R&D spending analysis of 21 key PV manufacturers in 2018

Mark Osborne, Senior News Editor, *Photovoltaics International*

Abstract

Photovoltaics International's annual analysis of PV manufacturers, research and development (R&D) spending in 2018 includes 21 companies that were public listed on various stock exchanges around the world. R&D spending data was taken from audited annual financial reports and converted to US dollars at the time of the reports being published. The analysis in this 2018 report is intended to provide a good representation of global R&D spending trends in the PV wafer, cell and module segments of the upstream solar market.

Company updates

Since the adoption of new selection criteria for PV manufacturers to be included in the 2017 report, several companies have merged (Neo Solar Power (NSP), Gintech and Solartech) to form a new Taiwan-based company, United Renewable Energy (URE). These three companies have therefore been deleted from the 2018 report and replaced with the new URE name.

Included in the analysis for many years has been 'Solar Module Super League' (SMSL) member Hanwha Q CELLS, which delisted from NASDAQ in October 2018, negating the need to file a 2018 annual report. The renamed Q CELLS is therefore not included in the 2018 report.

"For the second year in a row, spending exceeded the US$1bn level."

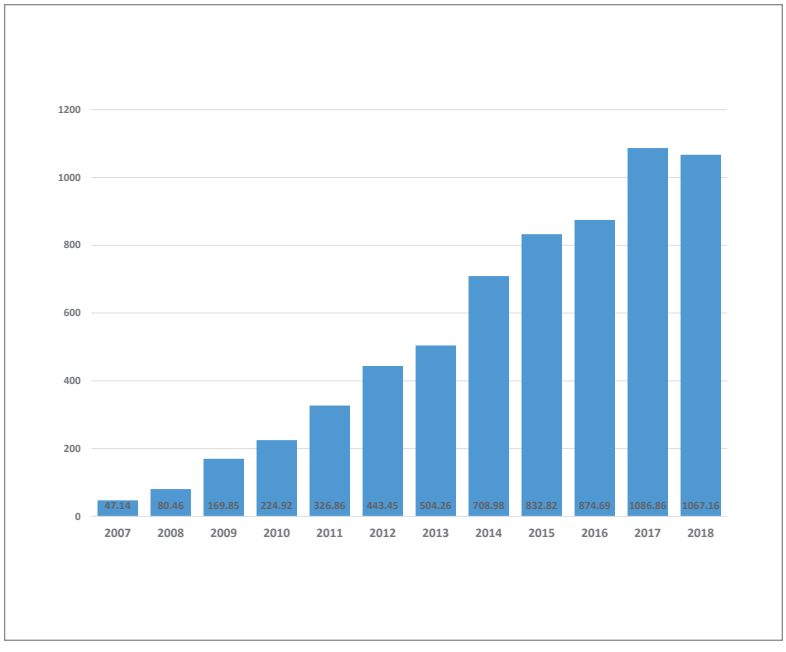


Figure 1. Total annual cumulative R&D expenditure (US$m) of 21 PV manufacturers 2007–2018.

In an effort to maintain a good representation of global R&D spending trends, several companies (Tianjin Zhonghuan Semiconductor (TZS), Zhongli Talesun, Solargiga and Comtec) have been included for the first time in the 2018 analysis. Historical R&D spending figures for the new additions have also been included in the 2018 report.

The PV industry remains highly dynamic, however, and before this report was published, China-based PV manufacturer Hareon Solar became technically bankrupt, had ceased all manufacturing and was subsequently delisted from the Shanghai Stock Exchange (SSE) in July 2019. Luckily, the company had published its 2018 annual report before the delisting and is included in this R&D report. However, because of the delisting, Hareon Solar is not expected to be covered in the 2019 report. In August 2019 another company, Hanergy Thin Film, delisted from the Hong Kong Stock Exchange, indicating it would not be publishing further audited annual reports, and consequently is also not expected to be covered in the 2019 report.

More positive developments involve the expected re-inclusion of two SMSL members, Trina Solar and JA Solar, in the 2019 report, because of preparations, which are at various stages, to relist on Chinese stock exchanges. Also planning a public listing is China-based major merchant solar cell producer, Aiko Solar. These are therefore expected to have meaningful positive benefits in the coverage of global R&D spending trends in 2019.

R&D spending trends in 2018

The cumulative annual R&D spending of 21 key PV manufacturers reached a total of US$1,067.16m (US$1.06bn) in 2018. For the second year in a row, spending exceeded the US$1bn level, although it is down slightly from the US$1,086.86m (US$1.08bn) cumulative annual R&D spending of the 20 key PV manufacturers in 2017 (Fig. 1).

