CLASS 16: INTRODUCTION TO SOLAR PANELS

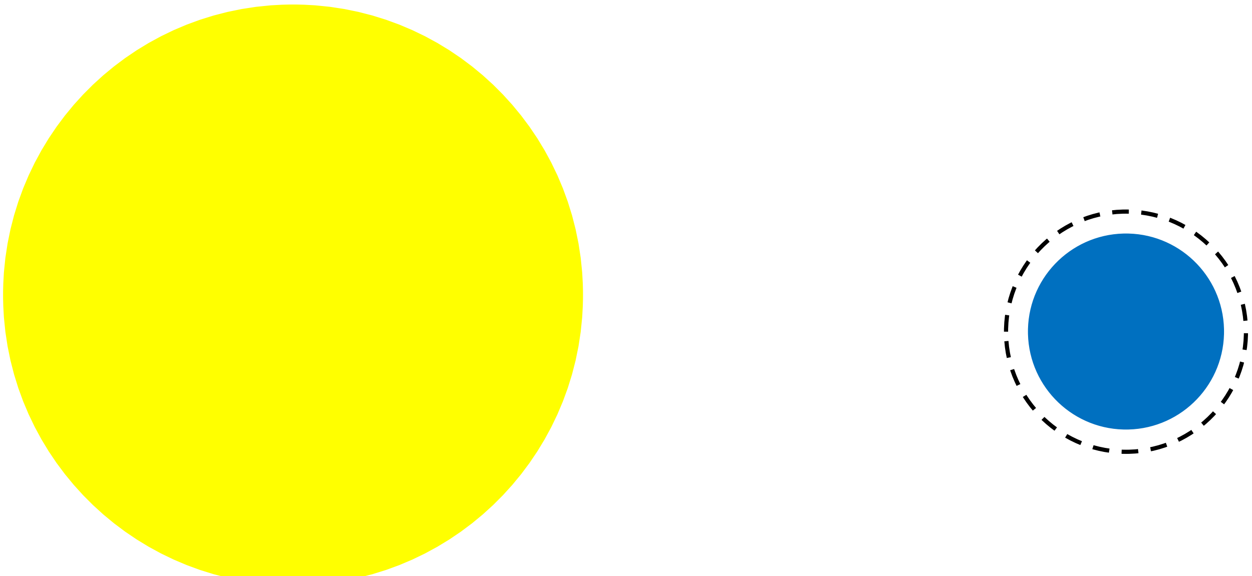
ENGR 102 – Introduction to Engineering

Introduction

Source: https://www.nrel.gov/research/re-photovoltaics.html

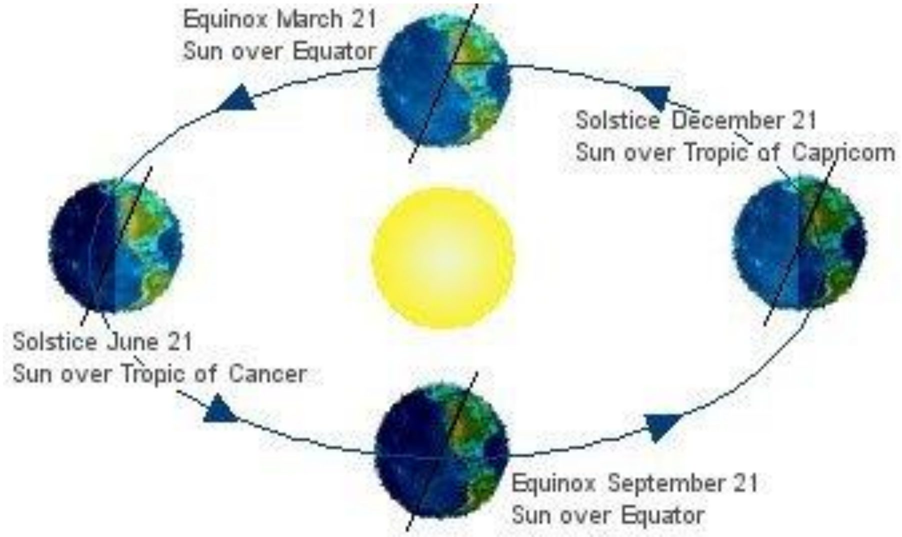
Photovoltaics convert solar radiation (thermal energy) to electricity (electrical energy)

