 2018, China accounted for only around 20,000MW of total combined cell, module and thin-film capacity expansions, or 37% of the total; India accounted for 28% of the total, while Egypt, the USA and Turkey accounted for 18%, 7% and 5%, respectively. A total of 15 countries announced capacity expansion plans in 2018.

In 2019, however, China accounted for over 90,000MW of combined cell, module and thin-film capacity expansions, or 94% of the total; India, Malaysia and Turkey accounted for 2%, 1% and 1%, respectively. A total of only 13 countries made announcements of capacity expansion plans in 2019.

The highly speculative 16GW of combined expansion plans in India in 2018 dwindled to just 1,000MW of the 1,500MW total in 2019. Clearly there has been major shift back to China in 2019. Expansions in South East Asia (Malaysia, Indonesia and Vietnam) have been minimal, and the small flurry of module assembly activity in the USA in 2018 did not continue into 2019.

Small, sporadic announcements, typically module assembly related, occurred in Jordan and Saudi Arabia.

**2019 manufacturing trends**

A trend noticeable in the last three years has been the scale of company announcements, particularly in China. Typically, the 500MW expansion or new plant announcements have given way to nameplate capacities of 5,000MW and above in 2018 and 2019. Indeed, 10,000MW expansion plans have been noted in 2019.

However, many plans announced that are in the 5,000 to 10,000MW range tend to include

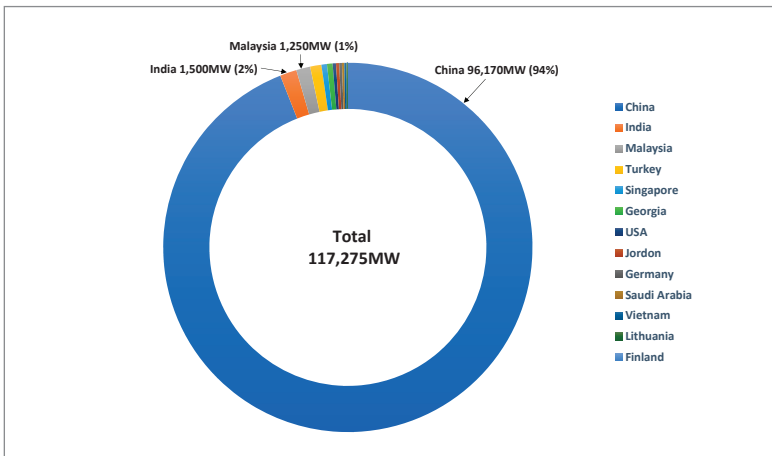


Figure 3. Total capacity expansion announcements by country in 2019 (MW).

multiple phases that can span several years at a given location(s). The scale of many greenfield site announcements means that timelines for construction through to tool install and ramp lends itself to an initial multi-gigawatt phase, especially with new solar cell capacity, taking longer than 12 months. The following tool install and ramp phases can be done significantly faster.

A consequence of multiphase build-outs is that some companies that made major expansion announcements in 2017, for example, have not announced new capacity expansions since, as they execute on multiphase, multi-year plans previously initiated. This has led to a drop in the number of companies announcing plans on an annual basis. However, it also provides insight into when these

sorts of company might announce new multi-gigawatt, multiphase and multi-year plans.

Another trend gaining momentum has been the need to dedicate capacity within a 2,000 to 5,000MW solar cell plant to different large-area wafer sizes. Though clearly a strategy seen with major merchant cell producers, such as Tongwei Solar and Aiko Solar, rapid migration to several large-area wafer sizes at SMSLs, in order to benefit from lower cost per watt at large plants, has also meant dedicated cell lines for different wafer sizes. That trend should be short-lived, as within the next few years the industry is more likely to end up adopting the largest wafer size (210mm x 210mm), which was just entering volume production at the end of 2019. However, it should also mean a forthcoming phase of tool upgrading at the multi-gigawatt level, which would also boost nameplate capacity at existing cell plants.

### 2019 summary

Total solar cell capacity expansion announcements in 2019 topped 48,000MW, compared with almost 18,000MW in 2018. With cell expansions, primarily for high-efficiency p-type mono PERC, dominant in 2018, heterojunction cell technology announcements have significantly increased in 2019, reaching at least 14,000MW, compared with just over 1,000MW in 2018. It should be noted, however, that with many HJ announcements being multi-gigawatt plans, these should be treated as multi-year projects, not least because many could initially only deploy pilot manufacturing lines.

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Dedicated module assembly capacity expansion announcements in 2019 also increased, topping 53,000MW, compared with 31,600MW in 2018.

Integrated cell and module capacity (where stated) was around 2,000MW in 2019, compared with 5,700MW in 2018.

Solar cell capacity expansions and module assembly expansions were overall well balanced in 2019, despite greater module assembly activity in the second half of the year.

Thin-film expansion announcements in 2019 were almost non-existent and well below 100MW. However, as noted in the manufacturing trends section of this paper, since 2017 there have been announcements of multi-gigawatt multiphase projects, which included thin-film companies. As these project expansions reach completion, new announcements could happen in 2020.