It is interesting to note that R&D spending doubled over the five-year period from 2013 (US$504m) to 2017 (US$1.08bn). Almost all the 20 PV manufacturers in the analysis were public in 2013, and all of them by 2014.

Spending pattern divergence

A continued trend since 2014, however, has been the growing number of companies that lowered

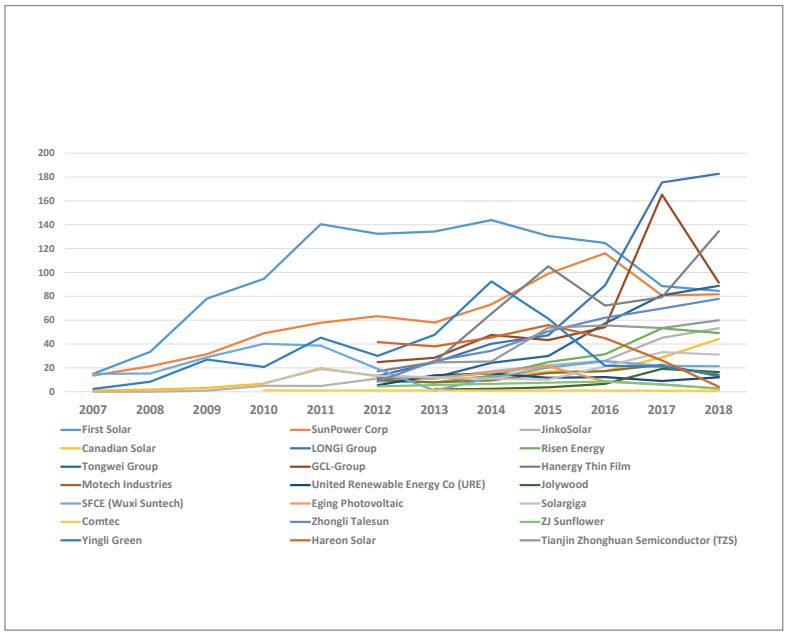


Figure 2. Total annual cumulative R&D expenditure (US$m) of 21 PV manufacturers 2007–2018.

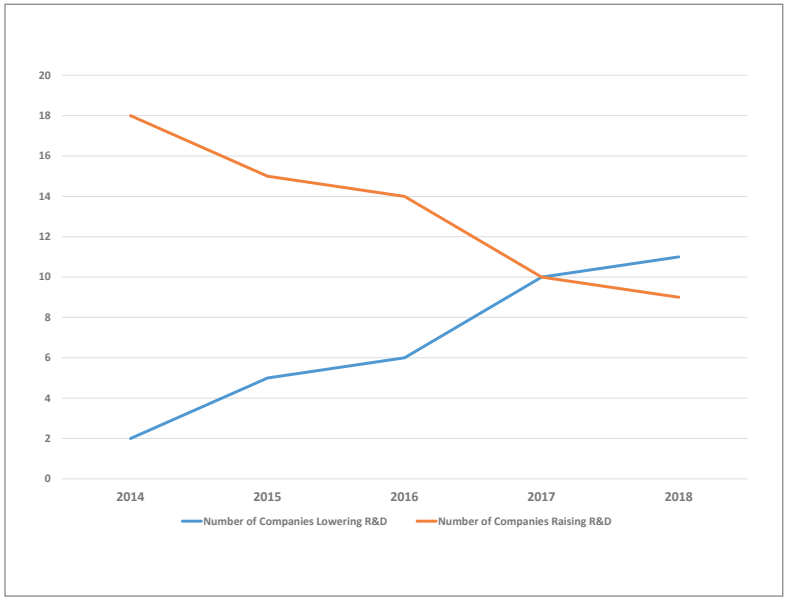


Figure 3. Trends of the number of companies spending less or more on R&D 2014–2018.

R&D spending, compared with those increasing spending on a year-on-year basis (Fig. 2).

As the chart in Fig. 3 highlights, only two companies lowered R&D spending in 2014, while the crossover point was reached in 2017, when 10 companies reduced spending, compared with the previous year. This trend continued in 2018, when for the first time the number of companies lowering spending (11) exceeded the number (9) increasing R&D spending.

Since 2015 there have also been two companies (First Solar and Yingli Green) that have reduced spending for four consecutive years. In the 2018 analysis, two companies (Eging PV and Hareon Solar) have been lowering spending for three consecutive years, while two companies (ZJ Sunflower and Wuxi Suntech) have been lowering spending for two consecutive years.

