

# R&D spending analysis of top PV module manufacturers in 2012

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## ABSTRACT

R&D expenditure by major PV module manufacturers has not been immune to the PV industry's period of profitless prosperity. However, spending in 2012 was not affected to the extent that many would have expected, with a number of companies increasing their R&D activities and boosting staffing levels to meet R&D roadmap requirements. This paper discusses the current trends in R&D spending and staffing levels, highlighting both leaders and laggards.

## R&D spending patterns

As Fig. 1 shows, there has been a direct correlation between the growth of the PV industry since 2007 and increased allocation of financial resources to R&D activities by leading PV module manufacturers. In 2012, however, that trend was reversed for the first time as the industry struggled to deal with the second consecutive year of chronic manufacturing overcapacity, declining ASPs, and financial

losses for all but one CdTe thin-film manufacturer.

With capital expenditures primarily relegated to maintenance, R&D spending at 12 of the major module suppliers combined has decreased from the highs seen in 2011. R&D spending in 2012 declined to US\$464 million, down from a peak of US\$510.4 million in 2011.

Separately, the 11 c-Si producers within the featured group spent US\$332 million

on R&D activities in 2012, down from the US\$369.9 million peak of 2011. However, the overall declines are relatively mild. The total decline was only US\$46 million, or a 9% decline year on year. The c-Si producers cut spending by only US\$35 million, or a 9.5% decrease year on year.

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The mild decline suggests that, despite the financial woes, companies are increasingly aware that R&D spending is a critical part of future earnings and differentiated product offerings. It should also be noted that, in the past, certain companies have said that they lowered spending because of the conclusion of specific R&D projects.

From Fig. 1 it is also evident that there was a significant jump in spending from 2008 to 2009; a similar spike in spending occurred in 2011 from 2010.

Fig. 2 highlights that seven companies reduced spending in 2012 from 2011 – these included First Solar, Yingli Green, Trina Solar, Canadian Solar, REC Solar and ReneSola. With respect to Suntech, we estimate (annual reports not released at time of print) that R&D spending declined from US\$38.6 million in 2011 to US\$19.2 million in 2012. The estimated decline is based on spending peaking in 2010 and the financial condition of the company over the 12-month period.

Since 2009 First Solar has topped the R&D spending ranks and has led its rivals by a wide margin. However, First Solar curtailed spending in 2012 by around US\$8 million, compared with the previous year, which had seen spending peak at US\$140.5 million.

Key to the declines were the relatively large cuts made by four of the seven companies that reduced spending – these included REC, Yingli Green, Trina Solar and Suntech.

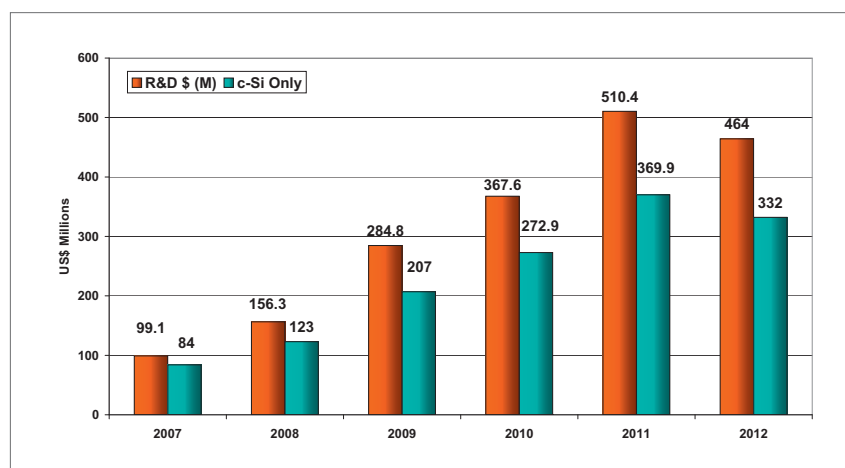


Figure 1. Top PV module manufacturers' combined R&D spending (US\$ millions) 2007–2012.

