Lifetime Energy Production – A Tool for PV System Optimization

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Introduction

One of the most commonly discussed metrics in the solar photovoltaic (PV) industry is price per watt ($/W). This metric permeates financial negotiations and news articles, and is simple to calculate from the nameplate rating divided by the price of a given PV module. One deficiency of this metric is that revenue generated by the facility ultimately determines the economic viability of a solar PV project, and that is best measured in price per kilowatt-hour ($/kWh). Additionally, the $/W metric does not capture the differences in PV module efficiencies. There are many computer programs that have been developed to calculate the energy production of specific PV modules in specific configurations. These tools require various levels of engineering acumen in order to correctly assess the economics of a solar project design.

This presentation describes a novel PV module rating system that provides a simple, bigger-is-better number based on Lifetime Energy Production (LEP) that can be used to compare PV modules in a cost-benefit analysis. Modules with the highest Rating are the most productive, but depending on their price they may not be the best choice for a particular project.

A "280 watt" PV module only provides about 280 watts of power at Standard Test Conditions.

STC: 1000 w/m^2 and 25 °C.

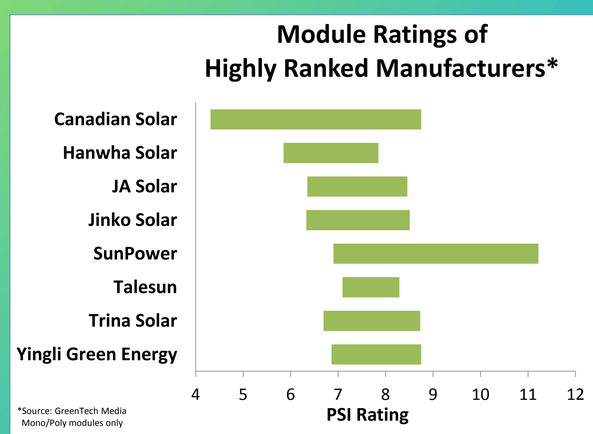
The energy it produces depends on sunlight, temperature and other factors.

Example 1: Cost-benefit analysis of two similar modules*

Manufacturer	ABC	XYZ
Model	----------	----------
Max Power (W_p)	255	260
Price ($/ W_p)	0.78	0.91
Type	Mono	Mono
Module Efficiency (%)	15.7	15.3
Tolerance	0 ~ +2 %	0 ~ +2 %
PSI PV Module Rating	8.15	7.48

*Source: enfSolar.com

In Example 1 above, manufacturer ABC offers a module with a Rating that is 9% greater than manufacturer XYZ's. However, the price per W_p for manufacturer ABC is 15% less. This gives ABC's module a revenue advantage. There are other factors that buyers must consider, such as delivery terms, warranty and reputation. The manufacturer names in this example are concealed per PV America presenter guidelines, but the module prices and data were obtained from the enfSolar website. The PSI Rating was provided by the Principal Solar Institute website.



The range of Ratings for each manufacturer is dictated by the variety of model numbers. Larger Rating numbers do not indicate the best PV module, but they do reveal the most productive in terms of energy per unit area. The price of each module combined with the Rating enables a simple cost-benefit analysis.

Example 2: Similar power, but different energy Ratings

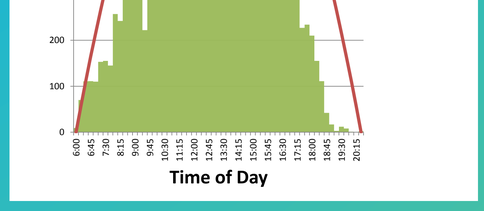
Manufacturer / Model No.	Nameplate Power (W)	PSI Rating	kW-h Factor
Ningbo / UL-280D	280	9.85	1.62
Trina Solar / TSM-280PA14	280	7.49	1.23
CSG PVTech / CSG280M2-36	280	7.42	1.22
Suntech / STP280-24/Vd	280	7.41	1.22
CentroSolar / SP7 280SW	280	7.04	1.16
Schott Solar / ASE-300-DGF/50-290	290	6.07	1.00

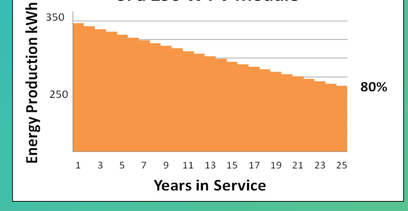
Power and energy are not the same thing. All of these PV modules have about the same nameplate power, but a wide range of PSI Rating. The PSI Rating is based on 25 year LEP. The relative energy production per unit area is indicated in the last column. The Schott modules would have to be available at about 60% of the Ningbo price to be more cost-effective energy producers. (6.07 / 9.85 = 0.61)

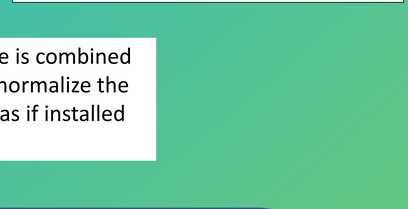
How is it possible that PV modules with the same wattage can have a large range of PSI Ratings?

How much energy will a PV module produce in 25 years? – Lifetime Energy Production (LEP)

It is difficult to obtain an accurate annual energy prediction because of natural variation in sunlight and temperatures due to weather conditions. The Rating method circumvents this difficulty by using a representative model to calculate nominal energy production for every module in our database.







These models of irradiance and temperature are applied to the seven key module characteristics, and the impact on each one is combined without weighting to obtain the 25 year LEP. Degradation over time is based on warranty terms, not accelerated testing. We normalize the energy value using the total irradiation accumulated per square meter in 25 years. In this way, PV modules can be compared as if installed side-by side irrespective of orientation, tracking configuration or inverter choice.

Concluding Remarks

A novel PV rating system based on Lifetime Energy Production has been presented that can be used in a cost-benefit analysis to supplement price per watt metrics. It is a tabulated number and thus requires no sophisticated modeling in order to apply it to specific PV modules. The Rating can also be used as a screening tool to quickly reduce the variety of modules for which detailed design modeling must be preformed. Because it includes an area efficiency term, it drives equipment decisions in the right direction for both rooftop and utility scale projects.

There are other uses of this Rating that have not been discussed in this presentation. The Rating has been used by independent power producers in due diligence processes for utility scale solar project acquisition, by residential installers to simply explain the differences between PV modules, and by the Solarize Frederic County MD initiative to document the performance of modules being bid into that program. It is our expectation that other uses will be discovered as it continues to gain acceptance.

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