As noted in the 2017 report, the spending pattern divergence has been due primarily to the financial condition of some of the companies, such as Yingli Green, Hareon Solar, SunPower and others, in the past. However, the growing number of companies reducing spending in 2018 is also a result of the weaker downstream PV market in China, after the Chinese government announced the '531 New Deal', which put a halt to utility-scale and DG markets, as installations were viewed to have far exceeded plans and the market was subsequently overheating.

As stated in the previous year's report, First Solar's sequential decline in spending is more to do with its production shift to the large-area Series 6 modules and the construction of three new manufacturing plants than any financial issues, as the company remains technically sold out for several years to come.

It is also interesting to note from the trends in Fig. 2 that, since 2012, only two companies (LONGi Group and Zhongli Talesun) have consistently increase R&D spending, year on year.

Other companies that increased spending in 2018 include JinkoSolar, Canadian Solar, SunPower, Tongwei, Hanergy Thin Film, URE, TZS and Comtec (Fig. 4).

"Following on from topping the spending rankings in 2017, LONGi Group maintains its position at the top for 2018."

R&D spending rankings

Following on from topping the spending rankings in 2017, LONGi Group maintains its position at the top for 2018. The company increased R&D expenditure from US$175.5m in 2017 to US$182.7m in 2018, marking the seventh consecutive year of increased spending (Fig. 5). Hanergy Thin Film was the second biggest spender on R&D in 2018, reporting expenditure of US$134.6m, up from US$79.2m in the previous year, when it was ranked fifth. Both LONGi Group and Hanergy Thin Film were the only companies to surpass US$100m in R&D spending in 2018.

Despite a significant reduction in year-on-year spending, GCL Group is ranked third with spending of US$91.4m, down from US$165.2m in 2017, when ranked second only to LONGi Group.

Moving up the rankings is Tongwei Group, reporting R&D expenditure of US$88.8m in 2018, compared with US$53.4m in the previous year. The company is therefore ranked fourth in 2018, up from seventh in 2017.

Dropping down one position in the rankings are First Solar and SunPower with spending of US$84.5m and US$81.7m respectively in 2018. First solar is ranked fifth-highest R&D spender in 2018 and SunPower sixth highest.

Zhongli Talesun, which has been included in the

report for the first time, had R&D expenditure of US$77.9m in 2018, up from US$69.8m in the previous year. The company would have been ranked sixth in 2017, but actually falls one position to seventh in 2018.

Tianjin Zhonghuan Semiconductor (TZS) is another new entrant to the report. The company had R&D expenditure of US$59.9m in 2018, up from US$53.5m in the previous year. As a result, it is ranked eighth, down one position if it had been represented in the 2017 report.

Leading SMSL member, JinkoSolar, increased R&D spending to US$53.3m in 2018, up from US$45.2m in 2017. Although this was record spending for the company, its ninth-ranked position means it has dropped from its eighth-place ranking in 2017.

Risen Energy lowered R&D spending in 2018 to US$49.2m, compared with US$56.4m in the previous year. As a result, the company falls from being ranked sixth in 2017 to tenth in 2018.

Second-ranked SMSL member, Canadian Solar, has significantly increased R&D expenditure year on year. In 2018, spending topped US44.2m, up from US$28.7m in 2017 – a 53% increase. Despite the marked increase, Canadian Solar's ranking drops from ninth in 2017 to eleventh in 2018.

New to the rankings in 2018 is Solargiga, reporting R&D expenditure of US$31.2m, down slightly from US$33.2m in 2017. The company is ranked twelfth in 2018 and would have been ranked above Canadian Solar in 2017, had the company been included in the previous report.

Ranked thirteenth is Wuxi Suntech. R&D expenditure in 2018 was US$21.4m, almost identical but slightly down from US$21.75m in 2017. However, because of the previously highlighted changes to some of the companies excluded and included in the 2018 analysis, Wuxi Suntech actually ranks one position higher at thirteenth.

Jolywood experienced a similar situation to Wuxi Suntech, jumping several positions to rank fourteenth in 2018, compared with its ranking of seventeenth in 2017, despite decreasing R&D spending from US$19.2m in 2017 to US$16.5m in 2018.

Although Yingli Green again lowered R&D spending in 2018, its ranking position remains unchanged at fifteen. Yingli Green's spending in 2018 was US$14.3m, down from US$21.2m in 2017.

Taiwan-based Motech significantly cut R&D spending in 2018, impacting its ranking position. The company had spending of US$12.9m in 2018, down around 48% from US$22.7m in 2017. As a result, it drops from being ranked thirteenth in 2017 to sixteenth in 2018. However, despite the deep cuts in R&D, Motech is ahead of its nearest country rival, URE.

