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King Abdullah Petroleum Studies and Research Center

Commentary

An Improved Understanding of the Balance of System Costs Can Improve the Economics of Solar PV Projects

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A better understanding of the trends in BOS costs can help developers derive better estimates of the risk and returns of regional solar project investments.

Much of the discussion around the cost of solar photovoltaic (PV) generation has focused on the costs of PV modules that convert sunlight to electricity. The overall capital cost of a PV system consists of two components: the cost of the modules and the balance-of-systems (BOS) costs. The BOS is a catch-all term to describe everything needed to erect and commission the PV system. The BOS costs include cables, the mounting system, solar inverters, labor costs, permitting costs, and site preparation costs.

Modules, for the most part, can be treated as a commodity. Many organizations track and publish the spot prices of internationally priced modules, much like the use of the spot markets in the oil industry. Although the modules are priced internationally, the BOS costs are regional and differ significantly across countries. A better understanding of the trends in BOS costs can help developers produce more accurate estimates of the risks of, and the potential returns from, regional solar project investments.

The learning curve and progress ratio

Manufacturers continually learn from their experiences and, consequently, become increasingly more efficient in producing goods. This enhanced efficiency translates into **cost reductions**. This process is referred to as the **learning curve** (LC), a concept that has been applied to numerous industries. The LC measures the cost of producing a good against the cumulative global manufacturing capacity of the good.

For example, if a product possesses an LC of 85%, each time the cumulative manufactured quantity doubles, the new cost of production is 85% of the previous level. Alternatively, an LC of 85% means that each time the cumulative manufactured quantity doubles, the manufacturing costs fall by 15%. This fall in costs is referred to as the **progress ratio**. Most industries possess an LC between 70% and 90%.

The solar PV module industry has had an 80% LC, or a 20% progress ratio. Note that this LC reflects only the module component – it does not represent the LC of the overall capital costs.

As manufacturers' experiences accumulate, they can produce goods in a more cost-effective manner. This is known as the learning curve.

The learning curve of the BOS

The overwhelming majority of PV LC studies discuss and analyze the LC of the modules, not the BOS. This is expected, as modules are the cornerstone of the industry and used to account for most of its capital costs. However, this situation has now reversed, and BOS costs are now responsible for nearly two-thirds of the industry's total capital costs.

A detailed study conducted by KAPSARC for over 20 countries found that the global average LC of the BOS was approximately 90%, i.e., a progress ratio of 10%. In other words, the cost reductions in the BOS segment were slower than those in the module component. Countries who were able to reduce their BOS costs significantly include Sweden (LC = 74.1%), China (LC = 78.3%), and Germany (LC = 80.3%).

The results obtained from this analysis could be used to inform the projection of future solar PV capital costs. Countries will know that modules have an LC of 80%; they can then refer to their specific LC for the BOS segment. Having better estimates for the LC of the BOS will result in more accurate projections of the potential financial returns of a solar project and will help inform the bids for future solar projects.

Key takeaways

- The capital cost of a PV system comprises two components: the module cost, and the BOS cost.
- Manufacturers continually learn from their experiences and, consequently, become increasingly more efficient in producing goods. This enhanced efficiency translates to cost reductions. This process is referred to as the learning curve (LC).
- The solar PV module industry followed an 80% LC, while the BOS segment followed a 90% LC.
- Currently, the BOS costs account for over half the PV industry's capital costs. More accurate estimates for the LC of the BOS will result in more accurate projections of the financial returns of PV projects and will help inform the bids for future PV projects.

References

Elshurafa, Amro M., Shahad R. Albardi, Simona Bigerna, and Carlo Andrea Bollino. 2018. "Estimating the learning curve of solar PV balance–of–system for over 20 countries: Implications and policy recommendations." *Journal of Cleaner Production* 196: 122-134.

A KAPSARC study shows that the LC of the BOS component is 90%, compared with an LC of 80% for modules. This indicates that the reductions in the BOS costs are occurring faster than those of the modules.

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