G.B.PANT ENGINEERING COLLEGE

SEMINAR ON

MAXIMUM POWER POINT TRACKING FOR PHOTOVOLTAIC SYSTEM

Submitted By :

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Contents..

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Objective

❖ What is a solar cell ?

A solar cell converts optical energy directly into electrical energy.

It is essentially a semiconductor device fabricated in a manner which generates a voltage when solar radiation falls on it.

❖ Efficiency of solar cell is less, it only converts 30-40% of energy incident on it to electrical energy.

❖ Need to use solar energy :

❑ pollution free

❑ maintenance free

❑ silent operation

❑ long life time

❖ Efficiency of solar cell increased by a technique called maximum power point tracking, by installing this technique we can get additional 20-30% of extra energy.
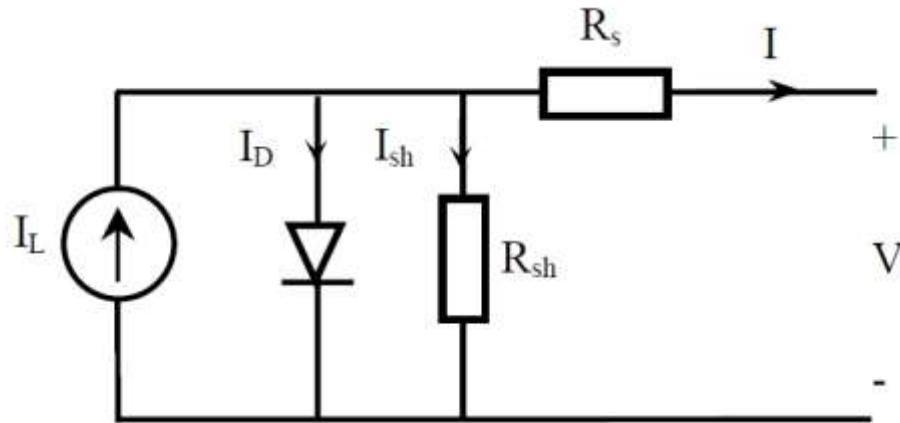
Mathematical Model of Solar Cell

Fig 1. Equivalent circuit of solar PV array.

$$I = I_L - I_o \left(e^{\frac{q(V + IR_s)}{kT}} - 1 \right) - \frac{V + IR_s}{R_{sh}}$$

Where:

I   is the cell current (A).
I_L is the light generated current (A).
I_o is the diode saturation current.
q   is the charge of electron $= 1.6 \times 10^{-19}$ (coul).
K   is the Boltzman constant (j/K).
T   is the cell temperature (K).
R_s, R_{sh} are cell series and shunt resistance (ohms).
V   is the cell output voltage (V).

V-I and P-V characteristics of a solar cell

Fig-2   The I-V & P-V CURVES

Fig. 3: Variation of I-V curve with solar irradiation
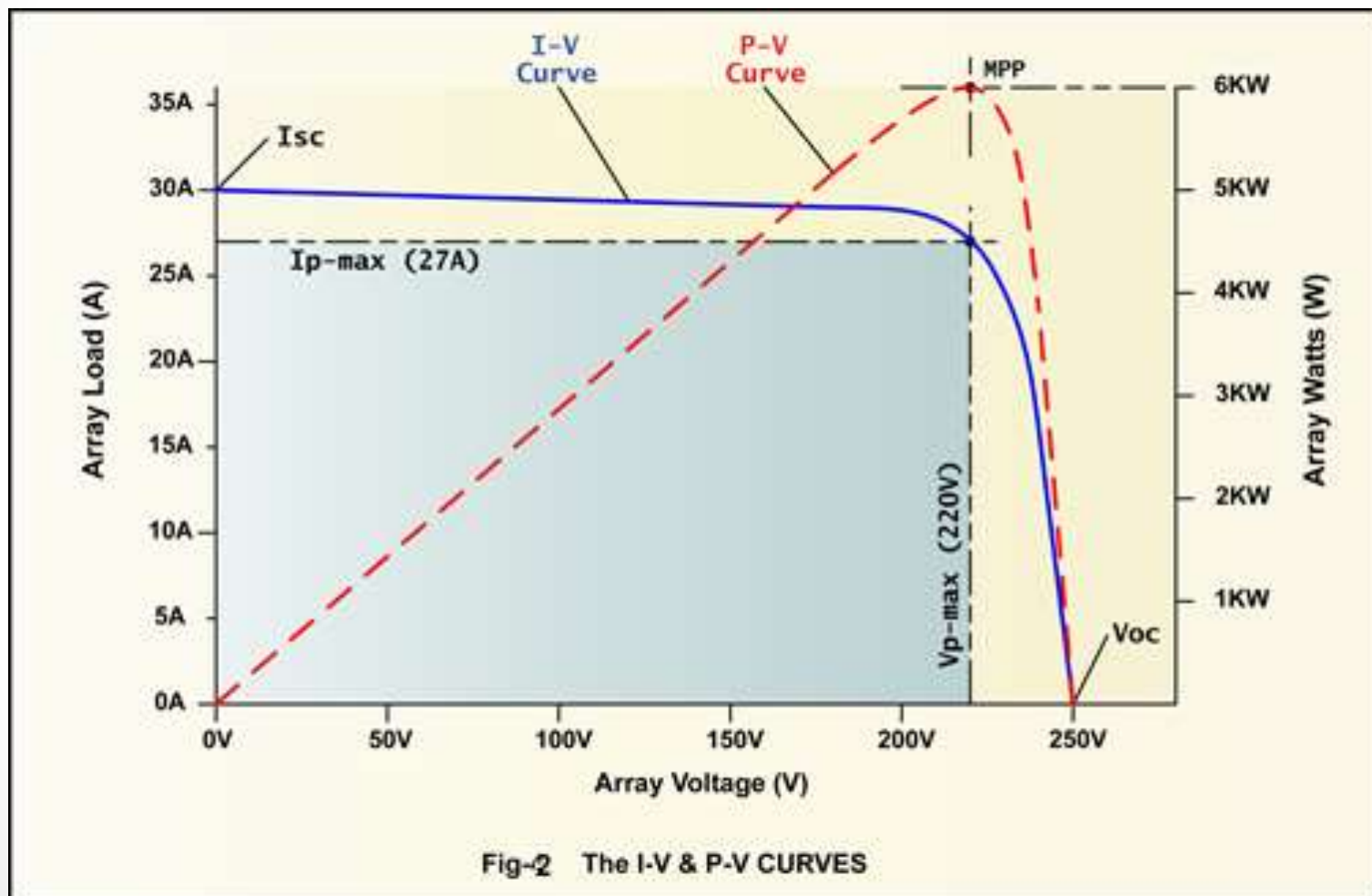