Before Gintech, Solartech and NSP combined under NSP, while changing the name to URE in 2018, their total R&D spending as separate businesses was US$14.89m in 2017. Under the URE name in 2018, the R&D spending declined to US$12.1m. However, with Gintech and Solartech rolled into NSP, the R&D spending of NSP in 2017 was US$9m, indicating that R&D spending as the renamed URE actually increased. Despite the merger, URE is ranked seventeenth in the 2018 rankings, only one position above where NSP stood in the 2017 rankings.

The collapse of Hareon Solar means the company falls from being ranked tenth in 2017 to eighteenth in 2018. R&D spending was only US$4.1m, down from US$26.2m in 2017. The company will not be ranked next year.

Eging Photovoltaic reported R&D expenditure of US$2.7m in 2018, down from US$6.1m in 2017, ranking the company in nineteenth position, one down from the previous year.

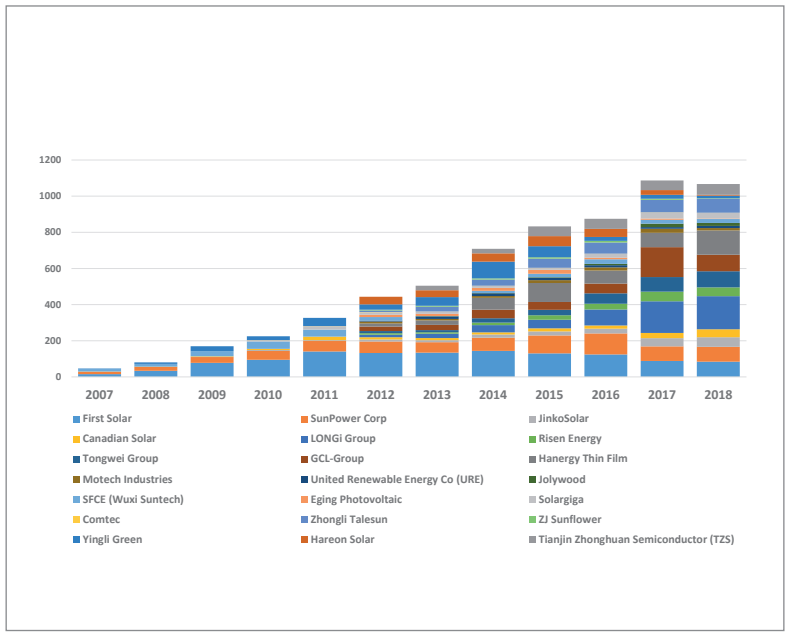


Figure 4. Annual R&D expenditure (US$m) of 21 PV manufacturers (public listed) 2007–2018.

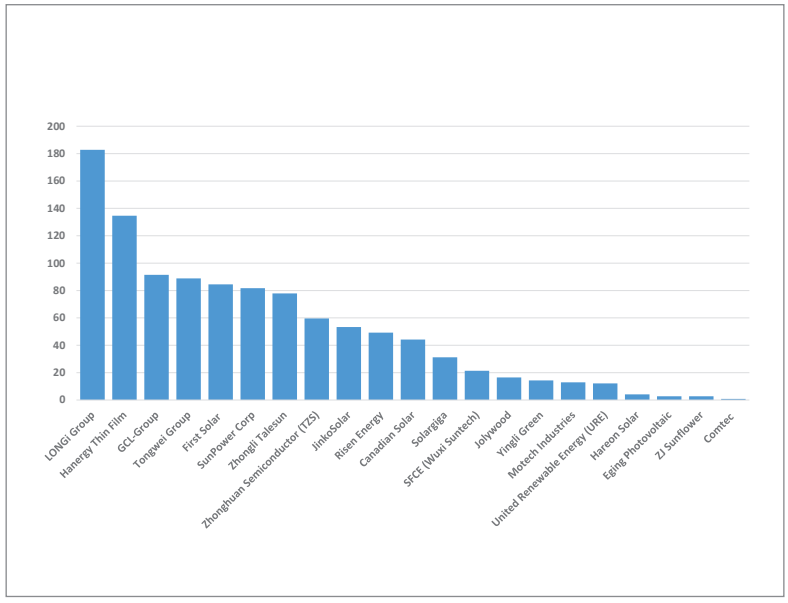


Figure 5. Annual R&D expenditure (US$m) of 21 PV manufacturers ranked (public listed) in 2018.

