

First Solar goes back to the future

By Mark Osborne, senior news editor, Photovoltaics International

ABSTRACT

Leading CdTe thin-film module producer First Solar is shifting its business emphasis back to module sales after becoming a leading PV project developer as part of a mid-term business plan that takes advantage of its restored cost-per-watt advantage and two new module products that will be introduced in the coming years that are intended to further its competitive position. We analyze the key metrics behind the transition, such as R&D expenditure, module conversion efficiencies and production capabilities and cost reductions.

The significant transition and new product introductions were announced at First Solar's 2016 Annual Analyst Day event in early April.

The company gave the first public insight into its next-generation module technology that not only relies on years of continued CdTe efficiency gains from world records set in both the lab and lead module lines but completely diverges from its existing module form factor.

First Solar is planning on introducing its 'Series 6' modules with 400W output using a completely new tool set for a large-area module. The Series 6 modules are in the league of those originally

developed by Applied Materials under its 'SunFab' brand for a-Si thin-film modules, which had some of the key deposition toolset derived from the FPD (Flat Panel Display) sector.

According to Raffi Garabedian, CTO at First Solar, the new technology, which is still under development, would be a major game changer as it would have significantly lower production costs when compared to the smaller form factor modules it has been producing to date.

The impression given during the event was that the Series 6 module would have a 2019 launch onwards and initially exclusively used on its own PV

power plant projects as the modules would likely require different mounting system design for fixed ground-mount and single-axis tracker systems as well as assisted mechanical handling systems due to size and weight.

The company noted that production tool orders were perhaps a year away from being placed, with dedicated 'greenfield' production facilities taking around 18 months to build, equip and be ready to potentially ramp in the late 2019 timeframe. Looking back over First Solar's previous manufacturing ramp profiles for its main production facilities in Malaysia, the company is expecting fab construction,



Credit: First Solar

First Solar is shifting the focus of its business to direct module sales once again, backed up by two significant new product launches.

Fab & Facilities

Materials

Cell Processing

Thin Film

PV Modules

Market Watch

qualification and ramps along similar timelines to before.

The Series 6 modules were said to provide a significant production cost reduction compared to what First Solar has achieved with its previous modules, which have remained at the US\$0.65/W capex level. First Solar said the large-area modules and new production line technology would also enable higher throughput levels than previously achieved, which stand at around 103MW capacity per line.

The second significant product development was the planned launch of its Series 5 module, a three-horizontal-stacked module unit the equivalent size and form factor of conventional c-Si 72-cell modules, widely used in utility-scale PV power plant projects. The Series 5 module system would initially be available in a late 2017, with fleet production line module efficiencies in the 17% range.

Pre-assembled at its existing

production plants, the Series 5 was said to provide a 'standardized' product offering to potential customers that had previously stayed with c-Si modules to simplify balance-of-system procurement and reduce costs.

Providing a system with an initial 365W (Pmax), First Solar said it expected strong interest in the new module format, enabling the company to tap into EPCs and project developers that would have liked to use its thin-film modules in the past but were deterred by the non-uniform format, fixings and raking systems. This could be a significant market opportunity, according to the company, though a part from the claimed higher energy density factor over a c-Si module, Series 5 would seem to bring the company in line with rather than ahead of its 72-cell c-Si technology rivals.

Underlying the new module product offering would be continued performance enhancements to its current fleet of 30 operating

production lines with continued focus on conversion efficiencies as per an updated roadmap.

Research and development

First Solar's perennial heavy spending on R&D can partially be explained by the proprietary nature of its CdTe production equipment and processes. The company has been ranked first in annual R&D spending for seven consecutive years (2009-2015), according to Photovoltaics International analysis of 12 key PV manufacturers undertaken each year.

First Solar allocated US\$130.6 million to R&D activities in 2015, compared to US\$143.9 million in the previous year. The lower spending year on year was attributed to reduced material and module testing costs associated with the development cycle of its next-generation modules.