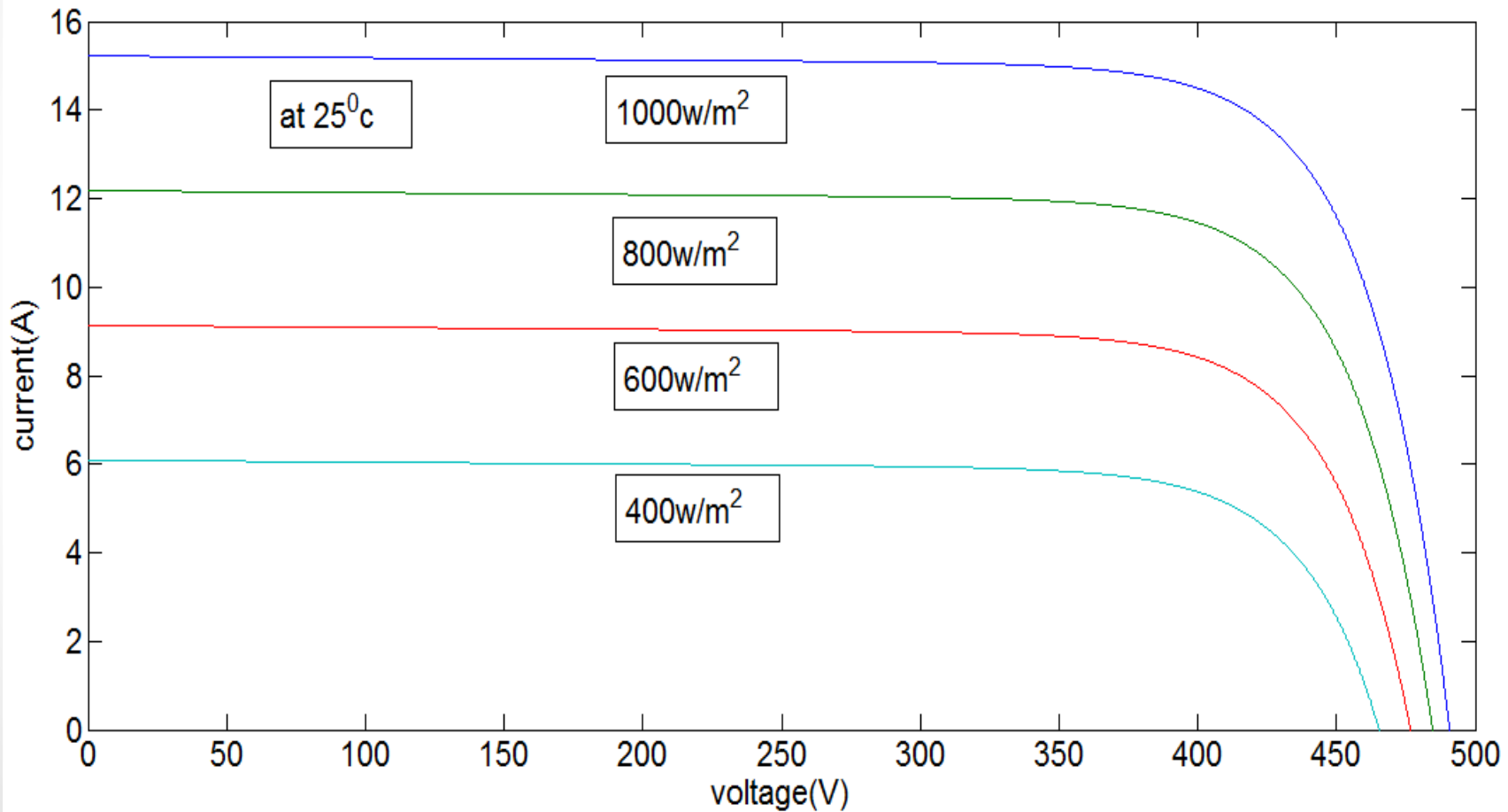Fig. 3: Variation of I-V curve with solar irradiation

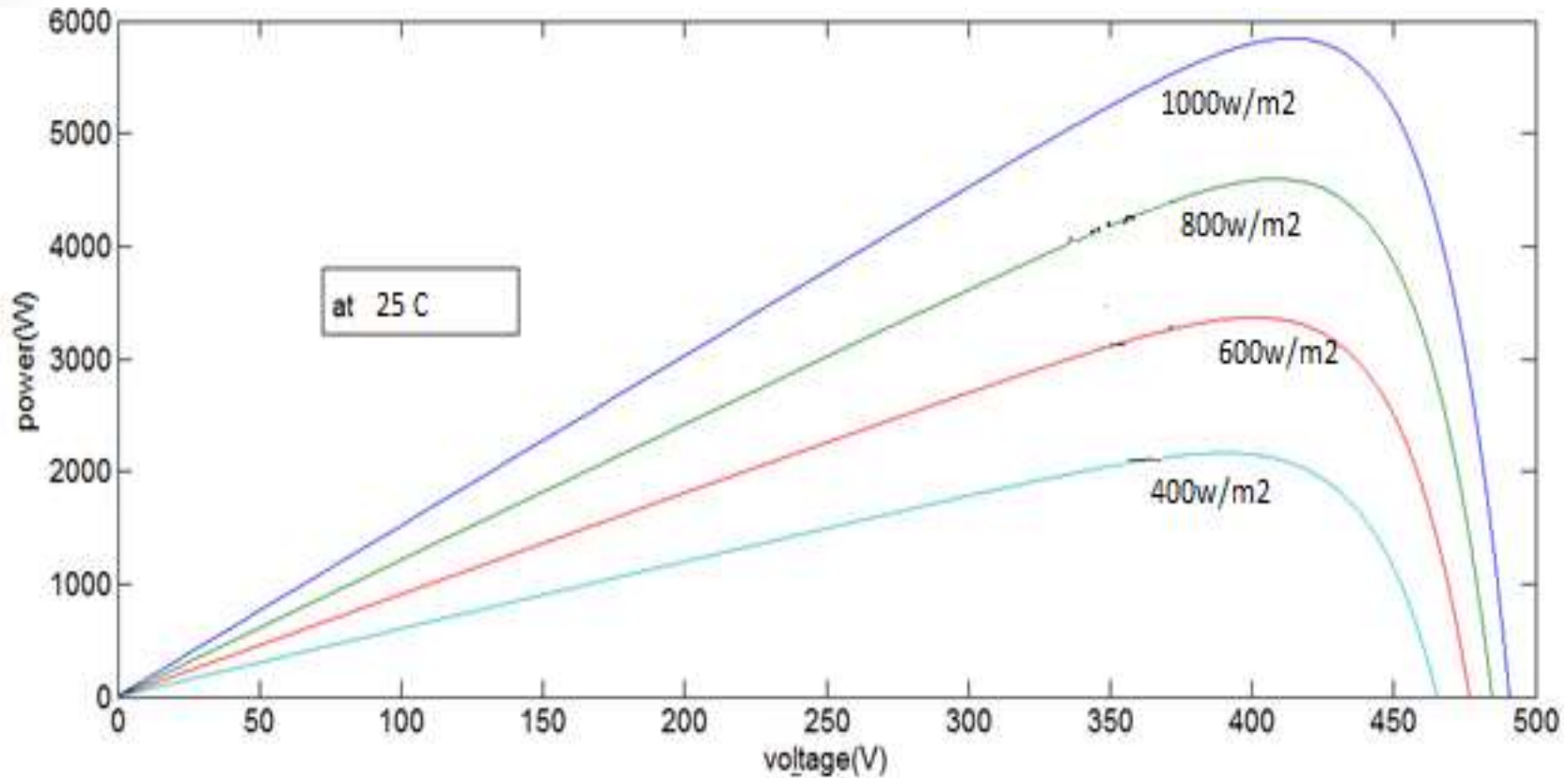# Fig. 4: Variation of P-V curve with solar irradiation
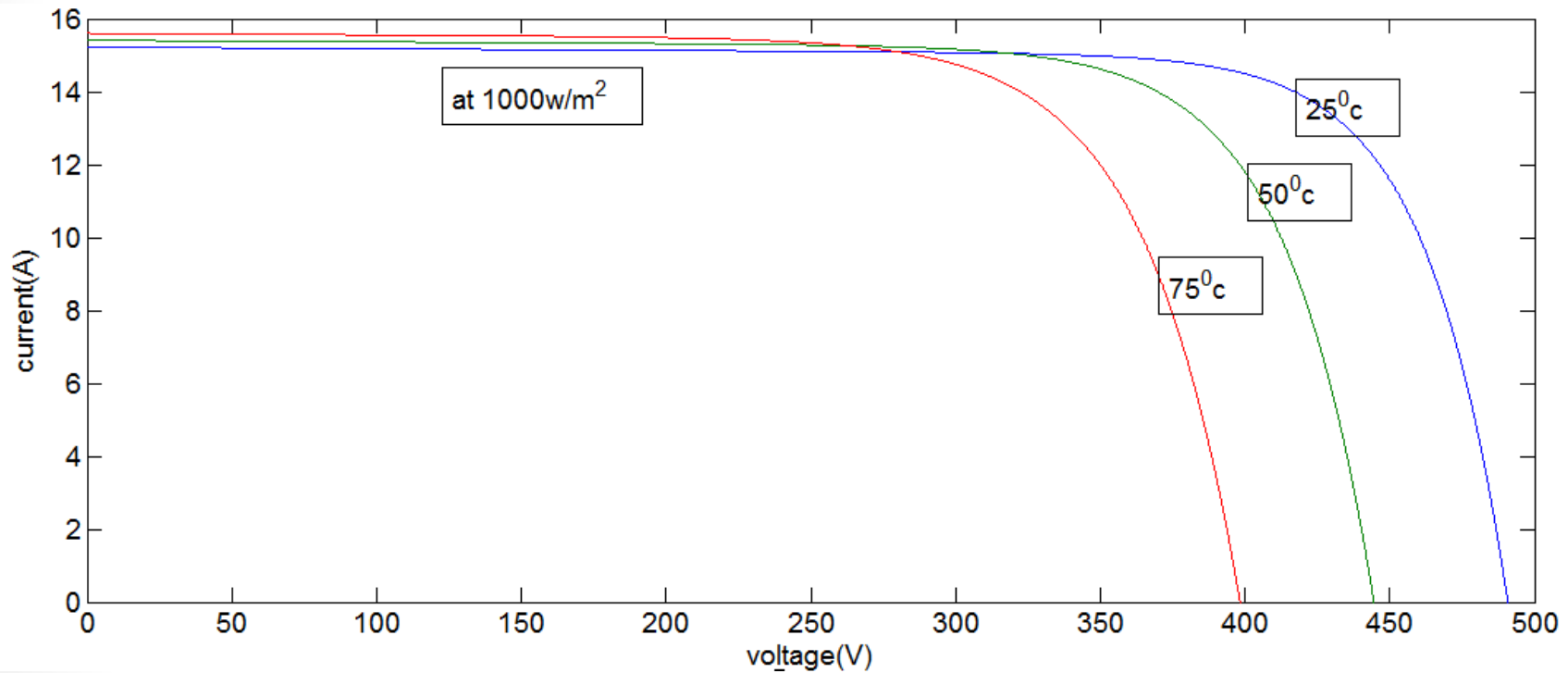
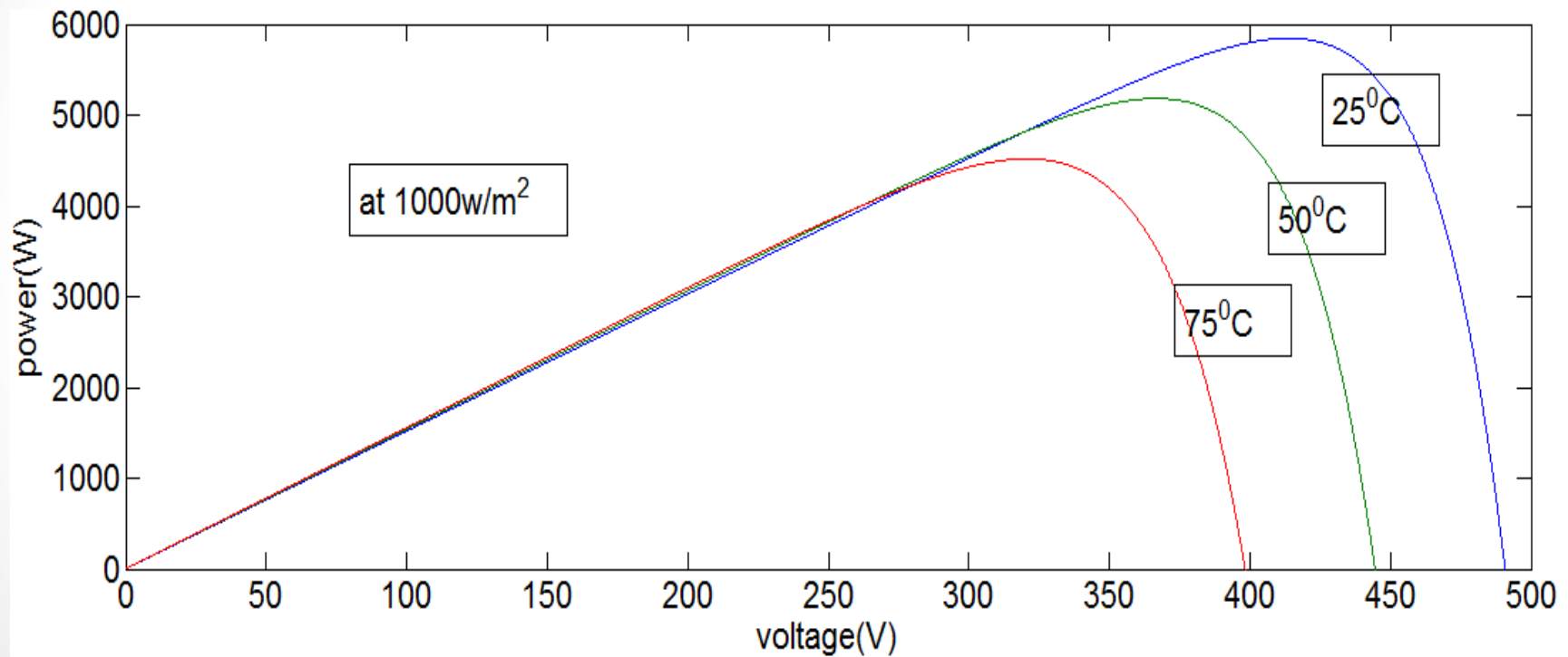# Fig. 5: Variation of I-V with temperature