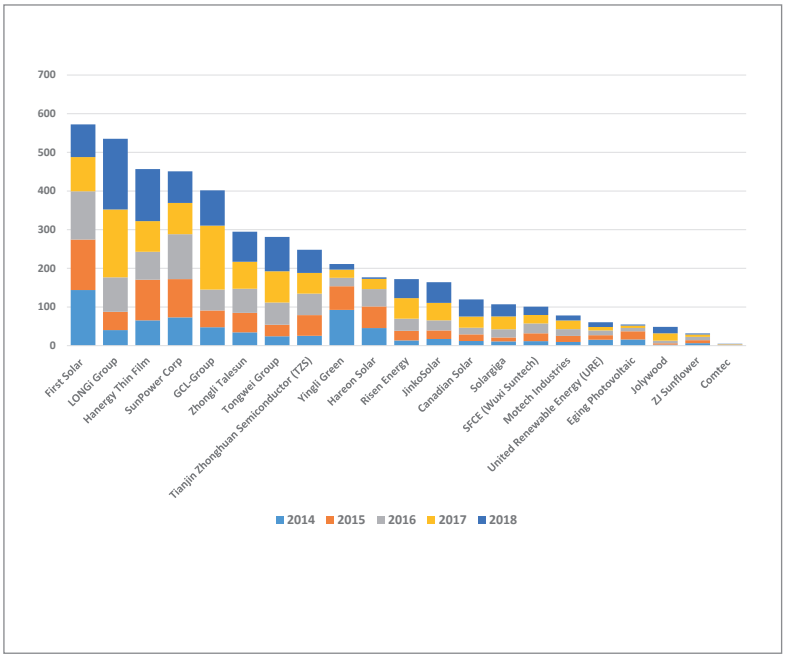


Figure 6. R&D expenditure (US$m) of 21 PV manufacturers ranked (public listed) 2014–2018.

In twentieth position is new entrant ZJ Sunflower, which had R&D expenditure of US$2.7m in 2018, down markedly from US$6.7m in 2017, and the lowest level since 2012.

New entrant Comtec had R&D expenditure of US$0.86m in 2018, up slightly from US$0.85m in 2017. The company sits at the bottom of the rankings in twenty-first position for 2018.

Five-year ranking trends

With continued volatility in the PV industry, which R&D spending is not immune to, a look at cumulative company annual expenditures over a period covering the last five years may provide insight into other trends related to R&D expenditure. The chart in Fig. 6 covers the last five years of annual R&D spending of the 21 key PV manufacturers addressed in this report.

There is clearly a group of five companies (First Solar, LONGi Group, Hanergy Thin Film, SunPower and GCL Group) that have become separated from the pack by a minimum of over US$100m in cumulative R&D spending over the last five years. Despite First Solar and SunPower dropping in the annual rankings, the changes over a five-year period are less pronounced for First Solar, which remains the cumulative R&D spending leader.

These five companies have been in the high US$500m to the low US$400m spending range over the last five years. However, SunPower's position dropped two places in the 2018 rankings, and has also been overtaken by LONGi Group and Hanergy Thin Film in the five-year period. Moreover, GCL Group was closing in fast on SunPower until a significant reduction in R&D spending took place in 2018. LONGi Group and Hanergy Thin Film have been two of the three fastest-growing companies in terms of R&D spending, notably in the last three years, as shown in the chart.

The chart in Fig. 6 also highlights that three companies (Zhongli Talesun, TZS and Tongwei Group) have formed a second strong group with accelerated R&D spending in the last four of the past five years. Zhongli Talesun, TZS and Tongwei Group have R&D spending that ranges between the very high US$200m level and the mid US$250m level.

Below TZS, things also look interesting, as the low levels of spending by Yingli Green in the last three years highlight its declining position in the rankings, while Hareon Solar collapsed. This means that the accelerated R&D spending by Risen Energy, JinkoSolar and Canadian Solar in the last two years shows their ability to move ahead of Yingli Green very soon. However, it can also be seen that they remain a significant distance behind the second leading pack of Zhongli Talesun, TZS and Tongwei Group. Despite the potential of Risen Energy, JinkoSolar and Canadian Solar to climb slowly up the ranking, primarily because others are falling by the wayside, there is every chance the gap between them and the second group will widen, locking in the two major SMSL members in the lower middle range. This situation may also be exacerbated by the expected return of two other SMSL members, Trina Solar and JA Solar, to the R&D analysis in 2019.

As for those companies below Canadian Solar, five years of R&D spending have mainly highlighted the chasm between the lead and second-placed groups, a gap that increasingly looks to be insurmountable.

"Five years of R&D spending have mainly highlighted the chasm between the lead and second-placed groups, a gap that increasingly looks to be insurmountable."

Five years of annual R&D expenditure as a percentage of revenue

Another metric that is being tracked but has not previously been covered in the R&D reports is R&D expenditure as a percentage of revenue. A key reason was the fact that the almost universal ratio of companies' R&D expenditure as a percentage of revenue lies within the 0.8% to 3% range. The exceptions to this have always been First Solar and SunPower, with much higher ratios.