Solar Radiation

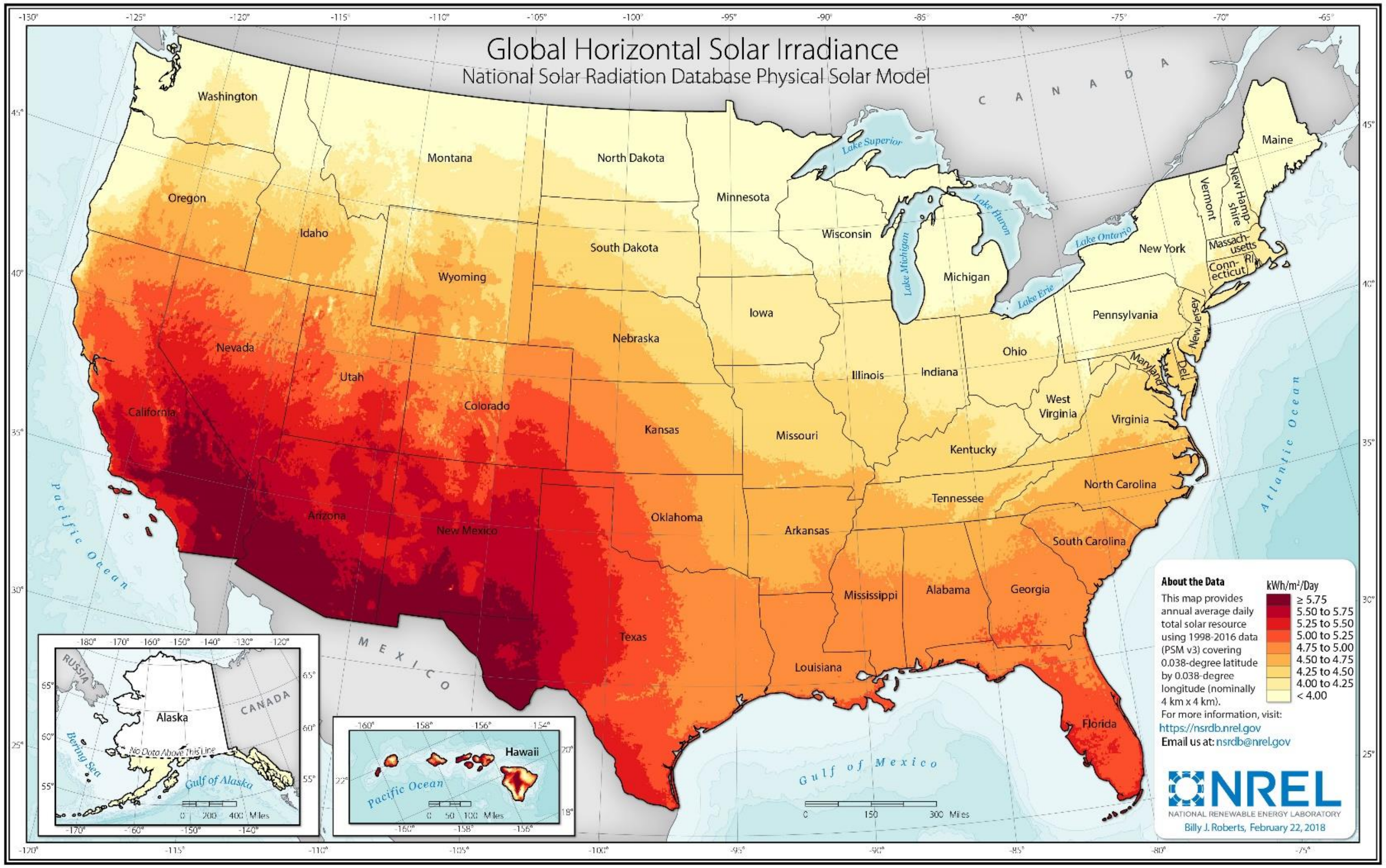


Solar Radiation (Sunlight)

- Availability on earth depends on:
  - Season
  - Time of day
  - Local landscape and weather
  - Geographic location



Solar Radiation



Solar Photovoltaics (PV)