Fig. 6: Variation of P-V curve with temperature

Methodology

❖ Introduction to maximum power point tracking (MPPT).

❖ Different types of techniques for MPPT.

    ❑ Fixed Voltage

    ❑ Fractional Open Circuit method

    ❑ Perturb and Observe technique (P&O)

    ❑ Incremental Conductance (INC).

❖ Hardware implementation.

Introduction

❖ **What is MPPT ?**

It is an electronic system that operates the photovoltaic modules in a manner to extract the maximum power from the system.

❖ **What is maximum power point ?**

It is a operating point at which maximum power can be extracted from the system. Usually represented as MPP.

❖ The output of solar module is a function of solar irradiance, temperature.

❖ Generally MPPT is installed in between PV system and load. Coupling to the load for maximum power transfer may required either providing a higher voltage at lower current or lower voltage at higher current.
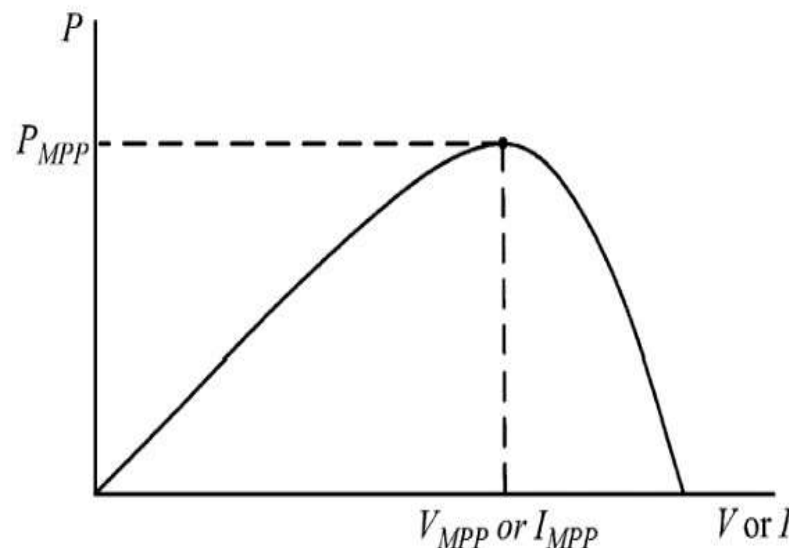
MPPT Techniques