In the first sample chart, shown in Fig. 7, First Solar and SunPower have been included in order to represent the historical high end of R&D expenditure as a percentage of revenue; also included are two major SMSLs (JinkoSolar and Canadian Solar), which have been perennial laggards in total annual R&D spending. A typical

example of a relatively small PV manufacturer has also been included in the form of Eging PV. This selection of companies is a good representation of the historical highs and lows of R&D expenditure as a percentage of revenue.

A key takeaway is that the proprietary technology used by First Solar and Sunpower, compared with the other companies, requires much higher R&D expenditure as a percentage of revenue. However, despite JinkoSolar and Canadian Solar being laggards in total annual R&D expenditure, as well as in expenditure as a percentage of revenue, it has historically had little negative impact on them, as both have become the two largest crystalline PV module manufacturers in the world today.

In the second sample chart, shown in Fig. 8, three major China-based integrated PV manufacturers – LONGi Group, TZS and GCL Group – have been included and are arguably the most closely matched from a business model perspective. The main deviation here is that GCL Group can be deemed the historical major incumbent and has been the largest company in the PV industry by revenue and scale in polysilicon and multicrystalline wafer capacity for many years.

LONGi Group and TZS have become fast-growing companies that have strong R&D spending regimes coupled with strong revenue growth. Indeed, in 2018 both companies' R&D expenditure as a percentage of revenue declined at almost the same rates, but the reality was that both companies' total revenue significantly increased, compared with the previous year, while R&D spending increased but clearly at a slower pace than revenue. In contrast, GCL Group reported markedly lower revenue in 2018, compared with the previous year. GCL Group companies have cut R&D spending significantly, year on year, because of financial constraints, causing R&D expenditure as a percentage of revenue to decline.

Therefore, it could be argued that emerging major players that have had high R&D spending in the last five years have gained significant market share against an historical incumbent. GCL, however, has been an investor in TZS as well as SunPower, which muddies the waters for a clear-cut comparison.

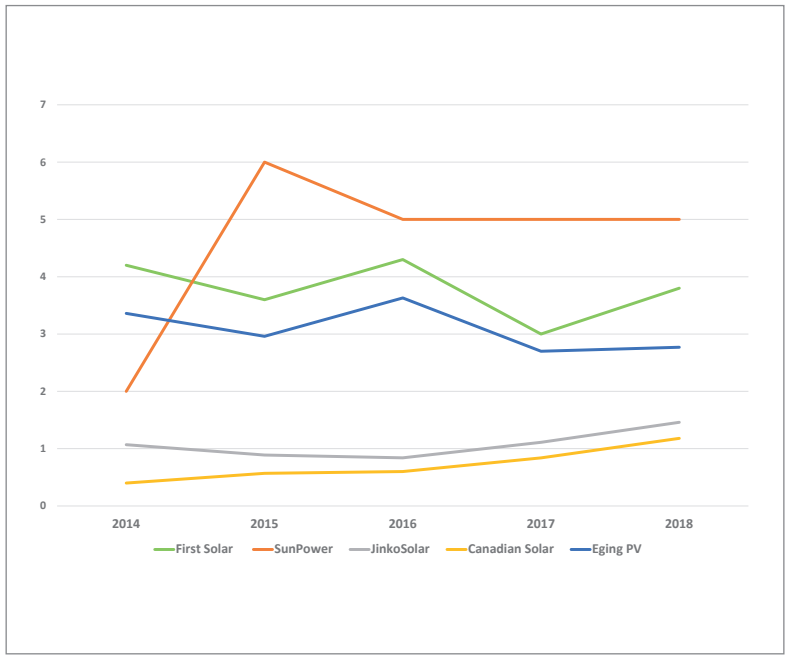


Figure 7. Annual R&D expenditure as a percentage (%) of revenue (sample 1).