Indeed, R&D spending would seem to have peaked in 2014, yet the company had exceeded annual spending above US\$100 million per annum since 2011. Based on R&D expenditure levels in the first quarter of 2016, First Solar is on track to allocate over US\$120 million to R&D activities in 2016, suggesting Series 6 module development will be a key focus through to volume production timelines.

Importantly, the company is on track in 2016 to exceed US\$1.0 billion in cumulative R&D spending since 2007, the first company to surpass the milestone and around double that of its nearest R&D spending rival, SunPower.

Although the company splits spending between manufacturing and downstream modular power plant developments, emphasis has been intensified in the last three years on thin-film module efficiency gains and line throughput increases.

Conversion efficiencies

Industry-leading R&D spending has returned a number of conversion efficiency records both at the cell and module levels in recent years.

At the beginning of 2015, First Solar reported a research cell with a conversion efficiency of 21.5%. First Solar said in June 2015 that it had surpassed multicrystalline module conversion efficiencies for the first time, with its CdTe module efficiency reaching a record 18.6% corresponding to the company's eighth major update since 2011.

First Solar then set a new world record research cell conversion efficiency of 22.1%, certified at the Newport Corporation's Technology and



Figure 1. First Solar revealed its large-area Series 6 module at its 2016 Analyst Day event

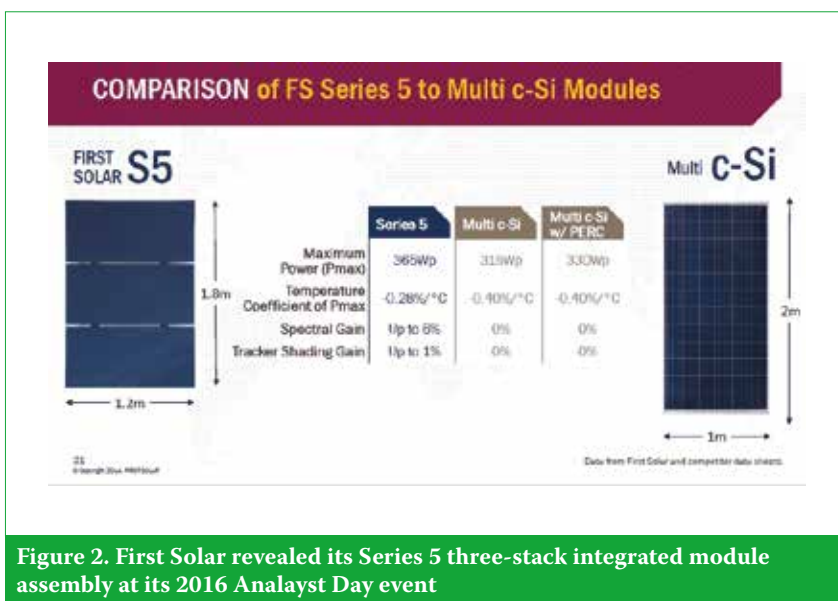


Figure 2. First Solar revealed its Series 5 three-stack integrated module assembly at its 2016 Analyst Day event

Applications Center (TAC) PV Lab in February 2016. According to First Solar, this was the ninth major update to CdTe record efficiency since 2011. The record cell was said to have produced at First Solar's Perrysburg, Ohio manufacturing factory and Research & Development Center using processes and materials applicable to commercial-scale manufacturing.

First Solar noted that in the fourth quarter of 2015 its lead manufacturing lines were producing PV modules with 16.4% conversion efficiency.

At the fleet level, First Solar said it reached average module efficiencies of 16.1% at the end of 2015, with guidance of achieving 16.7% at the end of 2016.

As the module efficiency chart shows, First Solar has achieved around 0.4%

to 0.5% efficiency gains per annum at its volume production lines through 2013. However, a major programme implemented in 2014 and completed in 2015 led to a 1.7% module efficiency gain in 2015 and a further 0.6% gain expected in 2016. The company has therefore achieved module conversion efficiencies of more than 0.5% over the last 10 years.

