Photovoltaic technology

Photovoltaic effect
- classical photoelectric effect experiment
- semiconductor

Electrical properties of semiconductors
- band model: quantum theory, conductance band, valence band, band gap
- impurities: addition of impurity – *doping*, *donor* impurity, n-type (negative charge carriers); *acceptor* impurity, p-type (positive charge carriers); electron & hole

P-N junctions
- established potential depletion region, build-in potential of V_{bi} at equilibrium
- ideal diode law: relationship between I and V under external voltage
- diode behaviour: forward/reverse bias, I-V diode behaviour under external voltage

Semiconductors
- effect of illumination: an photon of light produce an electron-hole pair
- I-V curves under illumination: (light-generated current) – (dark diode current)

Solar cells operating parameters
- Short circuit current (I_{SC}) - the maximum current when $V = 0$, hence $I_L = I_{SC}$
- Open circuit voltage (V_{OC}) - the maximum voltage when $I = 0$, hence $V = V_{OC}$
- *FF* (fill factor) = $V_{mp}I_{mp}$ / $V_{OC} I_{SC}$ hence $P_{max} = FF\ V_{OC}\ I_{SC}$
- effect of temperature: NOCT (Nominal Operating Cell Temperature)

Ideal solar cell performance
- every incoming photon of light will produce an electron-hole pair
- each electron-hole pair result in one electron flowing through the external circuit

Performance loss mechanisms
  Optical losses
- blocking of incoming radiation by the top contacts
- surface reflection of incoming light
- reflection of light from rear contact
  Recombination losses
- radiative recombination
- auger recombination
- recombination at trap sites
  Band gap losses
- below or above band gap

PV module and PV systems
-BOS (balance of system): solar cell, batteries, inverters, controllers and structure
- Standard testing conditions (STC): 1 kW/m^2 of AM1.5 irradiance, cell T of 25ºC
- PV module output under STC: "peak Watt" or W_p nominal capacity.

Types of solar cell materials and technologies
- efficiency, price, current market

Environmental, economic and social impacts