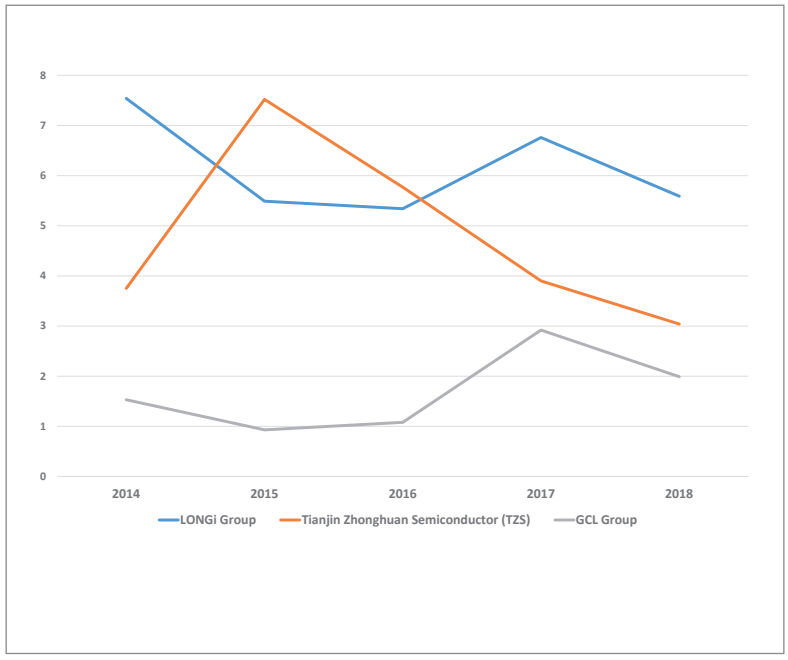


Figure 8. Annual R&D expenditure as a percentage (%) of revenue (sample 2).

Conclusion

Despite continued upheaval in the companies being tracked and those untracked, which will undoubtedly occur in 2019 as well, it remains somewhat remarkable that over US$1bn was allocated in R&D expenditure in 2018, following a record year and milestone in 2017.

As was the case in 2017, this report highlights that R&D spending trends remained volatile in 2018, still being impacted by some companies driving new technology adoption and market share gains, as well as by other companies being affected by company-specific financial challenges.

This report has also highlighted a clear leadership group of R&D spenders, which could become pivotal to their business strength and the weakening of others.

"R&D spending trends remained volatile in 2018."

Advertisers and web index

ADVERTISER	WEB ADDRESS	PAGE NO.
Aiko Cells	en.aikosolar.com	Outside Back Cover
Borealis AG	borealisempoweringsolar.com	7
Ecoprogetti srl	ecoprogetti.com	58
Energy Taiwan	www.energytaiwan.com.tw	33
EU PVSEC 2019	www.photovoltaic-conference.com/	9
Exateq GmbH	www.exateq.de	37
Heraeus Photovoltaics	www.Heraeus-Photovoltaics.com	62
Henkel AG & Company	henkel-adhesives.co/electronics	53
Innolas Solutions GmbH	www.innolas-solutions.com	11
Intersolar Global	www.intersolar.de	43
Intersolar Mexico 2019	www.intersolar.mx	23
JA Solar	www.jasolar.com	Inside Front Cover
Meco Equipment Engineers B.V	www.besi.com	60
Meyer Berger	www.meyerburger.com	5
Mondragon Assembly	www.mondragon-assembly.com	64
PV CellTech	https://celltech.solarenergyevents.com	29
Photovoltaics International	www.pv-tech.org/photovoltaics-international/overview	29
PV ModuleTech	https://moduletech.solarenergyevents.com	Inside Back Cover
PV-Tech.org	www.pv-tech.org	29
PV-Tech Research	www.pv-tech.org/solar-intelligence/pv-manufacturing-technology-quarterly-report	35
RENA	www.rena.com	56
Sentech Instruments GmbH	www.sentech.com	35
SNEC PV Power Expo 2020	www.snec.org.cn	27
Von Ardenne GmbH	www.vonardenne.biz	54

To advertise within Photovoltaics International, please contact the sales department: Tel +44 (0) 20 7871 0122

THE INDISPENSABLE GUIDE FOR MANUFACTURERS IN SOLAR

NEXT ISSUE:

- Capacity expansion report
- Heterojunction manufacturing
- Tandem perovskites

Photovoltaics International contains the latest cutting edge research and technical papers from the world's leading institutes and manufacturers.

Divided into six sections – Fab & Facilities, Materials, Cell Processing, Thin Film, PV Modules and Market Watch – it is an essential resource for engineers, senior management and investors to understand new processes, technologies and supply chain solutions to drive the industry forward.

An annual subscription to **Photovoltaics International**, which includes four editions, is available at a cost of just $199 in print and $159 for digital access.

Make sure you don't miss out on the ultimate source of PV knowledge which will help your business to grow!

SUBSCRIBE TODAY: **www.photovoltaicsinternational.com/subscriptions**

The PV-Tech blog

FINLAY COLVILLE
Head of Research
PV-Tech and Solar Media Ltd.

The new PV ModuleTech Bankability Ratings list

The new PV ModuleTech Bankability Ratings methodology has recently been outlined clearly across a series of six online PV-Tech articles that explained how PV module suppliers can be graded (from the top AAA-rated to the lowest/highest-risk C-rated). The final ratings system overview can be found on the final of the six articles here, with links to each of the series features highlighted at the bottom of this webpage also.