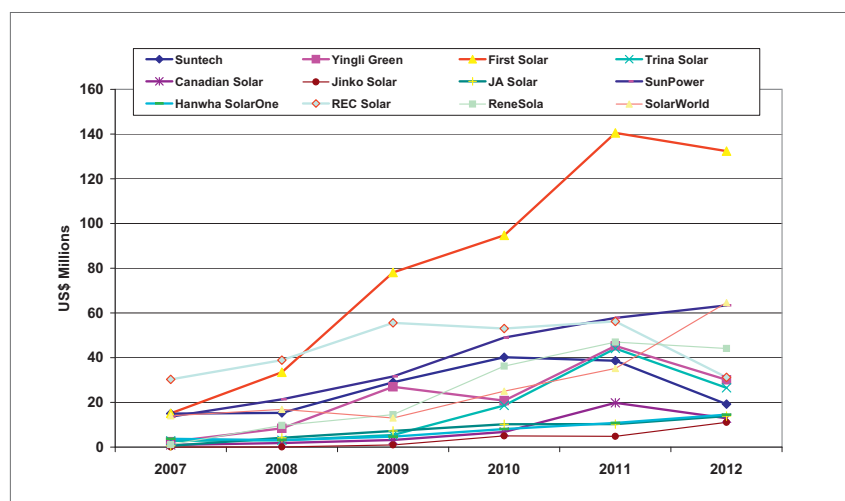


Figure 2. Top PV module manufacturers' individual annual R&D spending (US\$ millions).

Importantly, five companies actually increased R&D spending in 2012, including SunPower, Hanwha SolarOne, SolarWorld and JinkoSolar. Noteworthy was SunPower, which increased spending from US\$57.8 million in 2011 to US\$63.4 million in 2012. SunPower has been a consistent high-ranking spender throughout the period covered, one of only four companies to be so.

At the other end of the scale, Hanwha SolarOne increased spending from US\$10.8 million in 2011 to US\$14.5 million last year. However, the company remained in the lowest group of spenders (below US\$20 million per annum), which included Canadian Solar and the leading R&D spending laggard, JinkoSolar.

Guidance on R&D spending in 2013 remains limited; although companies typically guide shipment and revenue forecasts, few actually provide guidance with respect to R&D expenditure. Currently REC and SolarWorld have guided that 2013 spending would decline to US\$22 million and US\$52 million respectively.

### R&D staffing patterns

There is a close correlation between R&D spending and staffing levels within R&D departments. Increased spending on R&D often includes costs with associated increased staffing levels.

However, Fig. 3 highlights that in 2010 there was an explosion in R&D staffing levels among the major producers covered in this report, compared with small, but noticeable, increases between 2007 and 2009. This, however, is not noticeably mirrored in overall spending levels for the same period, as shown in Fig. 1.

Dedicated R&D staffing levels increased from just over 1,500 in 2009 to just short of 3,500 in 2010, an increase of approximately 125% year on year.

Although spending leader First Solar significantly increased its R&D headcount in 2010, from 267 to 533, it was the c-Si

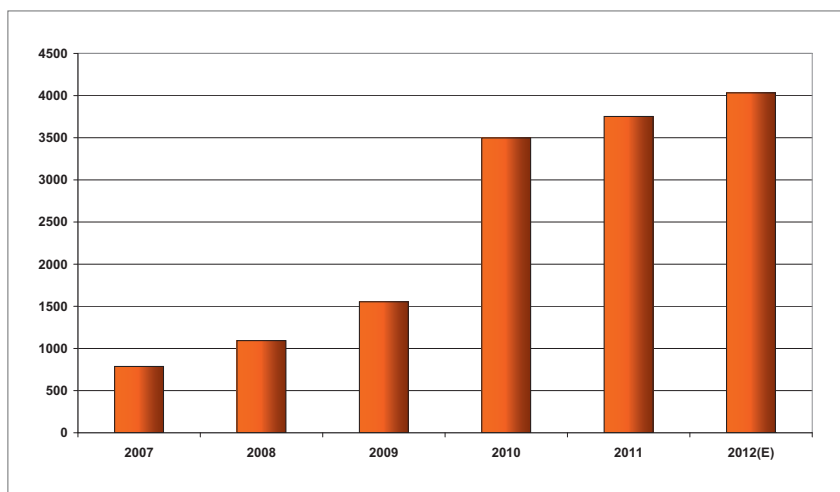


Figure 3. Top PV manufacturers' combined R&D employee numbers.

manufacturers that started playing catch-up. Combined, they increased R&D headcount from 1,287 in 2009 to 2,965 in 2010, an increase of just over 130%.