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                                    ┌─────────────────┐
                               ┌───→│  Fixed Voltage  │
                               │    │     Method      │
                    ┌────────┐ │    └─────────────────┘
                    │        │─┤
               ┌───→│Indirect│ │    ┌─────────────────┐
               │    │        │ └───→│   Fractional    │
┌──────────┐   │    └────────┘      │  Open Circuit   │
│   MPP    │───┤                    │     Voltage     │
│ Tracking │   │                    │     Method      │
└──────────┘   │                    └─────────────────┘
               │    ┌────────┐      ┌─────────────────┐
               │    │        │─────→│   Perturb and   │
               └───→│ Direct │      │    Observe      │
                    │        │      │     Method      │
                    └────────┘─┐    └─────────────────┘
                               │    ┌─────────────────┐
                               └───→│   Incremental   │
                                    │   Conduction    │
                                    │     Method      │
                                    └─────────────────┘
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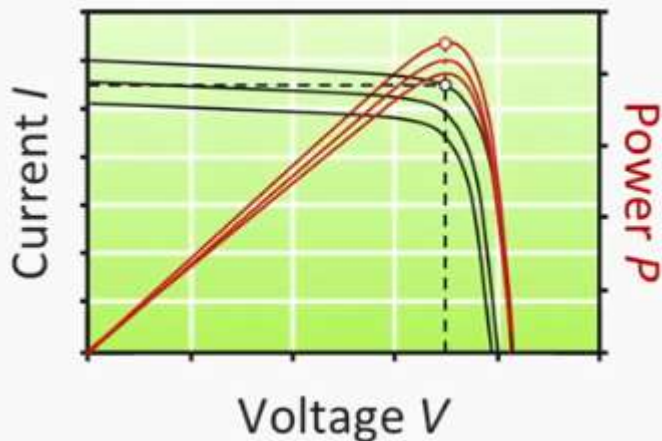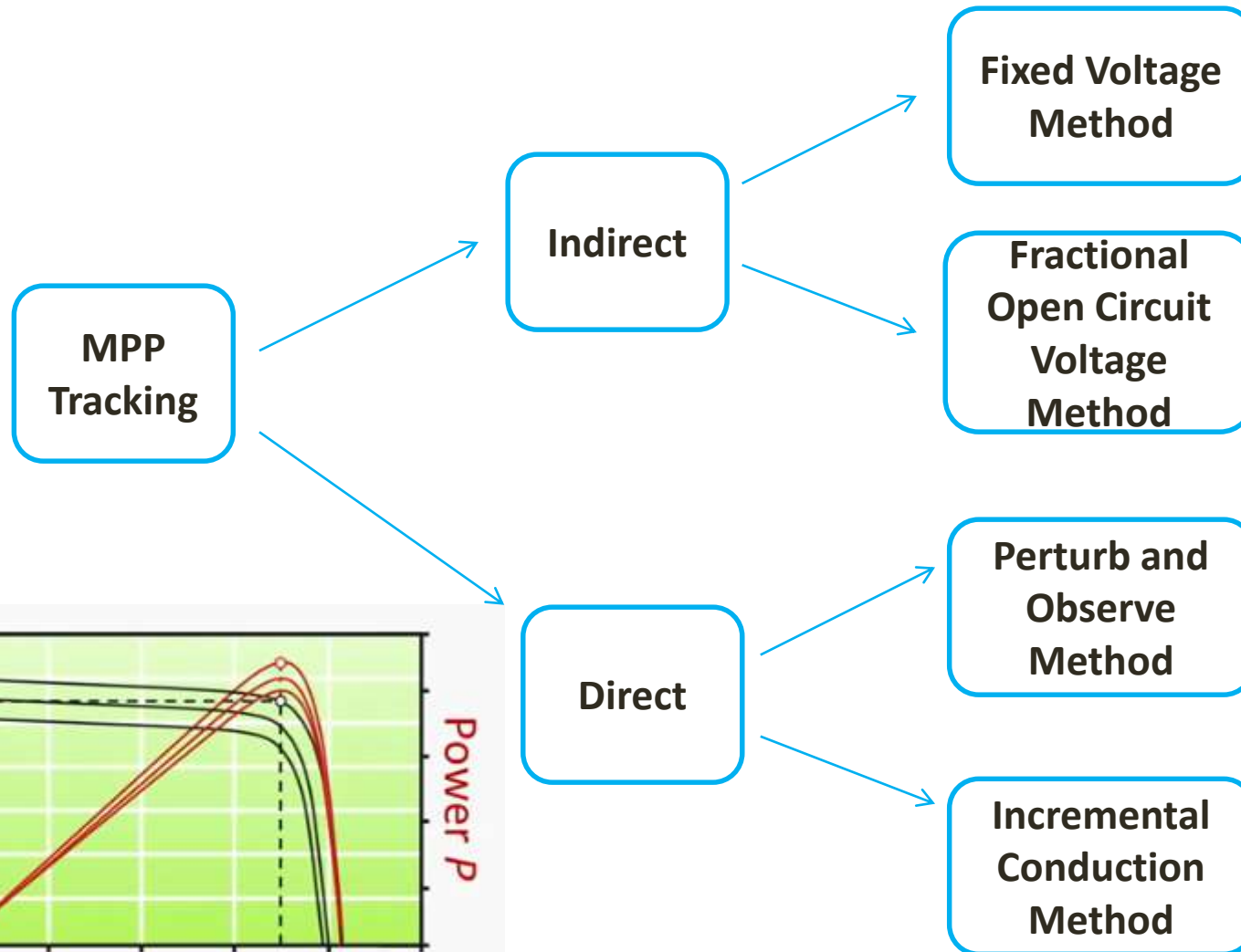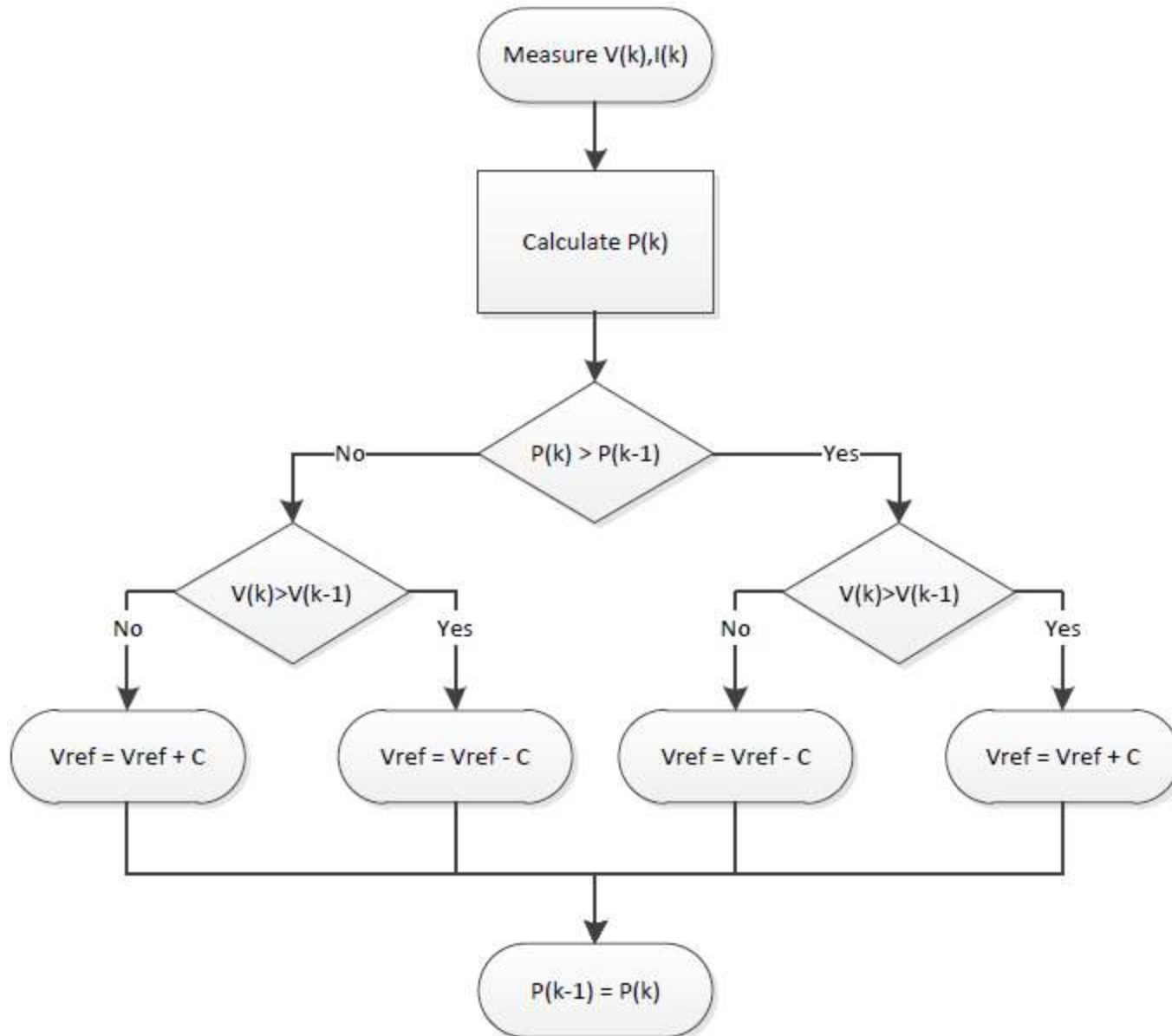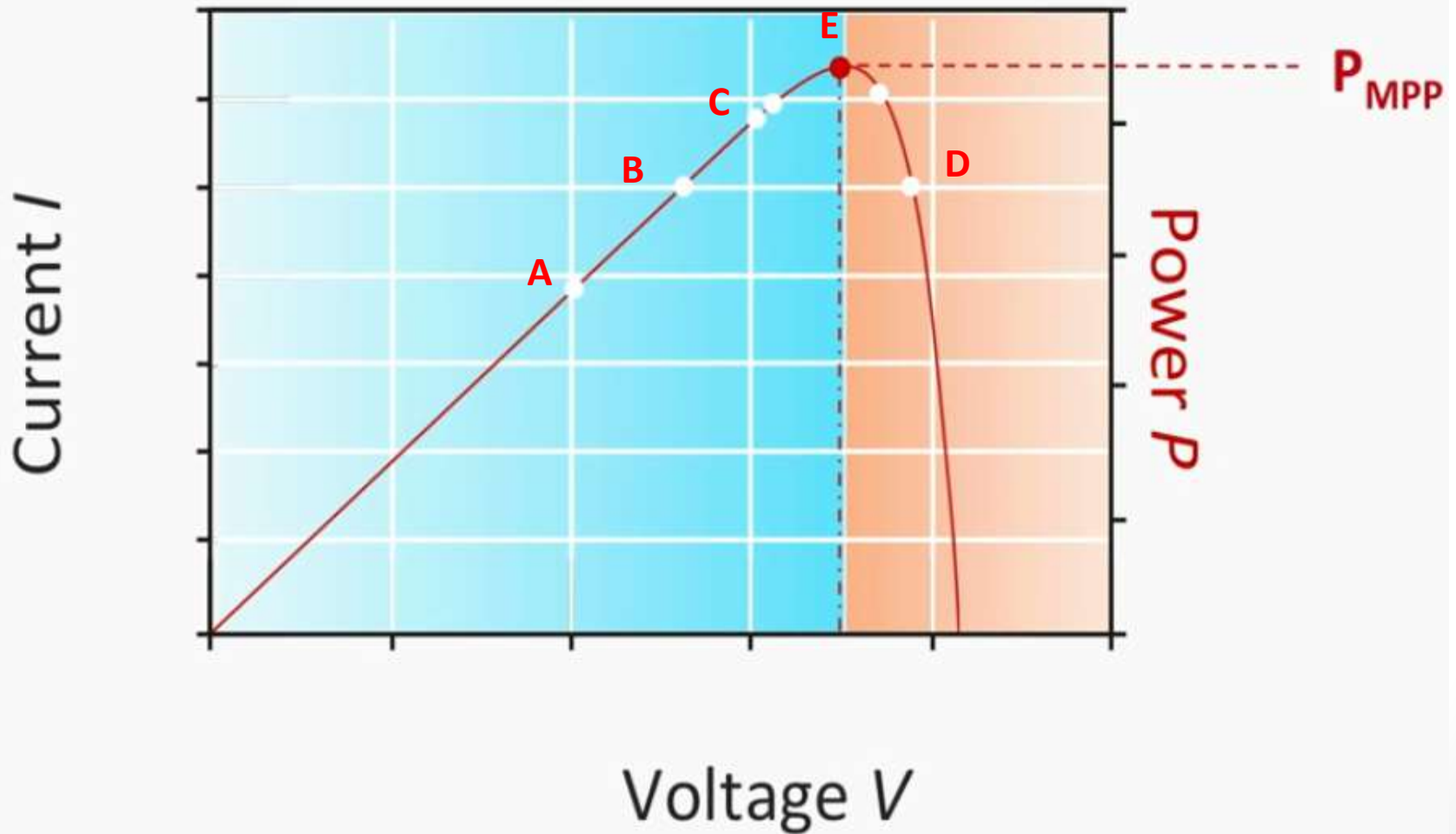
Perturb and observe(hill climbing)