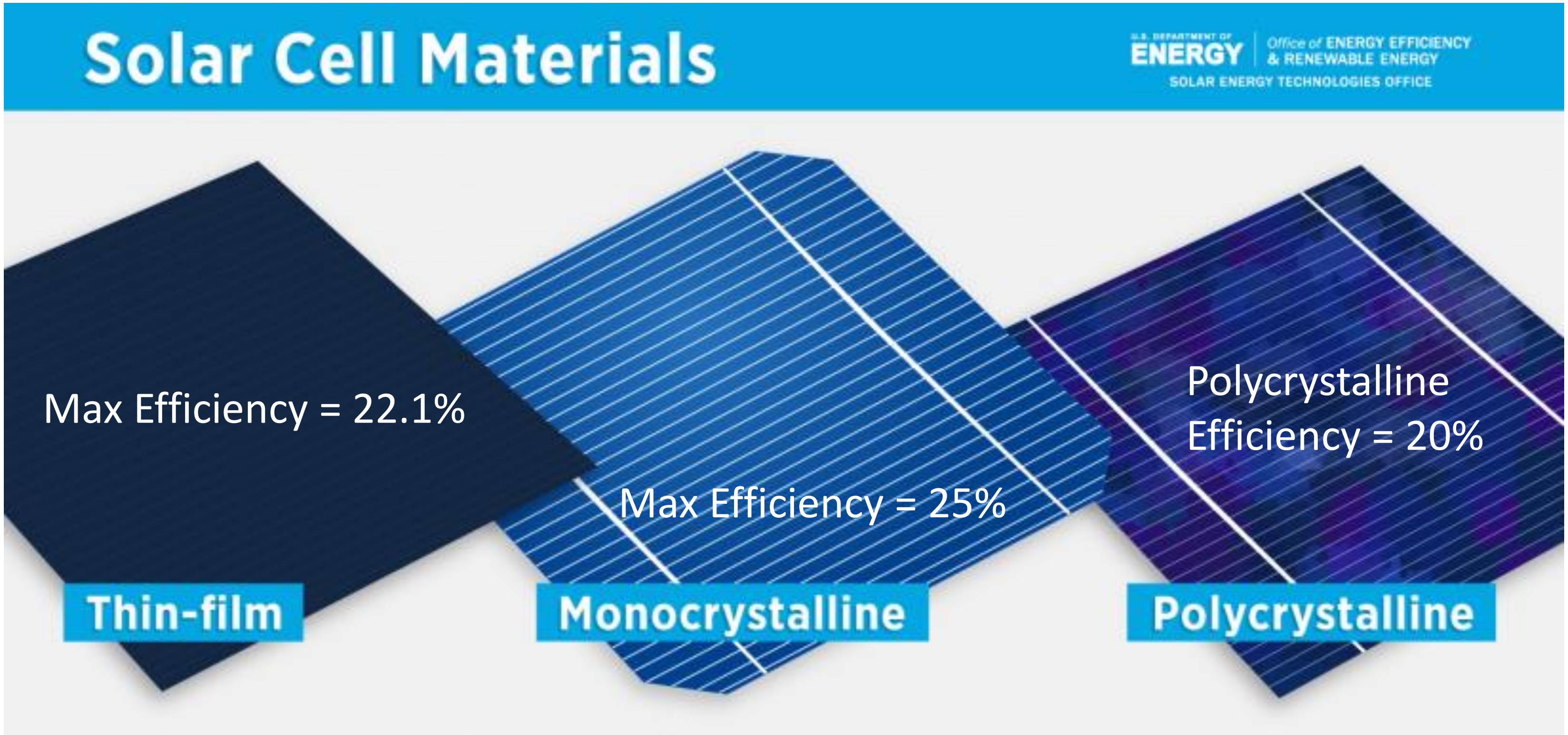
Convert solar radiation to electricity

Solar Photovoltaics (PV)

