

Solar Panel Selection

Solar panels, aka photovoltaic (PV) modules, are a headline procurement concern for PV system buyers. A PV module consists of a number of solar cells connected in series and parallel, integrated with other materials and devices, to deliver a suitable power combination of voltage and current. The PV industry produces modules in two broad categories of geometrical formats, larger sizes for ground-mounted and smaller for rooftop projects. Module efficiencies, a measure of the power produced per unit area for a given irradiance, are quoted for Standard Testing Conditions (STC). The power capacity of a module is rated in Watt-peak (W_p) capacity for its power output at the STC. Module prices are quoted per unit W_p. Naïve solar buyers tend to focus on these two figures: the STC efficiency shown on the module datasheet, and the price per W_p.

In our guide “Managing Solar Energy – Fundamental Science to Practical Systems”, we explain how to more insightfully assess and plan PV module purchasing. We explain how a PV module needs to be assessed for and monitored in actual operating conditions, to see that

it does what it says on the tin. Module technology is in a constant state of innovative flux – a high rate of technology obsolescence. Therefore, it's challenging for buyers to keep abreast of the pros and cons of new module designs (higher projected performance in lab tests, but risks of unknown degradation mechanisms in the field).

To educate the solar buyer, we start from the fundamentals of a solar cell: its basic physics, device architecture, what determines maximum efficiency, the power loss mechanisms, operational characteristics, bill of materials (BOM), and manufacturing processes. Similar detail is then covered from the cell to module. Module design variations will keep evolving and multiplying, but a well educated buyer will be able to effectively assess the newer designs for well informed purchasing decisions .

The reader of our guide will learn, among other crucial information:

What materials make up a solar cell, and module, and their corresponding effects on the device properties?

The materials used for different production batches may vary – hence, the need to check for critical BOM variations.

What are the manufacturing processes for cells and assembling modules from cells?

Do the modules with highest STC efficiency deliver the highest energy yield in actual operating conditions?

The short answer? Not necessarily. Reading the guide will provide further insights.

How do actual operating conditions affect expected performance?

How are the projected performance characteristics, including the annual power attenuation rate, assessed?

Module datasheets show guaranteed power performance profiles of 25 to 30 years, but this performance has obviously not been observed for the full duration in actual operating conditions.

How should the solar buyer test the module in actual operating conditions to verify it is on track for the projected performance?

What types of defects and degradation mechanisms can occur for different module designs in the field?

What are the leading indicators of such defects, and the field-testing techniques for early detection and remedial action?

The defects and degradation mechanisms in modules may have a wider detrimental effect on the installed system. Conversely, module degradation might be the result of an issue in another part of the system. Early detection and defect characterisation is critical for either scenario.

What is Cell-To-Module (CTM) efficiency? Counterintuitively, the composite module efficiency can, in fact, exceed that of the sum of its constituent solar cells taken separately. CTM design is customizable, in conjunction with the overall system configuration and site conditions, for higher energy yields.

Module selection affects the rest of the system design, in particular the low-voltage DC circuit in important, subtle ways. Power conversion efficiency, at STC, is not the only important feature. Further essentials about module technology and selection are elaborated in the guide.

We also discuss the prospects of breakthrough solar cell and module designs, involving novel materials and device structures.