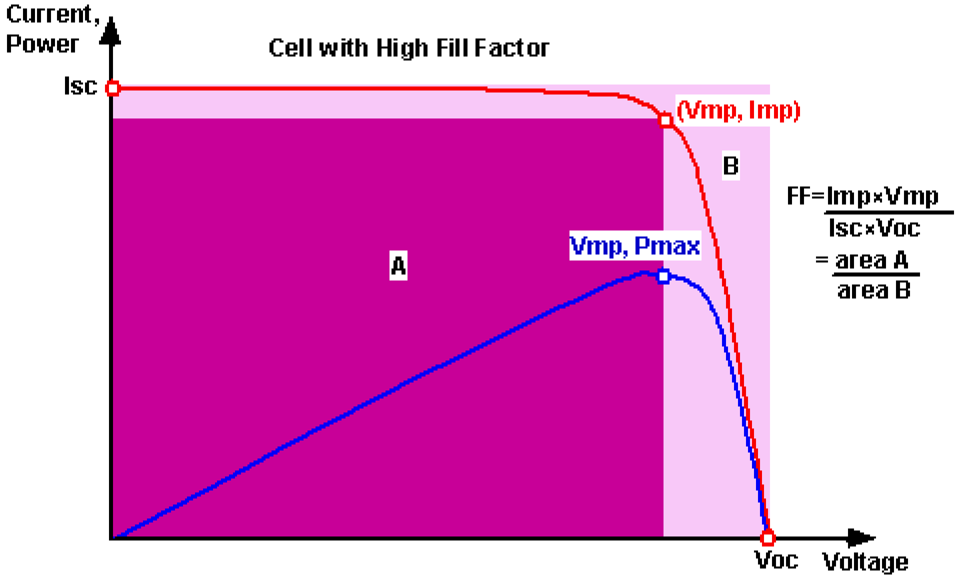
Fill factor is also often represented as a percentage. **Cell efficiency** refers to the portion of energy in the form of sunlight that can be converted via **photovoltaic** into electricity.

The short-circuit current and the open-circuit voltage are the maximum current and voltage respectively from a solar cell. However, at both of these operating points, the power from the solar cell is zero. The "fill factor", more commonly known by its abbreviation "FF", is a parameter which, in conjunction with V_{oc} and I_{sc}, determines the maximum power from a solar cell. The FF is defined as the ratio of the maximum power from the solar cell to the product of V_{oc} and I_{sc} so that:

$$FF = P_{MP} / (V_{OC} \times I_{SC})$$

$$FF = V_{MP} I_{MP} / V_{OC} I_{SC}$$

Graphically, the FF is a measure of the "squareness" of the solar cell and is also the area of the largest rectangle which will fit in the IV curve. The FF is illustrated below.



Graph of cell output current (red line) and power (blue line) as a function of voltage. Also shown are the cell short-circuit current (I_{sc}) and open-circuit voltage (V_{OC}) points, as well as the maximum power point (V_{mp}, I_{mp}). Click on the graph to see how the curve changes for a cell with low FF.

As FF is a measure of the "squareness" of the IV curve, a solar cell with a higher voltage has a larger possible FF since the "rounded" portion of the IV curve takes up less area. The maximum theoretical FF from a solar cell can be determined by differentiating the power from a solar cell with respect to voltage and finding where this is equal to zero. Hence:

$$\frac{d(IV)}{dV} = 0$$

$$V_{MP} = V_{OC} - \frac{nkT}{q} ln(\frac{qV_{MP}}{nkT} + 1)$$

The equation above requires Lambert functions to solve (see below) but a simpler approach is to use iteration to calculate V_{MP}. The equation above only relates V_{oc} to V_{MP} and extra equations are needed to find I_{MP} and FF. A more commonly used expression for the FF can be determined empirically as:[1]

$$FF = \frac{v_{oc} - \ln(v_{oc} + 0.72)}{v_{oc} + 1}$$

where v_{oc} is defined as a "normalized V_{oc}":

$$v_{oc} = \frac{q}{nkT} V_{oc}$$

Efficiency is the ratio of the electrical power output P(out,) compared to the **solar** power input, P(in), into the PV **cell**.

The efficiency is the most commonly used parameter to compare the performance of one solar cell to another. Efficiency is defined as the ratio of energy output from the solar cell to input energy from the sun. In addition to reflecting the performance of the solar cell itself, the efficiency depends on the spectrum and intensity of the incident sunlight and the temperature of the solar cell. Therefore, conditions under which efficiency is measured must be carefully controlled in order to compare the performance of one device to another. Terrestrial solar cells are measured under AM1.5 conditions and at a temperature of 25°C. Solar cells intended for space use are measured under AM0 conditions. Recent top efficiency solar cell results are given in the page

The efficiency of a solar cell is determined as the fraction of incident power which is converted to electricity and is defined as:

$$P_{max} = V_{OC} I_{SC} FF$$

$$\eta = \frac{V_{OC} I_{SC} FF}{P_{in}}$$

Where:
V_{oc} is the open-circuit voltage;
I_{sc} is the short-circuit current;
FF is the fill factor and
η is the efficiency.

The input power for efficiency calculations is 1 kW/m^2 or 100 mW/cm^2. Thus the input power for a 100 × 100 mm^2 cell is 10 W and for a 156 × 156 mm^2 cell is 24.3 W