Engineering Bulletin

SunWize Power & Battery

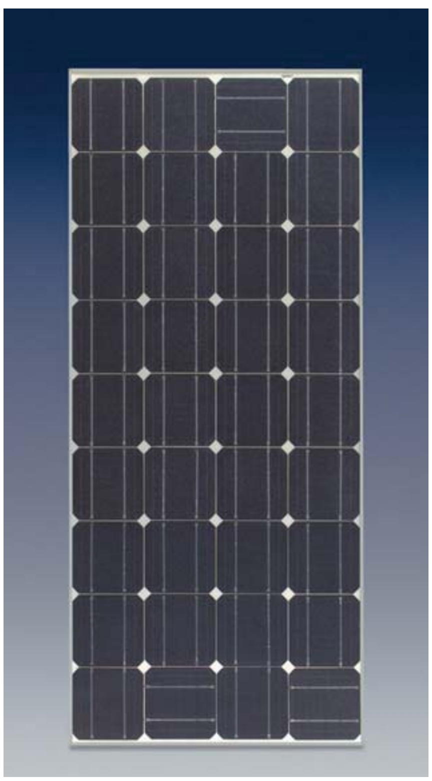
PV Module Efficiency

Customers often ask how efficient photovoltaic (PV) modules are. This is a valid question since PV module efficiency directly affects the physical size of a solar array relative to the load it is powering. The efficiency also impacts the cost effectiveness of solar relative to other power options.

Efficiencies help designers determine if solar is a practical solution and helps them determine which type of module to use.

Efficiency is a ratio of how well one form of energy is converted to another form of energy. In this case, the sun's energy on the earth is converted to DC electricity.

The sun provides approximately 1000 watts of power per square meter of area it shines on. This value varies greatly with the position of the sun day to day and season to season and is affected by other factors such as air quality and cloud cover. However, this value is the standard to which all solar components are measured and compared.



SunWize SW120 monocrystalline module..

PV module manufacturers replicate the effects of the sun using controlled light sources to simulate exactly 1000 watts of power per square meter. This allows all size and shapes of modules to be tested consistently and repeatedly under similar conditions. To measure efficiency the module is exposed to the light source and the module output power is measured. The ratio of theoretical power is then compared to the measured power, and the efficiency is calculated.

EXAMPLE:

A SunWize monocrystalline 120 watt solar module measures 0.92 m^2.

At 100% efficiency, this module would produce 920 watts based on:

$$1000 w/m^2 \times .92 m^2 = 920W$$

However, the factory rated power for this module is 120W +/- 5%.Thus, the best efficiency expected is:

$$120W \times 105\% = 126W / 920W = 13.7\%$$

The worst efficiency expected is:

$$120W \times 95\% = 114W / 920W = 12.4\%$$

Monocrystalline and polycrystalline modules typically range between 12 – 14% efficiency. Thin film or amorphous modules typically range between 6 – 7%. Each technology has different limitations that keep the efficiency locked into these ranges.

The efficiency of a module is dependent on many factors which can be separated into 3 main categories:

1. Electrical properties or the ability of the silicon technology to convert power from one form to another.

2. Mechanical properties such as light reflectivity and diffusion, and heat absorption of the material.

SunWize custom engineered 5.2 watt polycrystalline module powering gas flow monitoring device.

3. Manufacturing properties such as the ability to package cells densely with as little area as possible reserved for the mounting frame and the interconnecting bonds of the cells.

The PV industry is continually working to improve solar module efficiencies, primarily by improving the conversion efficiency of the solar cells. The great majority of solar cells being produced today are silicon-based.

While there are theoretical limits to the conversion efficiency of silicon as a semiconductive material, there is still room to improve the current levels. Examples include improving the purity of the silicon (the removal of impurities), anti-reflective treatments on the surface of the cell, surface etching of the cell to enhance the capture of reflected and diffused light, and minimizing the electrical bus-bar patterns.

As efficiencies at the cell and module level improve, the cost of PV modules will continue to decrease. This will make PV more compelling as a primary power source relative to other power generation options, especially as those options continue to increase over time.

Corporate Headquarters
1337 Main Street, P.O. Box 895, Philomath, OR 97370
1.800.827.6527 | power@sunwize.com | www.sunwizepower.com