❖ The concept behind the P&O method is to modify the operating voltage or current of the PV panel until you obtain maximum power from it.

❖ The tracker operated by periodically incrementing or decrementing the solar array voltage.

❖ In this we use only voltage sensor, to sense the PV array voltage.

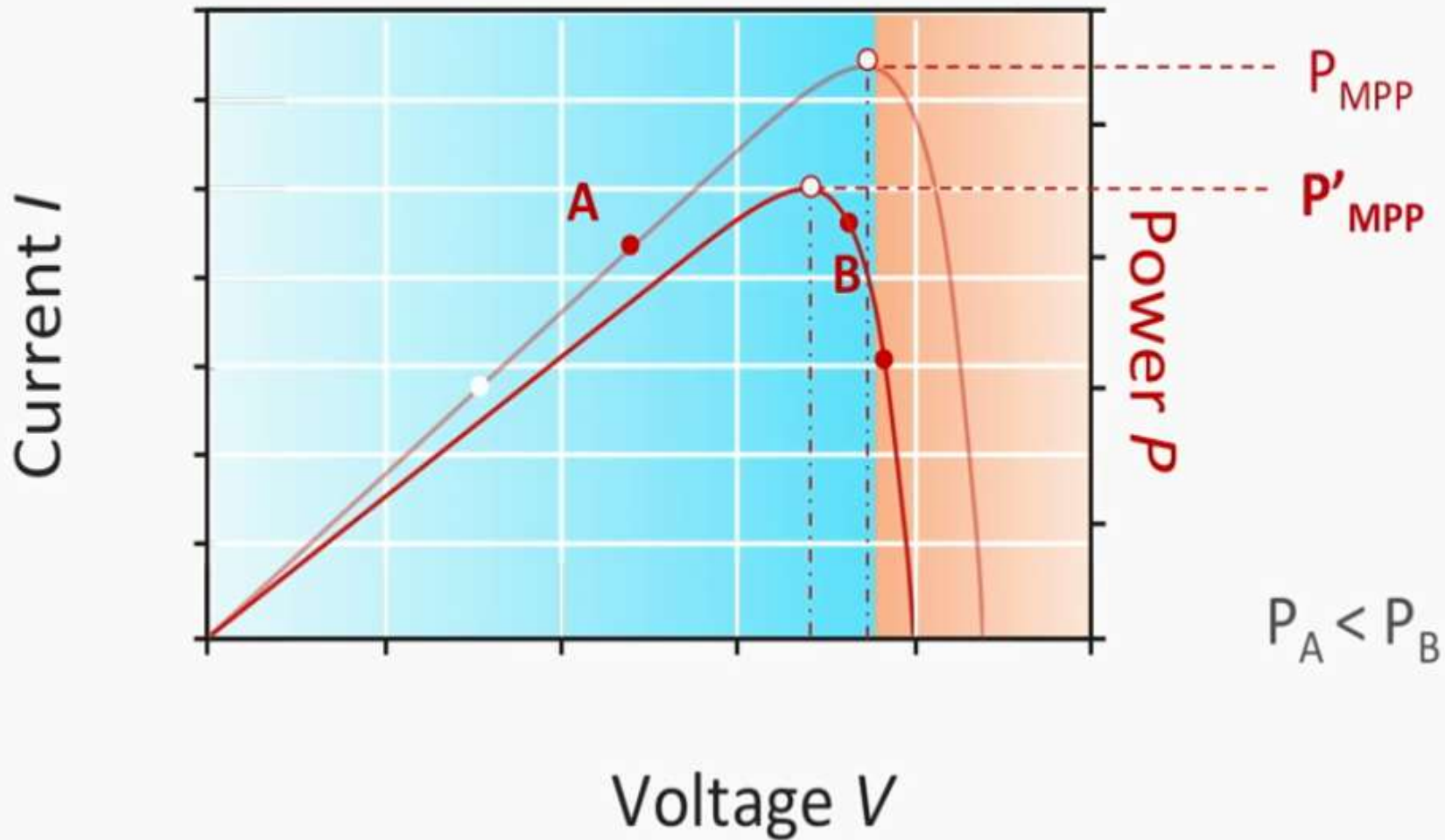❖ Hill climbing method fail under rapid environment change conditions.

