PV capital expenditure shifts from polysilicon to cell capacity additions

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ABSTRACT

Capital expenditure by the solar PV industry continues to rebound from the lows of 2012, but the spending trends have now shifted from polysilicon expansions to cell capacity additions. In particular, the transition to cell capex has been driven mainly by the need for Chinese module suppliers to diversify manufacturing outside mainland China and especially to countries in Southeast Asia, coupled with the ongoing problems for polysilicon producers struggling to adapt to sales prices for goods produced.

Capital expenditure (capex) in technology sectors is notoriously cyclic in nature, reflecting the global aspirations of supply-based manufacturers to seek market-share gains when cash flow is positive and the climate for investment is attractive.

The solar PV industry certainly follows this generalisation, but the fine details of solar PV capex remain potentially more turbulent and harder to follow than complementary and adjacent technology sectors such as semiconductors and displays.

This article provides an overview of solar PV capex over the past few years, explaining the motives and outcomes arising from investments across the full value chain of the upstream manufacturing segment, spanning polysilicon production through to module assembly.

The conclusions point towards a shift in caution across the value chain towards committing capex to new expansion activities, with any new facilities governed by long build-out timelines being postponed due to uncertainty regarding the near-term evolution of the solar PV industry. This uncertainty is shown to be grounded in concerns related to end-market demand growth, raw material consumption levels, and the delicate balance between total in-house production costs and component average selling prices (ASPs).

Understanding the drastic swings in solar PV capex

During the period 2006-2010, allocating capex to expand upstream operations was seen by almost every component producer in the solar industry as the default means of growing market share. This included standard crystalline silicon (c-Si) technologies that were proven in manufacturing and a host of competing options that had barely made it out of the research labs.

As a consequence, capex levels exploded to figures that prompted most capital equipment suppliers to urgently set up solar-specific business units. And capacity levels, in particular across China, for c-Si p-type production grew to levels that could have met the entire global demand.

However, it was the collapse of component sales prices (from polysilicon through to modules) between 2011 and 2013 that truly ushered in austerity measures throughout the entire industry. Indeed, this forms the starting point for the analysis presented in this article, with decision-making on PV capex before 2013 being largely of academic interest only.

Figure 1 shows the first direct effect of the pricing collapse on solar PV manufacturing, where the market capitalization values of publicly listed companies hit a dramatic cliff edge. The graphic here – taken from Yahoo! Finance – shows the stock prices for three of the main c-Si manufacturers in the solar PV industry today: Canadian Solar (CSIQ), Trina Solar (TSL) & JinkoSolar (JKS).

The downturn period can be seen to last about 18 months, from Q4'11 to Q2'13. Yet, during this time, there was no slow up in end-market growth. Therefore, to remain solvent, everything turned to cash saving and cost reduction in manufacturing. Capex for upstream manufacturing was one of the first things to be removed, with most PV manufacturers operating on draconian maintenance-only capex models.

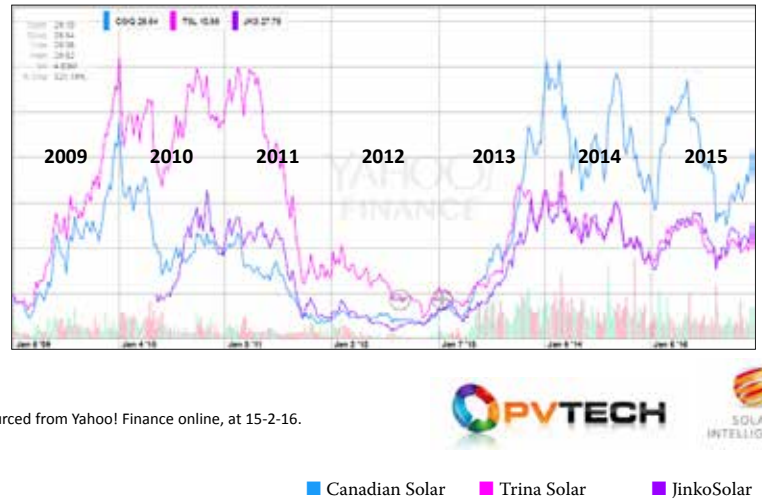
Cost savings became the only option as cash remained elusive

Any cash generated from ongoing operations, or from additional borrowings, was allocated to downstream projects business where return on investment remained healthy and was an option welcomed from the investor community that was attracted to vehicles that could guarantee a long-term revenue stream.

The ensuing lack of cash available for

Credit: Innotech Solar

The latest rebound in solar capex has seen investment increase in cell capacity additions.



Sourced from Yahoo! Finance online, at 15-2-16.

Figure 1: The collapse of the market capitalization values of leading solar PV manufacturers at the end of 2011 led directly to PV capex being reduced to minimal levels across the industry during 2012 and 2013.