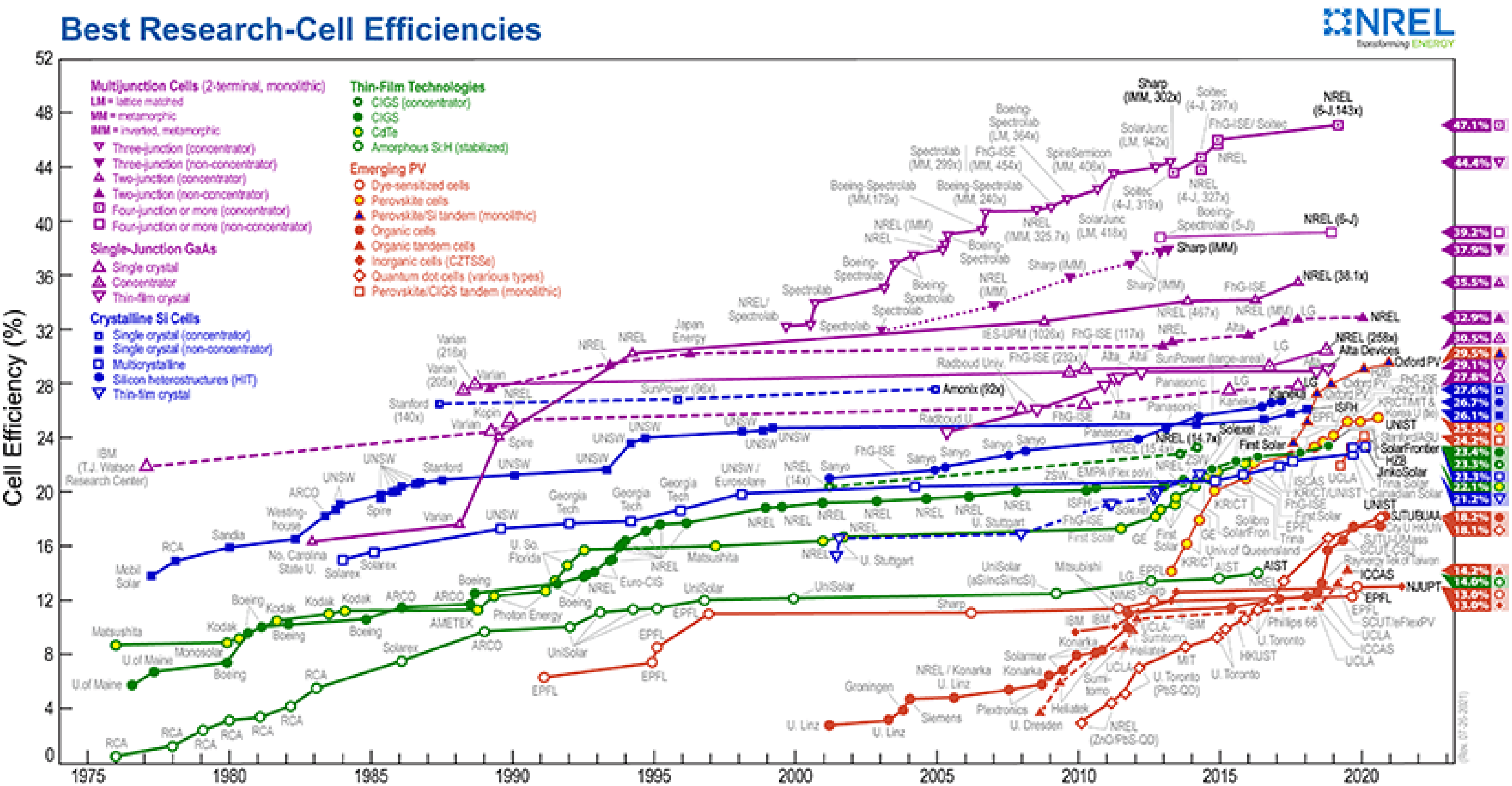
Not all the sunlight hitting the PV is converted to electricity.

The percentage converted is the efficiency.

Efficiency (η): $\eta = \frac{what\ you\ get\ out}{what\ you\ put\ in} = \frac{electricty}{solar}$