Perturb and observe(hill climbing)

Measure V(k),I(k)

Calculate P(k)

P(k) > P(k-1)

No

Yes

V(k)>V(k-1)

No

Yes

V(k)>V(k-1)

No

Yes

Vref = Vref + C

Vref = Vref - C

Vref = Vref - C

Vref = Vref + C

P(k-1) = P(k)

Flow Chart

Perturb and observe(hill climbing)

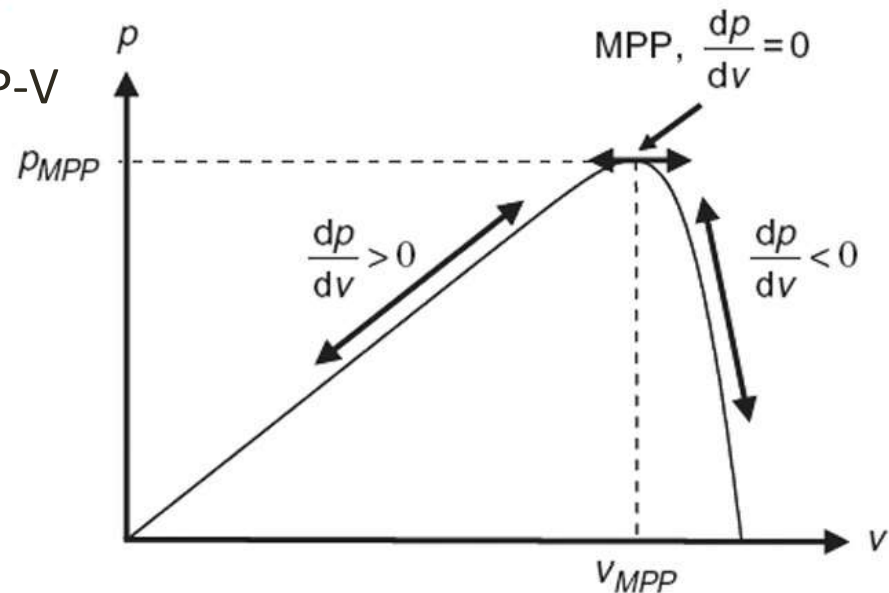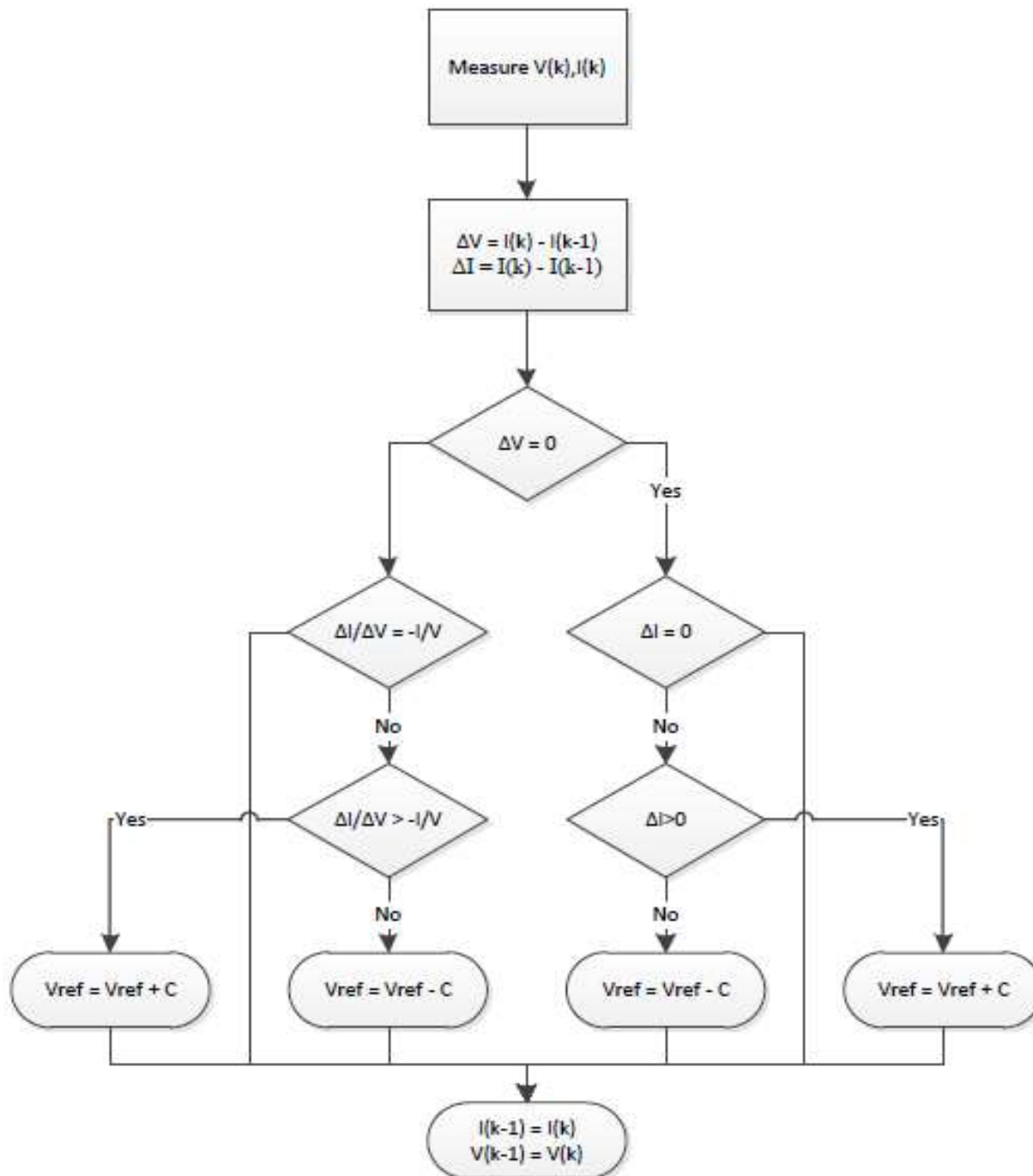# Perturb and observe(hill climbing)

Increment Conductance

❖ Incremental conductance uses two voltage and current sensors to sense the output voltage and current of the PV array

❖ Here we are sensing both current and voltage simultaneously. Hence the error due to change in irradiance is eliminated. However the complexity and cost of implementation increases.