Combined total capacity expansions in 2019 sailed past 117,000MW, compared with over 58,000MW in 2018. As a result, 2019 was a record year for nameplate capacity expansion announcements, surpassing 2017, when announcements topped 97,000MW.

### A record setting Q1 2020

Preliminary data compiled by PV Tech highlights an unprecedented level of announcements of solar industry capacity expansion plans in just the first quarter of 2020, easily surpassing any total annual plans in the history of the industry (Fig. 4).

PV Tech’s preliminary analysis of upstream manufacturing capacity expansion announcements in Q1 2020, across ingot/wafer, solar cell and module assembly segments combined, exceeded a staggering 500GW (Fig. 5). To put this in perspective, this is more than double PV Tech’s preliminary analysis of capacity expansion plans announced in 2019 (a combined total of just over 228GW). The vast majority of announcements in Q1 2020 were driven by China-based PV manufacturers revealing plans for facilities in China.

### Ingot/wafer expansions

Capacity expansion announcements in Q1 2020 related to the combined ingot and wafer segment exceeded 123GW, compared with approximately 118GW of expansion plans announced in all of 2019, according to preliminary PV Tech data.

### Solar cell expansions

Solar cell (c-Si) capacity expansion announcements in Q1 easily topped 212GW. This contrasts with PV Tech’s preliminary 2019 figures of planned expansions topping 53GW.

### PV module assembly expansions

With regard to total module assembly capacity expansion announcements in just Q1 2020, preliminary figures suggest almost 164GW has been reached. In comparison, total module assembly capacity expansion plans in 2019 reached nearly 57GW.

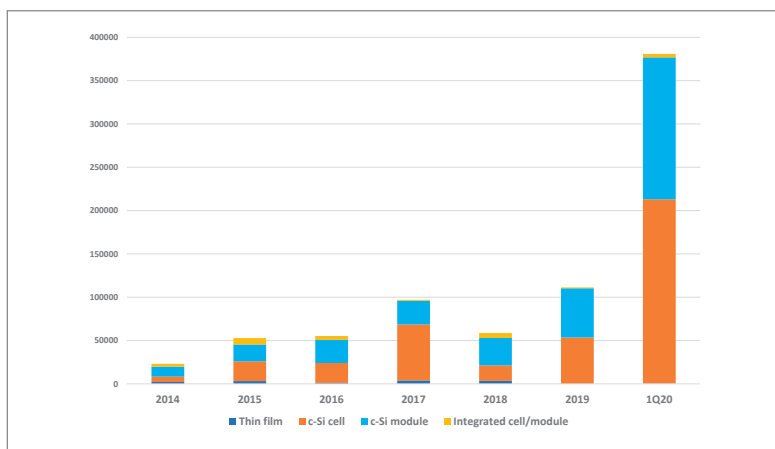


Figure 4. Annual capacity expansion plans by product type in 2019 vs. Q1 2020 (MW).

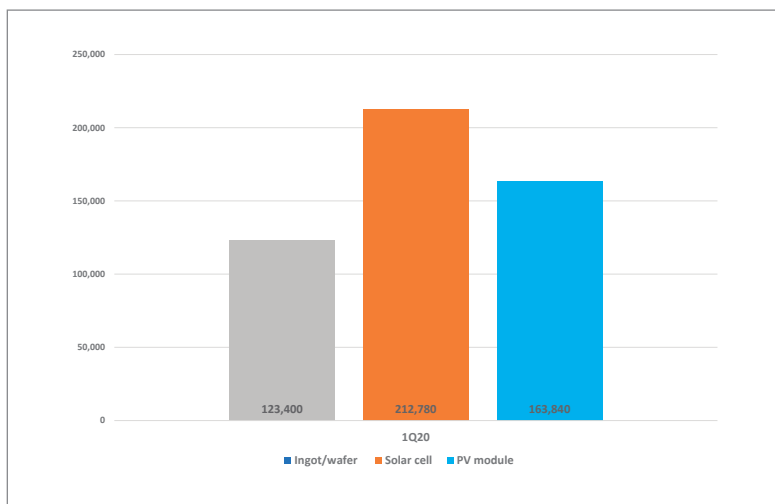


Figure 5. Capacity expansion announcements in Q1 2020 by product type (MW).