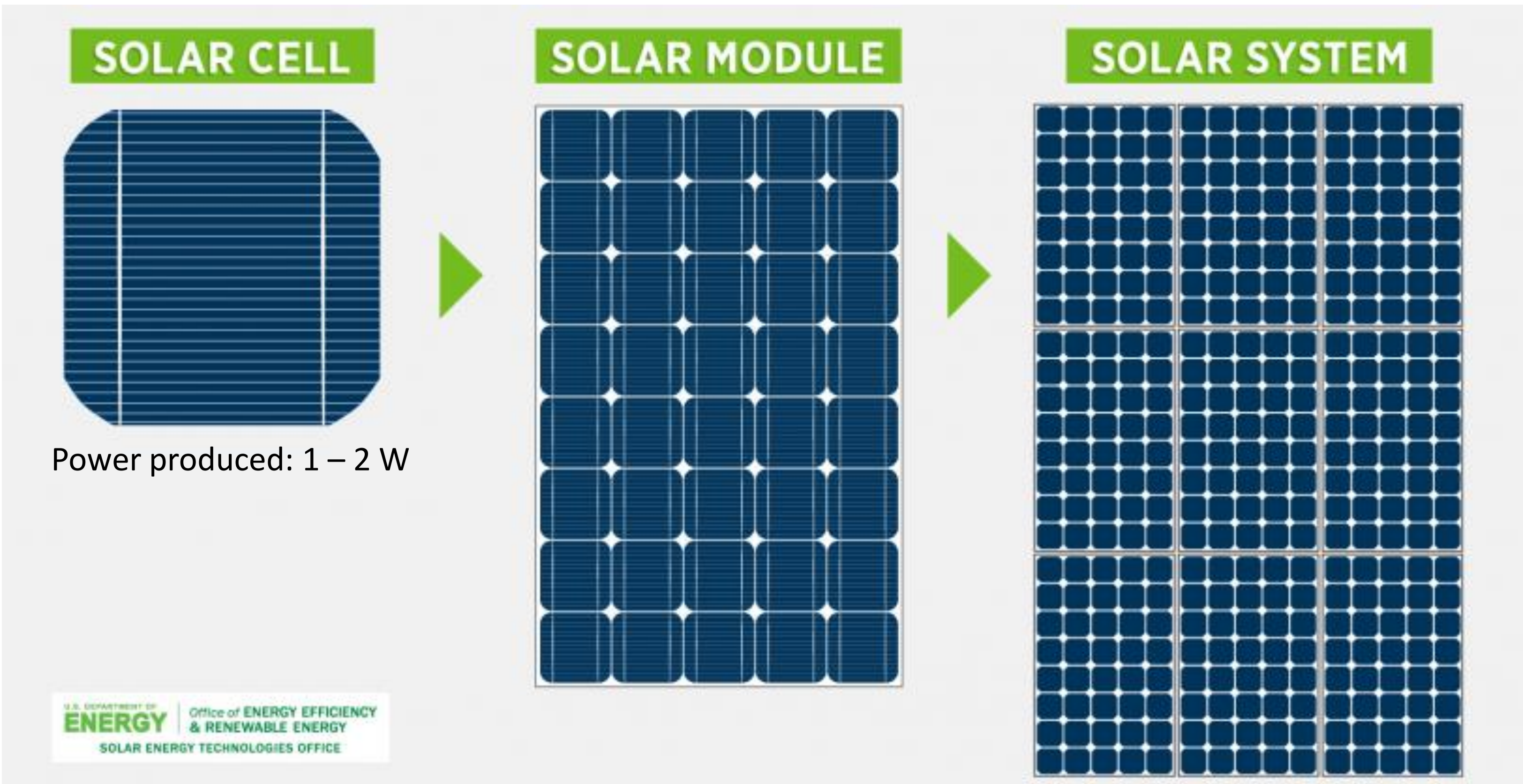


PV Cell - Efficiency



Solar Photovoltaics (PV)

Capture more light → increase electrical output



Power produced: 1 – 2 W

Solar Photovoltaics (PV)

Typical residence daily energy usage = 30 kWh

Average solar irradiance in Bend = 4.25 kwh/m^2/day

This value reports ‘full sun’s’ worth of incoming solar radiation at 1 kw/m^2, so in this case we have 4.25 h/day

$$\frac{30\,\frac{\text{kWh}}{\text{day}}}{\frac{4.25\text{h}}{\text{day}}} = 7\text{kW}$$

But system is not 100% efficient. Assume 80%.