❖ Based on fact that slope of P-V

$\dfrac{dp}{dv}$=0 at Mpp

$\dfrac{dp}{dv}$>0 at left Mpp

$\dfrac{dp}{dv}$<0 at right Mpp

Measure V(k), I(k)

$\Delta V = I(k) - I(k-1)$
$\Delta I = I(k) - I(k-1)$

$\Delta V = 0$

Yes

$\Delta I / \Delta V = -I/V$

$\Delta I = 0$

No

No

$\Delta I / \Delta V > -I/V$

$\Delta I > 0$

Yes

Yes

No

No

Vref = Vref + C

Vref = Vref - C

Vref = Vref - C
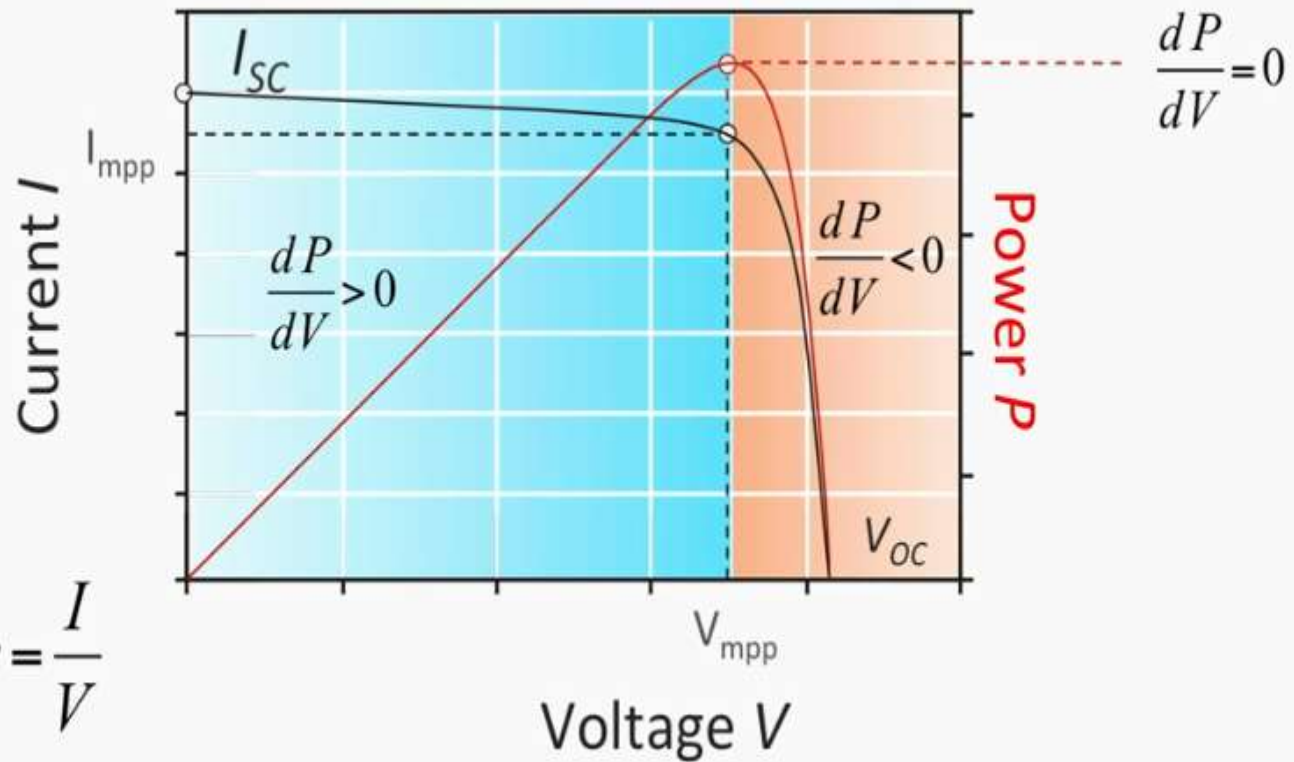
Vref = Vref + C

$I(k-1) = I(k)$
$V(k-1) = V(k)$

Flow Chart

Increment Conductance

$$Conductance = \frac{I}{V}$$

Increment Conductance

$$\frac{dP}{dV} = \frac{d(I \times V)}{d\ V}$$

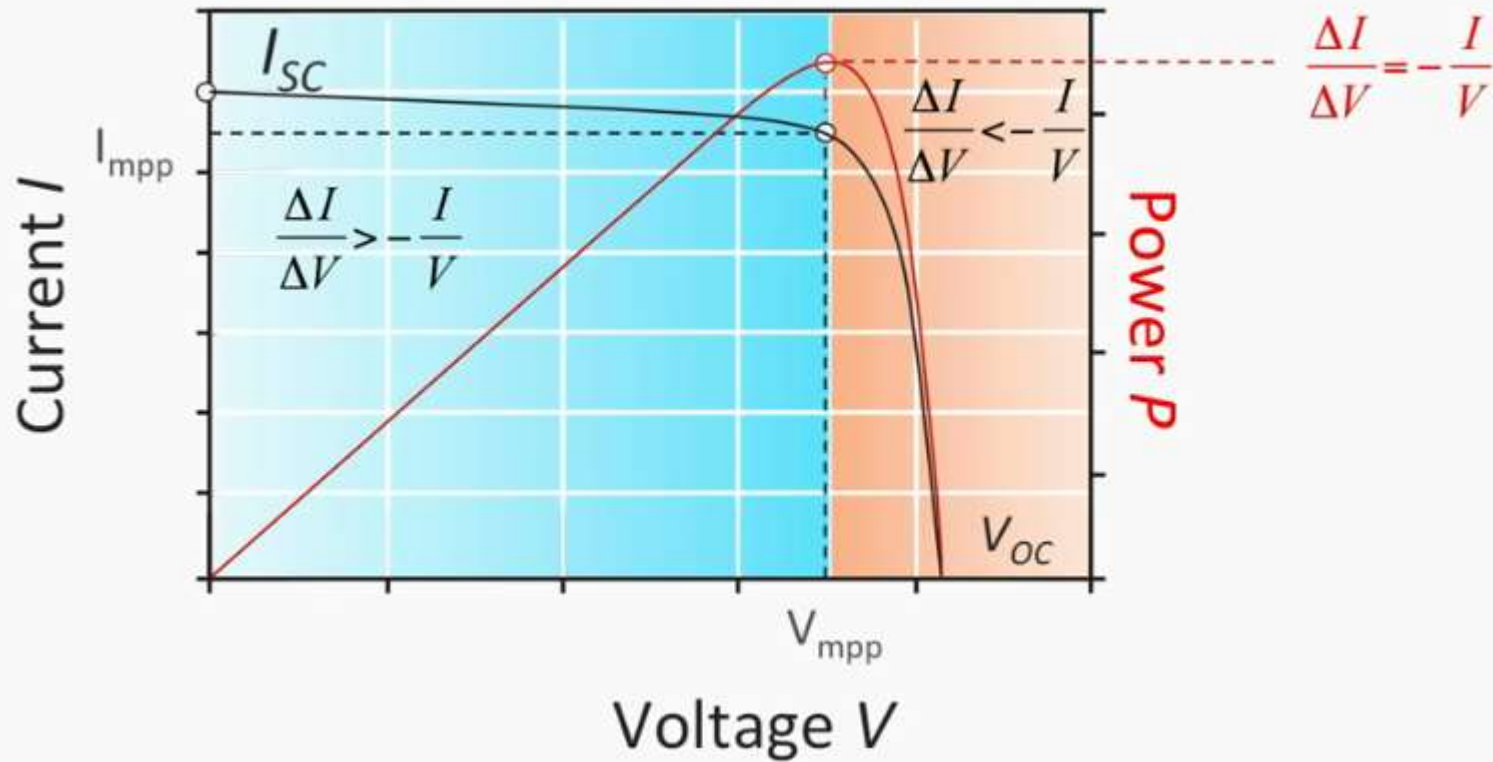$$\frac{\Delta I}{\Delta V} = -\frac{I}{V} \qquad \text{At MPP}$$

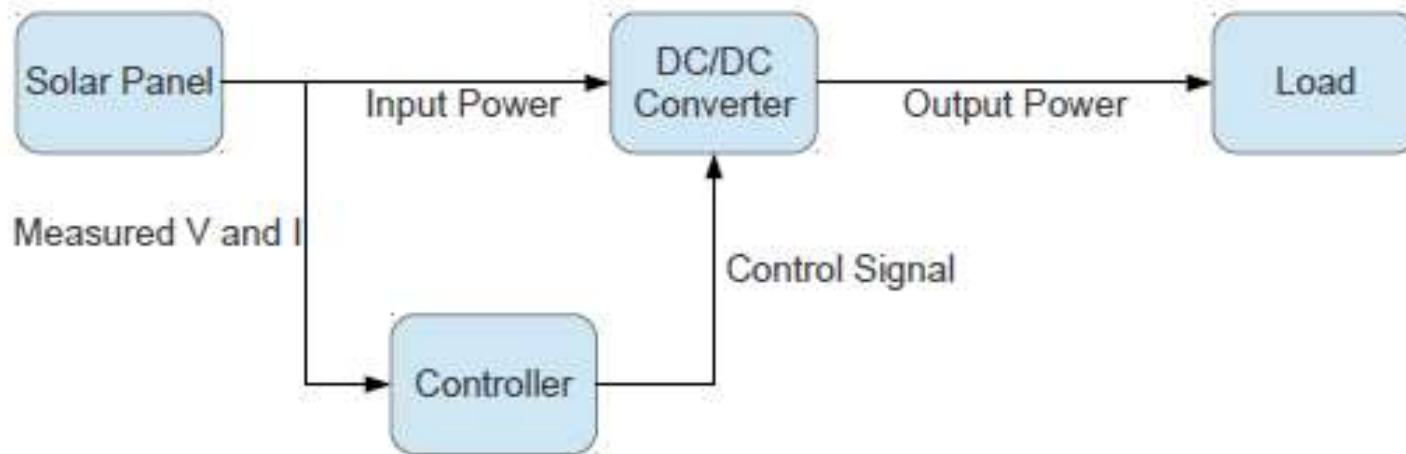$$\frac{dP}{dV} = I + \frac{V \times d\ I}{dV}$$