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Staffing levels have continued to increase since 2010, albeit at a significantly slower rate, reaching a total of 4,032 at the end of 2012. It should be noted that, although REC provides detailed employee data in its annual reports, the company does not break down employee levels dedicated to R&D.

The continued increase in R&D staffing levels throughout the last six years belies the fact that five companies (Trina Solar, JinkoSolar, Hanwha SolarOne, ReneSola and SolarWorld) reduced their R&D headcount in 2012 (see Fig. 4). Suntech is estimated to have reduced its R&D headcount in 2012 because of both headcount peaking in 2010 and the estimated reduction in R&D spending owing to its financial position over the last 12 months.

There were five companies (Yingli Green, First Solar, Canadian Solar, JA Solar and SunPower) that increased R&D-specific staffing levels in 2012. However, there could be an error in reported staffing levels at First Solar, for which it was necessary to extrapolate differently from previous years. Should the staffing levels have stayed the same or decreased, then overall headcount for the combined group of companies would have declined by only 120, or just over 3%.

Excluding First Solar, noteworthy is the fact that the massive increase in R&D headcount at Yingli Green in 2010 was not another anomaly. Yingli Green has continued to increase staffing levels, which reached a record high of 1,464 for the company and the sector in 2012.

At the opposite end of the scale, the laggard in R&D headcount is harder to reveal, notably as a result of inconsistent staffing levels of some companies over the period covered. Although JinkoSolar is one of the laggards, so too is JA Solar.

However, if we take a laggard to mean a company employing less than 100 in R&D activities in the last three years, then none (excluding REC) could be called a laggard in 2012. But JA Solar and SolarWorld would have been classified as laggards in previous years. The company with the lowest R&D headcount at the end of 2012 was actually Hanwha SolarOne with 104.

Six companies in 2012 (Hanwha SolarOne, JA Solar, SolarWorld, JinkoSolar, ReneSola and Canadian Solar) had headcounts of between 100 and 200, while there were significant leaps for Suntech (estimated), First Solar and Trina Solar.

### R&D spending rankings and analysis

Leading in R&D spending rankings (Fig. 5) has historically had little correlation with the same companies ranked on a revenue, shipment or production level basis. Only First Solar has achieved a

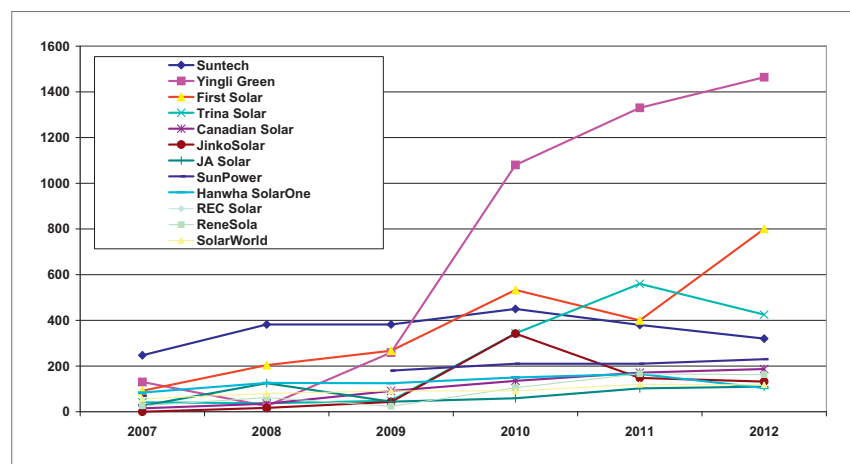


Figure 4. Top PV module manufacturers' R&D headcount by company.