$$\text{PV system size} = 7\,\frac{\text{kW}}{0.8} = 8.75$$

For a home located in Bend, OR an 8.75 kW system is needed

Typical solar panel (module) power rating is 200 W

$$\frac{8.75\text{e}3}{200} = 43.75$$ Need 44 solar panels

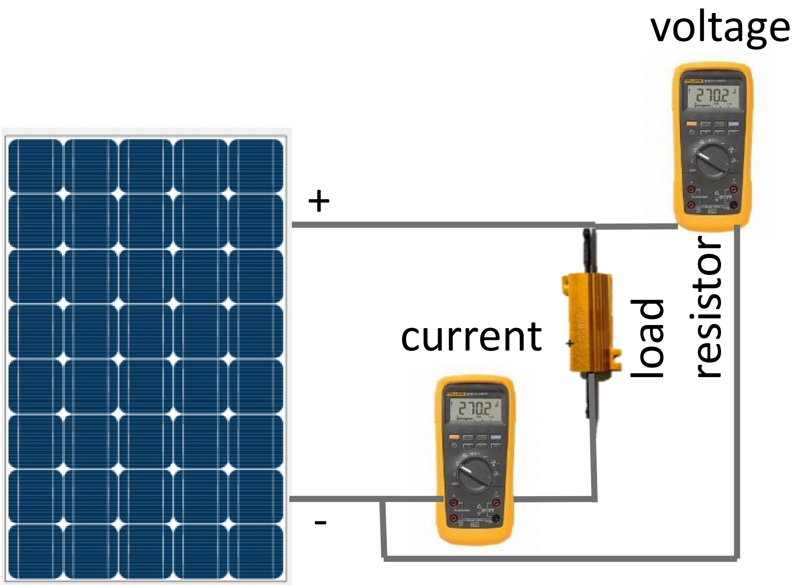
Solar Photovoltaics (PV)

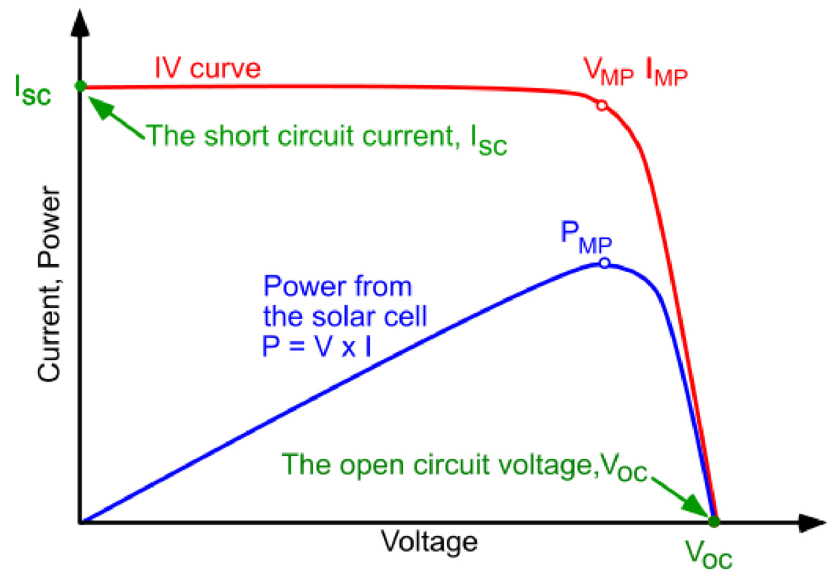
Typical solar panel (module) power rating is 200 W

Where does power rating come from?

PV Characterization – The IV Curve

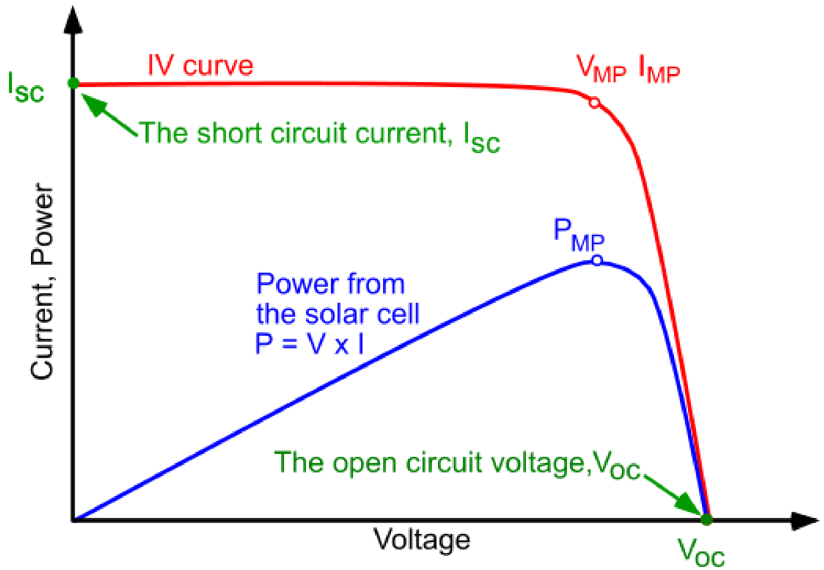
The cell is illuminated at one sun and key parameters measured