Figure 2: PV capex went through two growth peaks between 2007-2009 and 2010-2011, driving the industry into overcapacity, which in turn led to strong price declines across the whole PV value chain.

PV manufacturing also prevented any technology buy-cycle from occurring, with changes in PV production for c-Si components limited to improvements that did not require any process flow alterations to existing production lines. The only two exceptions to this rule in the industry at the time were First Solar and SunPower, each with in-house technology expertise and differentiation. These companies continued to invest heavily in R&D and capex through the downturn period to ensure that in-house production remained competitive when investments were restarted across China and other Southeast Asia manufacturing hubs.

In some ways, however, the focus on cost reduction did focus the attention on manufacturing processes, something that had largely been bypassed during the days of building new factories and installing production lines as fast as possible. This was seen in particular at the ingot stage with casting furnaces for p-type multi block driving process optimization and wafer quality to efficiency levels that had not been considered possible for multi cells just a few years earlier.

In fact, several other changes during 2011-2013 can be grouped together as forming the basis of the PV technology roadmap at the time. These included multi-busbar forming in module production, the use of improved silver paste, higher aspect ratios for screen-printed fingers, diffusion furnace upgrades and the increased use of automation across China.

Upturn in PV capex from 2013

Confidence returned to the solar industry in the second half of 2013, and investments for upstream manufacturing started to pick up again. This is shown clearly in Figure 2, derived from analysing the capex trends across a sample group of 100 leading PV manufacturers during the time period shown. The downturn phase shown here is an almost carbon copy of that in Figure 1 for the stock prices of the companies shown.

However, to many of the PV equipment suppliers that benefited during the boom phase of 2006-2011, the upturn from 2013 onwards will look very different on order books for tools. In fact, the two upturn phases should really be treated separately, as there are few similarities for PV capex.

First, a large portion of the PV capex during 2008 to 2011 is sitting mothballed today across the value chain, from polysilicon factories in China that failed to meet quality or cost targets to ambitious thin-film a-Si-based fabs that were struggling at the best time to reach double-digit percentage efficiency levels.

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However, in order to understand better what PV capex looks like from 2013 onwards, we need to examine spending in more detail across the value chain. The following section addresses this by examining the capex trends of the leading c-Si module suppliers to the industry today, and then looking at capex being allocated by the top-50 PV manufacturers across the whole manufacturing value chain.

Silicon Module Super League focus on midstream capacity consolidation

During the previous capex upturn phase, the main Chinese cell and module manufacturers had aspirations to expand across the full c-Si value-chain, with gigawatt-level capacities from polysilicon to module. What evolved mainly was expansion confined to ingot/wafering, cell and module production, leaving polysilicon to dedicated suppliers.

Indeed, capacity additions at the ingot and wafer stage were also curtailed, with GCL-Poly becoming the lead force in supplying multi c-Si wafers within China. Internal wafer supply to the main cell and module producers in China declined to below 50%, with many fully dependent on outsourcing wafers locally.

Looking at the Silicon Module Super League of 2015 – comprising Canadian Solar, JA Solar, JinkoSolar, Hanwha Q CELLS, Trina Solar and Yingli Green –

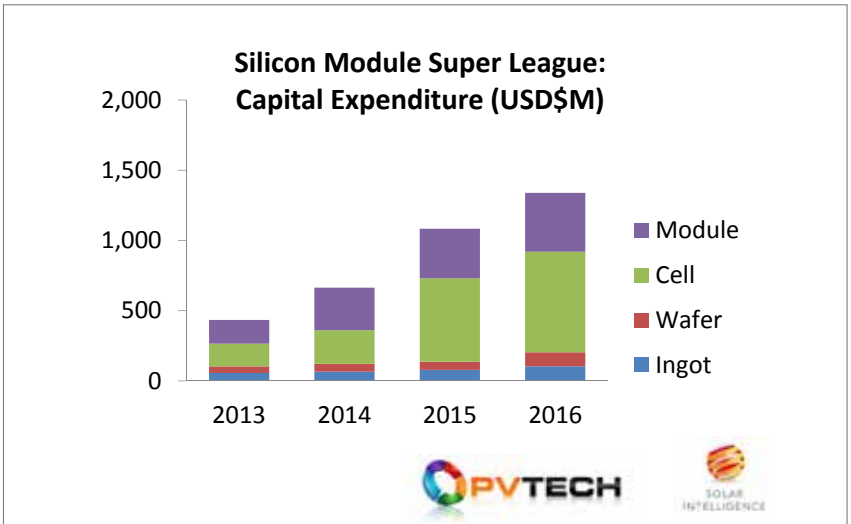

Figure 3: PV capex for the Silicon Module Super League shows the growing trend for new cell and module capacity located outside China, and the continued shift away from adding new ingot and wafer equipment.