The major upgrade included the implementation of R&D work with equipment upgrades. In basic terms, First Solar's R&D efforts have been able to improve short-circuit currents and fill factor (FF), with increased open-circuit voltage and carrier lifetime, supported by recent record lab efficiencies. Equipment upgrades included high precision laser structuring or patterning of CdTe solar cells.

First Solar currently expects its research solar cell roadmap to achieve 24% conversion efficiencies over the next one to two-year period. Research modules efficiencies are expected to reach 19.4% in 2016 and 21.7% in the next one to three-year period.

Manufacturing capacity expansions

Expectations ahead of the analyst event had been that due to First Solar's PV project pipeline and third-party demand for its modules, which had combined to push all operating lines to full utilization levels in the fourth quarter of 2015, the company would announce a new wave of capacity expansions.

Some analysts seemed disappointed when Tymen deJong, COO of First Solar, noted that despite the ability to produce one module per second that time figure would not be decreasing just now.

First Solar acknowledged that it had retained the eight production lines (800MW) of equipment previously mothballed after closing its two manufacturing facilities in Germany but had not determined when these lines would be upgraded to existing line efficiency and throughput levels and deployed in an unspecified location(s).

Management highlighted that it would keep all production lines running at full capacity in 2016, which had equated to 3.1GW produced in 2015, up from 2.5GW in 2014, when lower utilization rates and fewer lines were in operation.

In contrast to R&D expenditure since 2011, First Solar's capital expenditures have declined sequentially, reaching a low of US\$166.5 million in 2015. The sequential declines are primarily attributed to underutilisation rates and excess capacity to demand during the period.

However, based on First Solar's capex guidance for 2016 (US\$300 million to US\$400 million) upgrades to both its mothballed equipment and implementation of automated Series 5 module assembly plans are already underway. The company has subsequently noted in its Q1 2016 earnings call that around US\$130 million of planned capex in 2016 would be allocated to the launch of its Series 5 product.

Beginning in late 2017, deJong noted that the company could deploy four mothballed lines (400MW) of current Series 4 modules and add a further four upgraded mothballed lines (425MW) in a new facility in 2018.

The ramp of its Series 5 module

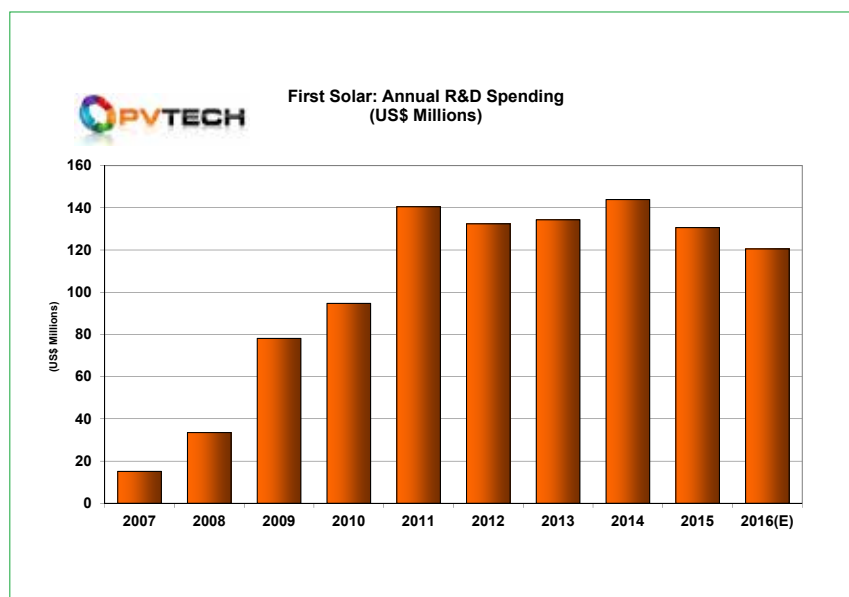


Figure 3. First Solar annual R&D spending (US\$ millions)