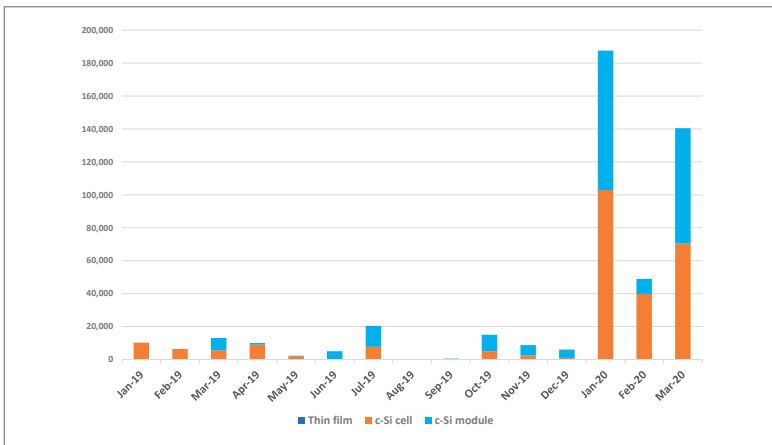
### Q1 2020 by month

#### January 2020

The most active month for capacity expansion announcements in the first quarter of 2020 was January, leading up to Chinese New Year celebrations. A preliminary total of 22 companies announced expansion plans in this month, which was dominated by over 102GW of solar cell expansion announcements, followed by module assembly plans totalling almost 85GW (Fig. 6). Preliminary ingot/wafer expansions exceeded 52GW in January.

Key announcements kicked off in early January, when JA Solar announced plans to expand mono solar cell and module assembly capacity by 10GW each. Major merchant cell producer Aiko Solar announced expected capacity ramps over a three-year period totalling 12.8GW in 2020 alone, and totalling almost 36GW through 2022.

**“PV Tech’s preliminary analysis of upstream manufacturing capacity expansion announcements in Q1 2020 exceeded a staggering 500GW.”**



**Figure 6. Monthly capacity expansion plans by product type Q1 2020 (MW).**

### February 2020

Not surprisingly, the extended Chinese New Year, travel restrictions and escalating impact of COVID-19 led to only eight companies announcing further capacity expansion plans in February. The month was again dominated by solar cell expansion plans that totalled almost 40GW, with only 9GW of module assembly expansion plans and zero plans to add ingot/wafer capacity, according to PV Tech's preliminary analysis.

Highlights included an announcement by major merchant solar cell producer Tongwei Group of further expansions plans which entailed a new 30GW manufacturing hub. JA Solar's second wave of plans totalling 8.6GW is also of note, including cell technology upgrades that would boost nameplate capacity in 2020.

### March 2020

Despite COVID-19 challenges escalating through early to mid-March, well over 70GW of new ingot/wafer capacity expansion plans were announced in China, followed by just over 70GW of solar cell and 70GW of module assembly plans. Despite the very strong figures, however, only five companies contributed to the preliminary total in March, which was dominated by GCL System Integration Technology (GCL-SI) and LONGi Group.

In late March, GCL-SI announced a new 60GW megacomplex to house the complete manufacturing supply chain to feed 60GW of annual PV module production in a multiphase, multi-year plan. LONGi also announced another wave of future expansions that included a 10GW mono ingot project, a 7.5GW mono solar cell project, a 5GW module assembly project and an advanced integrated cell and module project totalling 680MW.

### Key trends in Q1 2020

With manufacturing equipment costs significantly lower than five years ago, having module assembly plants with lower utilization rates has little impact on production costs when companies are already at significant scale. This also applies to solar cell production plants but to a lesser degree.

The large-scale announcements are being fuelled by near-term end-market growth projections, coupled with a major technological race to achieve higher conversion efficiencies and lower production costs. That will also displace more than 100GW of legacy manufacturing from multicrystalline ingot/wafer capacity to p-type and n-type monocrystalline with large-area wafers, to next-generation cell technologies, such as HJT, after the mainstream PERC era.

However, there was a relatively large number (seven) of announcements in Q1 2020 related specifically to integrated high-efficiency (HJT) cell and module projects, totalling around 4,400MW, which could be highly speculative through 2020. The number of HJT announcements in the last 15 months, regardless of some being speculative rather than becoming effective capacity, indicates that HJT is the clear next-generation (post-PERC) choice for PV manufacturers.

It should also be noted that the analysis does not include HJT activity from major mid-term expansions from the likes of GCL-SI, Aiko Solar and Tongwei, which is understood will include HJT production lines in future expansion phases recently announced that span several years.

## Technical notes

### Preliminary data

The data for the capacity expansion plans for 2019 and Q1 2020 remain 'preliminary' because a number of public-listed companies are still due to report full-year 2019 financial results through to the end of April 2020. Companies will often have added capacity in a financial year that was outside specific announcements or an expansions-only feature, or that can be analysed in annual reports. Therefore, there is a level of backdating necessary as well as time required to obtain confirmations of expansion plans when very little or no data existed.

### Effective capacity

Historically, capacity expansion announcements are no guarantee that such plans will go ahead. Should plans be executed, the capacity becomes 'effective capacity'. The process can typically take between 12 and 18 months from when plans are announced to when capacity is converted to effective capacity.

Since 2014, PV Tech's analysis has shown that the conversion rate of plans/announcements becoming effective capacity can be as little as 50%. Many factors are at play, including low conversion rates for start-ups or new industry entrants to next-generation technology adopters. Certain countries and regions have also proved to have a history of perennially low conversion rates, some being as high as 90%. The inability to raise necessary funds, changes in market dynamics, and the lack of inward investment incentives are also factors contributing to low conversion rates, after expansion announcements are made.