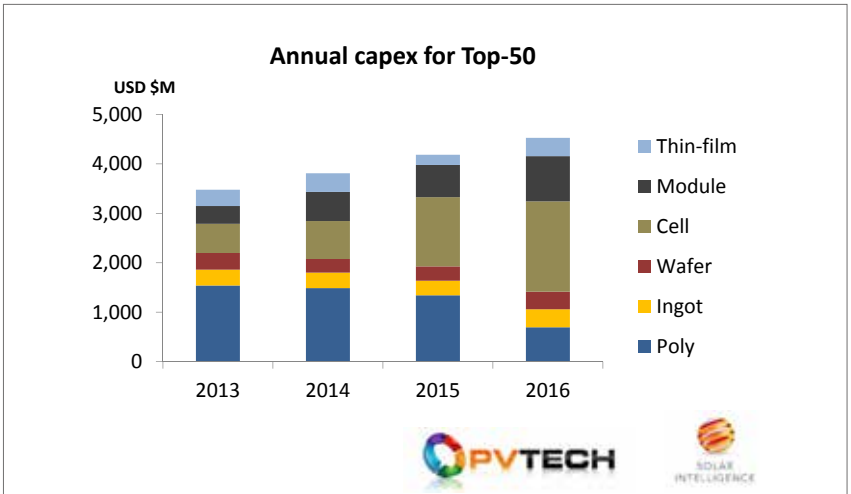

Figure 4: While PV capex rebounded in 2013 and has been growing each year since then, the contributions across the value chain have been shifting, with polysilicon investments falling and being replaced in particular by cell equipment purchases.

and extracting manufacturing capex for the period 2013-2016 reveals how the upturn in capex for these companies saw a continuation of this midstream manufacturing focus (see Figure 3).

Spending on ingot and wafering has been largely at maintenance-only levels, with limited new capacity brought online by this grouping of manufacturers. Rather, the focus has been on cell and module capacity additions, with cell capex dominating in part because of the larger $/W capex for cell lines alongside the declining cost of new module tooling coming exclusively from Chinese module suppliers.

With the increased focus of these module suppliers on having a more diversified geographic spread of c-Si cell and module production, this trend is expected to continue. This will further act to segment out polysilicon and wafer supply to the PV industry, in the absence of any further consolidation or acquisitions within China.

Polysilicon capex surge halted as pricing shows no sign of rebound

A further level of detail on recent capex trends can be seen by looking at the capex of the top-50 PV manufacturers across the whole value-chain from polysilicon to modules, and including the contributions from the only two thin-film suppliers of note to the industry today (First Solar and Solar Frontier). This top-50 group of manufacturers produces in excess of 80-90% of components within the solar industry today, and the market share has been gradually increasing in the past few years.

The capex breakdown is shown in Figure 4, and shows clearly the shift from capex going into polysilicon plant build-outs to the c-Si cell stage. While the trends related to the Silicon Module Super League discussed above are equally valid for the top-50 group, in regards to the ingot to module spending, the polysilicon capex changes from 2013 to 2016 tell an altogether different story.

Due to the multi-year build process associated with bringing new polysilicon factories online, most of the spending on polysilicon was authorised by companies as far back as 2009-2011. At this point, few had any idea about the rapid price declines that would impact on polysilicon producers, and this has been the most important factor driving the changes in polysilicon capex during 2013 to 2016.

The polysilicon capex is coming mainly from new plants being built with the prospects for some of these still at risk, as impairment charges (based on regular downward forecasts for polysilicon prices out to 2017) continue to have a crippling impact on the financial stability of the companies involved.

Other factors are driving polysilicon capex down, such as limited cash available in China to increase capacity levels to grab more market share within a US$13-15/kg spot price environment. Furthermore, problems have arisen at several sites in starting operations with the prerequisite purity levels and quality needed ahead of mass production ramping.

Conclusions

Capex to the solar PV industry for upstream manufacturing has gone through its prolonged downturn phase and has been growing each year since 2013. However, in contrast to the frantic spending that characterized the previous capex upturn phases from 2006 to 2011, spending in the past few years has been heavily weighted first to legacy decisions to construct new polysilicon plants, and then to cell production mostly outside China and Taiwan.

Beyond 2016, capex allocated to ingot and wafer stages will start to rebound, with polysilicon spending possibly still having to wait somewhat longer before seeing renewed investor confidence in the viability of particular polysilicon technologies or the strategies of the companies seeking to make further upstream investments in this sector.

About the Author

Finlay Colville joined Solar Media as head of the new Solar Intelligence activities in June 2015, before which he was vice president and head of solar at NPD Solarbuzz until October 2014. Widely recognised as a leading authority on the solar PV industry, he has presented at almost every solar conference and event worldwide, and has authored hundreds of technical blogs and articles. He holds a Ph.D in nonlinear photonics.