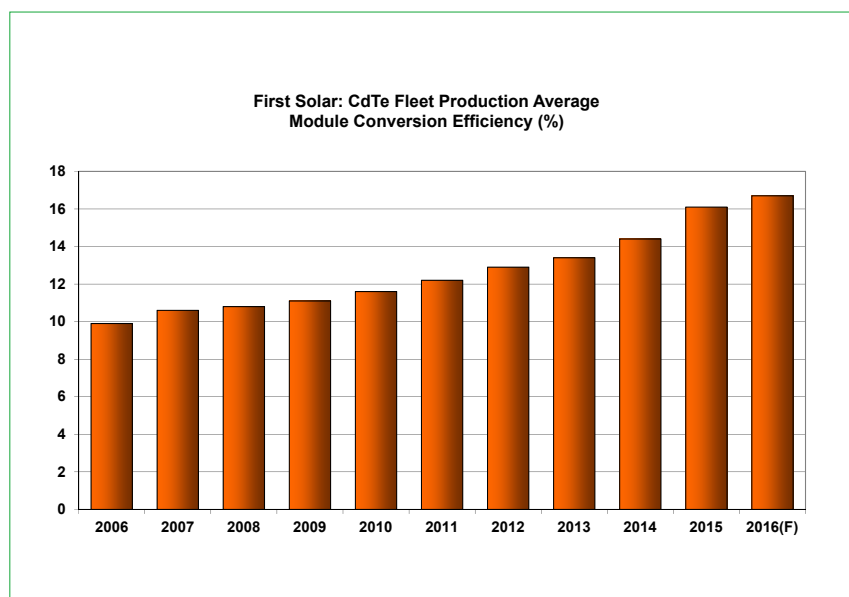


Figure 4. First Solar: CdTe fleet production average module conversion efficiency (%)

system would initially include four lines that will have the stacked module assembly tools added in late 2017 with full production expected in 2018. Additional Series 5 production lines would be added based on market demand.

First Solar noted that a greenfield Series 5 production facility with a capacity of around 450MW would require capital expenditures of around US\$300 million, and an 18-month construction timeline.

The impression given was that some existing Series 4 lines would add the assembly tools required for Series 5 modules as and when required. The Series 5 module lines were said to have a calculated capital cost of around US\$0.45/W, slightly higher than Series

4 at US\$0.35/W, due to the additional stack assembly equipment.

In 2019, First Solar highlighted the potential to start ramping its Series 6 modules that would be housed in a new dedicated facility, but would carry only a capital cost of around US\$0.40/W. Around 2GW of Series 6 production could be in operation in 2020, the company said.

Capacity of 2GW of Series 6 modules would require US\$800 million in capital expenditure and 18 months construction of a greenfield site, as previously noted. However, a potential capacity expansion roadmap was provided that could take capacity to close to 7GW in 2020.

It should be noted that although emphasis is naturally being placed on

the two new product introductions, a significant nameplate capacity of existing Series 3 (small-area) modules will remain in production.

However, a knock-on effect of retaining full utilization rates in 2016 is a slowdown in expected module conversion efficiency gains. Indeed R&D activities being focused on Series 6 development and implementation would also limit improvements in the short-term.

Business model shift

With significant capital expenditures potentially ahead in 2018 through 2020 for the large-area Series 6 modules and to a lesser extent the Series 5, subject to greenfield needs and demand, increasing its PV project completions is likely to strain First Solar's balance sheet.

Highlighting recent well known bankruptcies and distressed companies in the solar sector, management said First Solar would follow a strictly conservative approach to both upstream capacity expansions and downstream project development.

Indeed, the sacrificial lamb in this strategy would seem to be the downstream project development arm, which First Solar will keep at around current annual completion levels, while re-emphasising its earlier status of being a module producer and supplier with the eventual added capacity.

An advantage of a renewed emphasis on module business was claimed to be the better margins achieved with higher efficiencies, new market opportunities with Series 5 and significant margin improvement with the deployment of Series 6.

Management noted that pushing its PV project pipeline further out to the ramp of Series 5 and 6 would only add further margin improvement to its balance sheet, limiting the expected effect of its net cash balance declining through 2020 due to the capacity expansions.