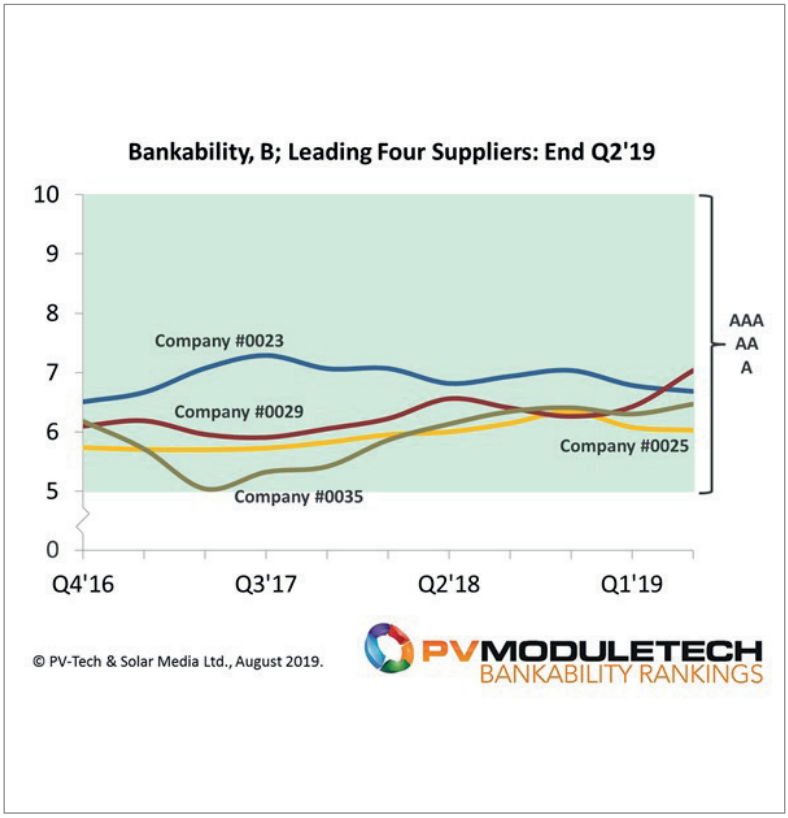
The new PV-Tech Ratings system is the first industry analysis that combines each company's track-record in large-scale global shipments, with its financial health, on a rolling quarterly basis. The analysis uses data collected over 10 years at PV-Tech, across a wealth of manufacturing and financial inputs; these are all covered in the series of six articles on PV-Tech recently.

In contrast to all other tier-based or top/leading-supplier related tables and lists disseminated throughout the industry over the past few decades, the PV ModuleTech Bankability Ratings system uses statistical analysis and modelling, carefully validated against each company's historic and current status within large-scale PV module deployment.

The driver for the new ratings system has been from downstream PV module users and investors who have been constantly confused about which module suppliers were truly bankable, being able to supply volumes with confidence and having a balance-sheet that reduced the risk of imminent bankruptcy or in-house manufacturing re-organization.

This PV ModuleTech Bankability Ratings system finally allows project developers, EPCs, site investors and asset owners to understand the key investment differences across the range of PV module suppliers bidding to supply to commercial, industrial and utility-scale PV solar sites globally. It is ideal for competitive benchmarking, and shows the strengths and weaknesses of each PV module supplier from each of the key manufacturing and financial perspectives. It is perfect for short-listing potential suppliers, prior to factory audits and reliability tests that are essential to meet specific investor requirements.

No module company today meets the top-performer AAA-rated grade, and that this has rarely been obtained by any PV module supplier in the past. This is not too much of a surprise however, as I will explain during the webinars, and is in part arising from a still-fragmented landscape where the market-leaders command typically a 10% market-share of module supply; and where some 200-plus companies fight over business globally. It is also arising from the rather precarious financial health of companies that have been overly-dependent on revenue streams from module sales that have been impacted regularly by ASP declines well above cost-reduction measures implemented internally.



Four PV module suppliers are currently AA-rated, as of the end of Q2'19. The AA-rating grade is the highest any PV module supplier meets today.

The highest ratings grade achieved by a PV module supplier today is AA-rated, and there are only four companies within this top-performer category only.

The forthcoming PV ModuleTech 2019 conference in Penang, Malaysia on 22-23 October 2019 will see many of the AA-rated and A-rated companies presenting and in attendance. This event will start with a 45-minute talk I will deliver, specific to the PV ModuleTech Bankability Ratings.