$$\frac{\Delta I}{\Delta V} > -\frac{I}{V} \qquad \text{To the left of MPP}$$

$$\frac{\Delta I}{\Delta V} < -\frac{I}{V} \qquad \text{To the right of MPP}$$
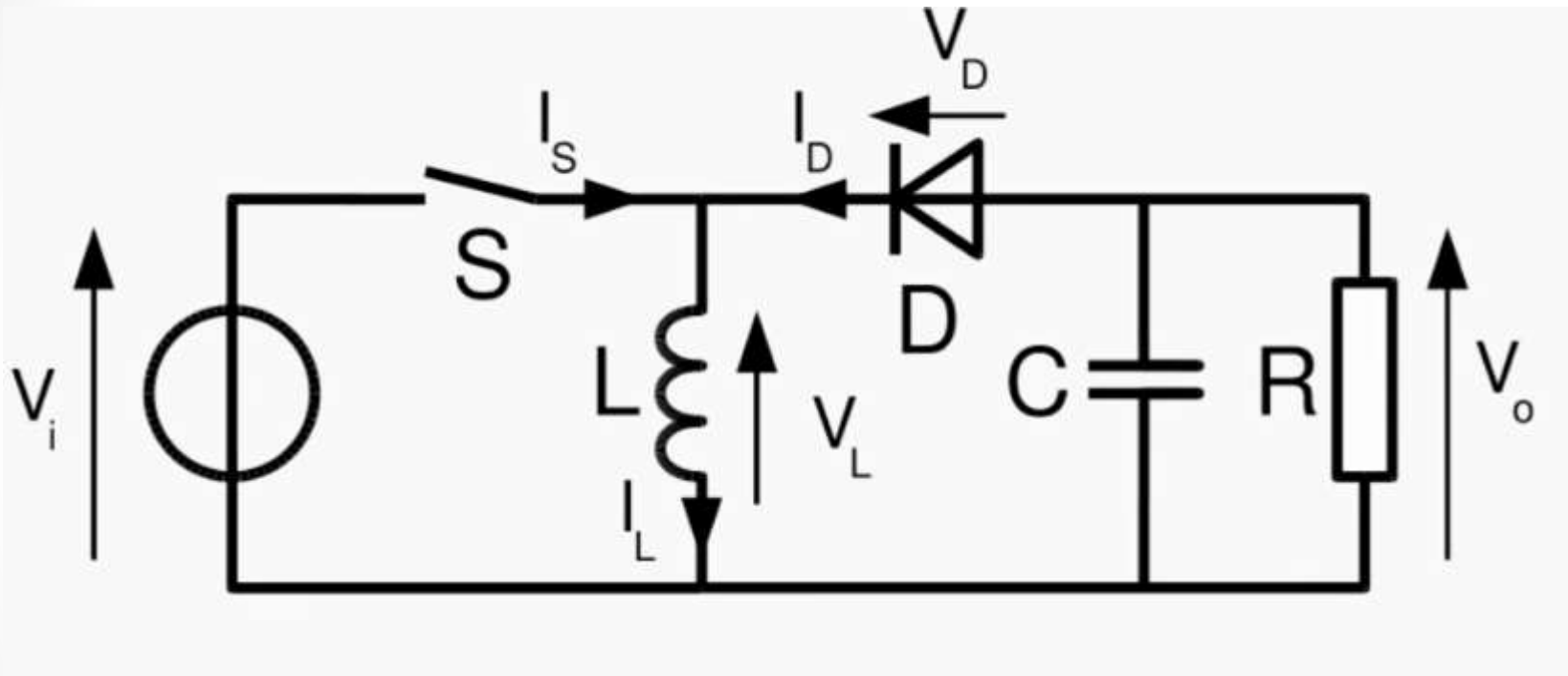
Increment Conductance

System Modeling

MPPT block scheme

Hardware Implementation

Buck Boost DC-DC Converter

Advantages

➢ MPPT method can extract maximum available power from the PV module.

➢ This can increase the tracking efficiency.

➢ If your energy use is greatest in the winter (typical in most homes) and you have cold winter weather, then you can gain a substantial boost in energy when you need it the most!

Conclusion

In this presentation a detailed analysis of various maximum power point tracking algorithms were carried out. Incremental Conductance algorithm which holds good performance than any other methods under normal and varying atmospheric conditions. Power output obtained from incremental conductance method is high us compared to other methods under varying atmospheric conditions. Maximum Power Point Tracking algorithm which place a major role for a grid connected Photo voltaic system. A most suitable MPPT technique is chosen based on the implementation cost, number of sensors required, complexity. So for residential and industrial purposes INCREMENTAL CONDUCTANCE ALGORITHM performs better results.
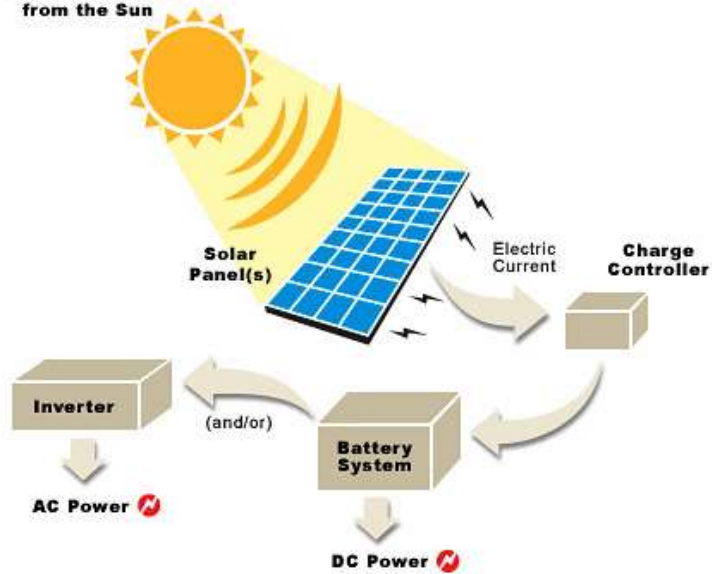
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➤ "PV Power System Using Maximum Power Point Tracking (Increment Conductance Algorithm)" Vol. 3, Issue 5, May 2014 @IJIRSET, Mohammed Ali Khalifa, Kamal Mohamed Saied,Sami Salem Bitro, Miftahul Anwar, Muhammad Nizam

➤ "New perturb and observe mppt algorithm and its validation using data from pv module" @IJAET, Bikram Das ,Anindita Jamatia, Abanishwar Chakraborti Prabir Rn.Kasari& Manik Bhowmik

➤ "Analysis of Different MPPT Techniques" Vol. 5, Issue 3, March 2016 @IJAREEIE, Athira B,. Greeshma V,. Jeena Johnson

➤ "A New Maximum Power Point Tracking for Photovoltaic Systems" Mohamed Azab, International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering Vol:2, No:8, 2008.

➤ "Enhancement of Solar Photovoltaic Cell by Using Short-Circuit Current Mppt Method" Burri Ankaiah, Jalakanuru Nageswararao @ www.ijesi.org Volume 2 Issue 2 ‖ February. 2013 ‖ PP.45-50

Thanks…

Any Query???