Conclusion

As detailed, First Solar is shifting emphasis back to module sales as part of a mid-term business plan that takes advantage of its restored cost per-watt advantage and two new module products to be introduced in the coming years that further its competitive position. With a shift to large-area thin-film modules, initially championed by Applied Materials a decade ago, First Solar is going back to the future.

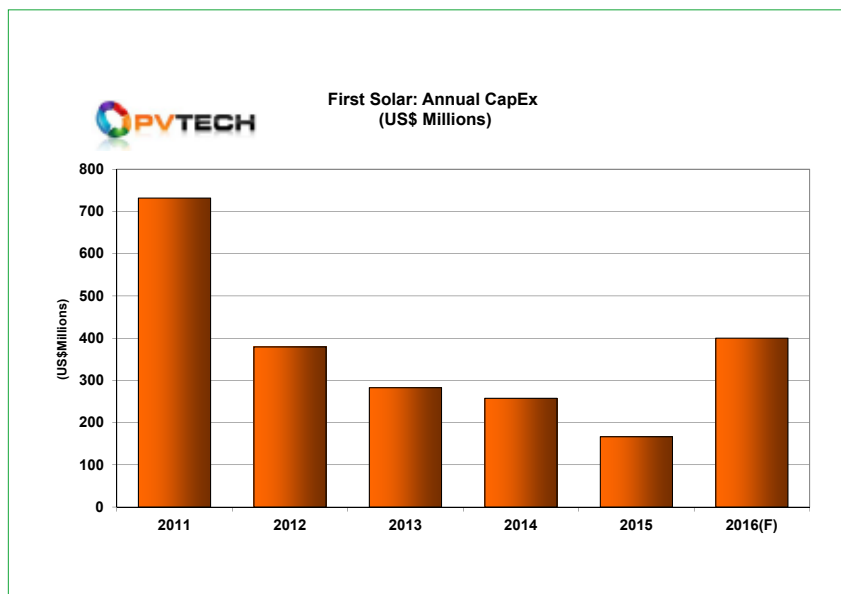


Figure 5. First Solar annual capex (US\$ millions)

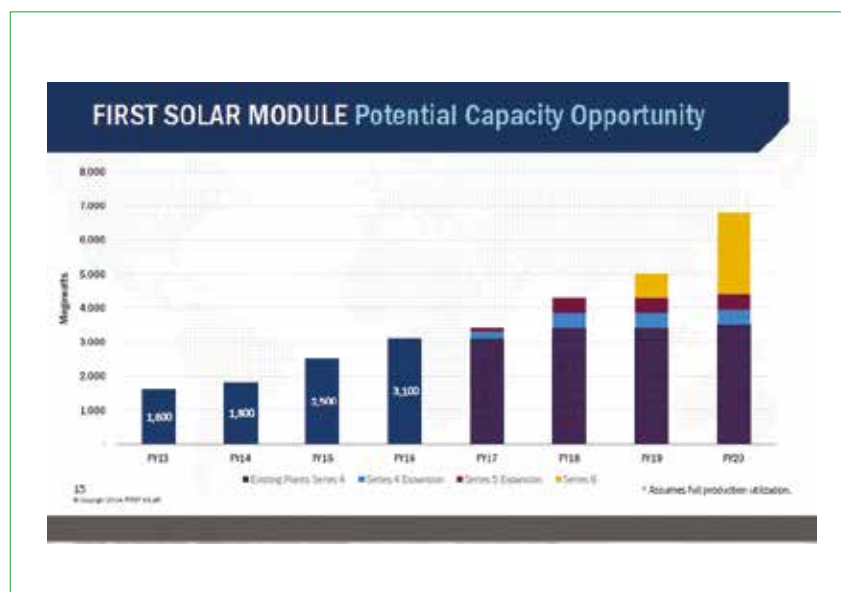


Figure 6. First Solar's guided potential manufacturing capacity expansion roadmap at 2016 Analyst Day event.