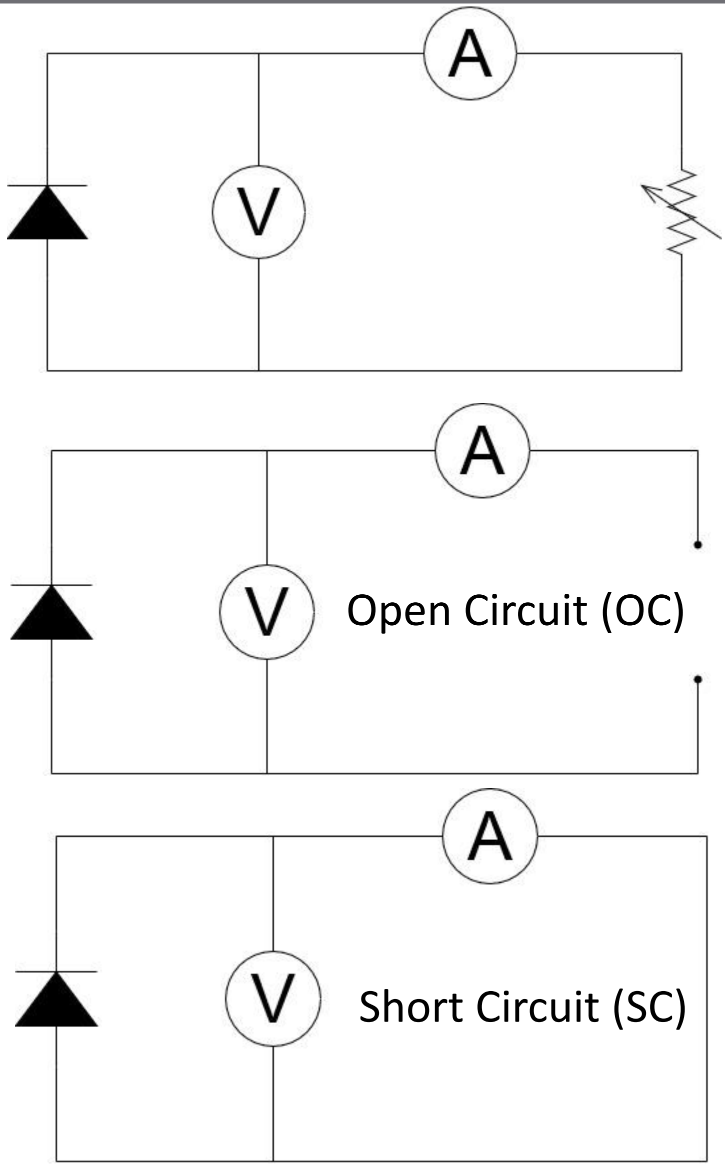




Maximum power point (P_{MP}) is where the cell should be operated. It occurs at V_{MP} and $I_{MP.}$ Calculate P as a f(V) and identify the maximum.

PV Characterization – The IV Curve





Webb

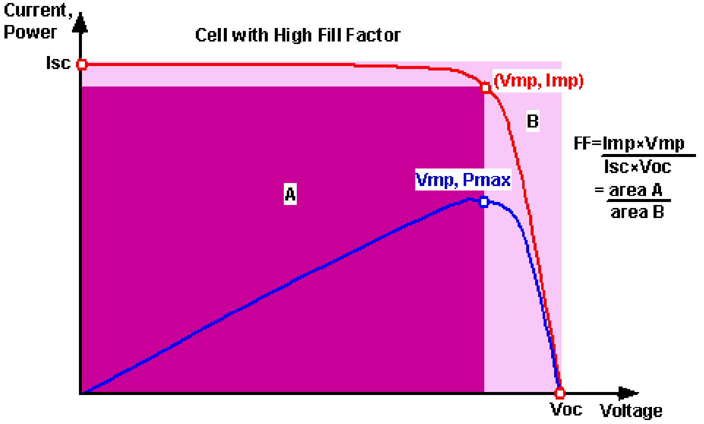
PV Characteristics - Efficiency

$$\text{PV Efficiency } (\eta) = \frac{\text{Solar cell power output}}{\text{Sun input energy}}$$

Operating at max:

$$\eta = \frac{P_{MP}}{P_{in}}$$

$$FF = \frac{P_{MP}}{V_{oc} I_{sc}}$$



Things impacting efficiency:

- Spectrum and intensity of the incident sunlight
- Temperature of the solar cell

Optimizing Collection Through Tracking

- Continuously face sun
- Maximize irradiation

Optimum collection occurs when the sun's rays are perpendicular to the panel surface