Ranked	2007	2008	2009	2010	2011	2012	Market Ranked 2012
1	REC	REC	First Solar	First Solar	First Solar	First Solar	2
2	First Solar	First Solar	REC	REC	SunPower	SolarWorld	N/A
3	Suntech	SunPower	SunPower	SunPower	REC	SunPower	9
4	SolarWorld	SolarWorld	Suntech	Suntech	ReneSola	ReneSola	N/A
5	SunPower	Suntech	Yingli Green	ReneSola	Yingli Green	REC	N/A
6	Hanwha SolarOne	ReneSola	ReneSola	SolarWorld	Trina Solar	Yingli Green	1
7	Trina Solar	Yingli Green	SolarWorld	Yingli Green	Suntech	Trina Solar	4
8	Yingli Green	JA Solar	JA Solar	Trina Solar	SolarWorld	Suntech	3
9	ReneSola	Trina Solar	Trina Solar	JA Solar	Canadian Solar	Hanwha SolarOne	10
10	Canadian Solar	Hanwha SolarOne	Hanwha SolarOne	Hanwha SolarOne	Hanwha SolarOne	JA Solar	8
11	JA Solar	Canadian Solar	Canadian Solar	Canadian Solar	JA Solar	Canadian Solar	5
12	Jinko Solar	Jinko Solar	Jinko Solar	Jinko Solar	Jinko Solar	Jinko Solar	7

Figure 5. Top PV manufacturers' ranking by R&D spending 2007–2012.

market leadership position within a given year while holding the leadership position in R&D spending. At the other end of the scale, JinkoSolar has seen its market ranking rise rapidly over the last few years and is currently ranked seventh in the market.

Fig. 5 also highlights that, at the lower laggard level of R&D spending, Canadian Solar, JinkoSolar and Hanwha SolarOne have consistently underspent compared with rivals, yet are market ranked 5, 7 and 10 respectively.

However, with regard to JinkoSolar and Hanwha SolarOne, both companies increased spending in 2012, and notably JinkoSolar more than doubled spending. In respect of Hanwha SolarOne, the company is fast-tracking its assimilation of former Q-Cells cell and module technology in a 'copy smart' strategy, and spending could continue to rise modestly over the next few years.

Another trend highlight is the fact that three manufacturers (SolarWorld, ReneSola and REC) had not been in the top 10 market rankings yet have consistently been positioned high in the R&D rankings.

Although REC had led the R&D rankings ahead of First Solar, the company dropped to near the middle of the table last year. Primarily, REC had spent heavily on developing its FBR polysilicon technology and wafer technology. Wafer technology investments at ReneSola also dominated R&D activities and are expected to continue but also include the development of its Virtus wafer/cell and module offerings.

In the case of SolarWorld, recent high-spending activity has been focused on monocrystalline wafer technology as well as the development of performance PERC cell technology. SolarWorld expects to commercialize both activities in 2013, which could explain its guidance that R&D spending would decline in 2013.

There is a certain sense of relief in being able to correlate First Solar's and SunPower's consistently high spending strategies with their cell and module conversion efficiency records. SunPower recently launched its X-Series module, employing its latest Maxeon Gen 3 solar cell technology, which has conversion efficiencies of over 24%. The modules have efficiencies of 21.5% and above. First Solar has recently reported a range of record CdTe thin-film cell and module records both in the lab and at the manufacturing level. Already this year, R&D test cells produced at First Solar's Perrysburg, Ohio, factory and R&D centre have been verified by NREL to have reached a new record cell conversion efficiency of 18.7%.

The company has also been focused on bringing higher cell and module efficiencies from the lab to fab at a faster pace than ever before.

However, the news in February 2013 that First Solar would acquire US-based monocrystalline solar cell start-up TetraSun shook the industry. Having exited R&D into competitive CIGS thin-film technology and rejuvenated its commitment to CdTe technology, First Solar has plans to begin 'tentative'

production of TetraSun's copper-based monocrystalline cells in the second half of 2014.

It would be reasonable to predict that First Solar's R&D spending levels will continue to be at high levels for several more years to come.

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## Conclusion

Overall, R&D spending for the majority of the group has been closely tied to new product introductions but with an emphasis on the development of lower cost processing. According to the latest edition of the ITRPV, significant changes are predicted, especially in the field of solar cell design and a related move to n-type mono wafers and a switch to copper metallization starting in 2015. Indeed, a whole suite of evolutionary changes from wafers, materials, cells and modules is expected that should require, and has already forced, some leading companies to continue to invest in R&D activities, with that trend expected to continue in the mid-term.