Unit 2:- Solar Energy

Syllabus…Unit 2

- Solar radiation, Flat plate collectors, solar concentration, thermal applications of solar energy, photovoltaic technology and applications, energy storage.

Books …

- Gilbert M. Masters, *Renewable and Efficient Electrical Power Systems*, Wiley - IEEE

Press, August 2004.

- Godfrey Boyle, *Renewable Energy*, Third edition, Oxford University Press, 2012.
- Chetan Singh Solanki, *Solar Photovoltaics-Fundamentals, Technologies and Applications*, PHI Third Edition, 2015.

Supplementary Reading:

- D.P.Kothari, K.C.Singal, Rakesh Rajan, *Renewable Energy Sources and Emerging Technologies*, PHI Second Edition, 2011.

Lecture 1

- Introduction
- Solar energy
- Solar radiation
- Global Horizontal & Direct Normal Radiation
- Solar Irradiance
- Why Solar Energy
- Advantages
- Difference Between Lumens, Lux and Watts
- Solar radiation
- Longitude & Latitude
- Altitude & temperature

Introduction

- India is nearly **17% of world population (with an growth rate of 1.2%)**
- Land area of 3.2 million Sq km, is 2.4% of the world, 0.01 sq million Kms is required to meet complete demand of country

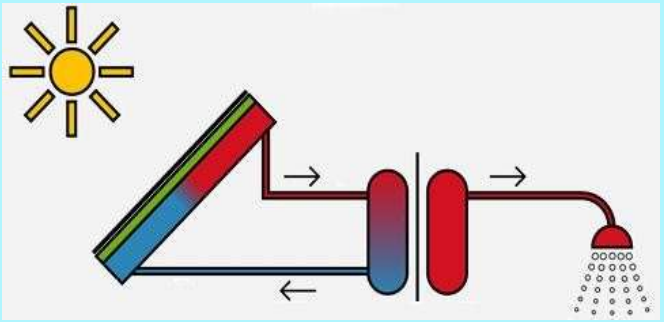
- We have ONLY 6.7% of coal, 0.3% of oil and 0.6% of gas reserves of world

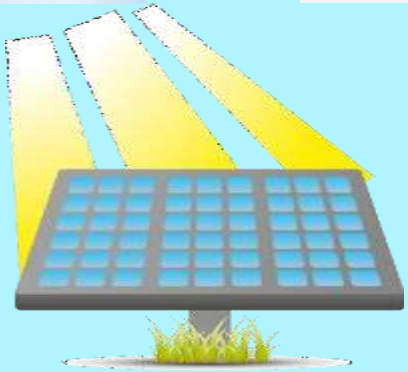
- **Capital cost per MW for coal based power plant is 7.75 cr. and for solar plant is 3.5 cr.**

Solar energy…

Solar Thermal Passive Energy

Solar Thermal Active Energy



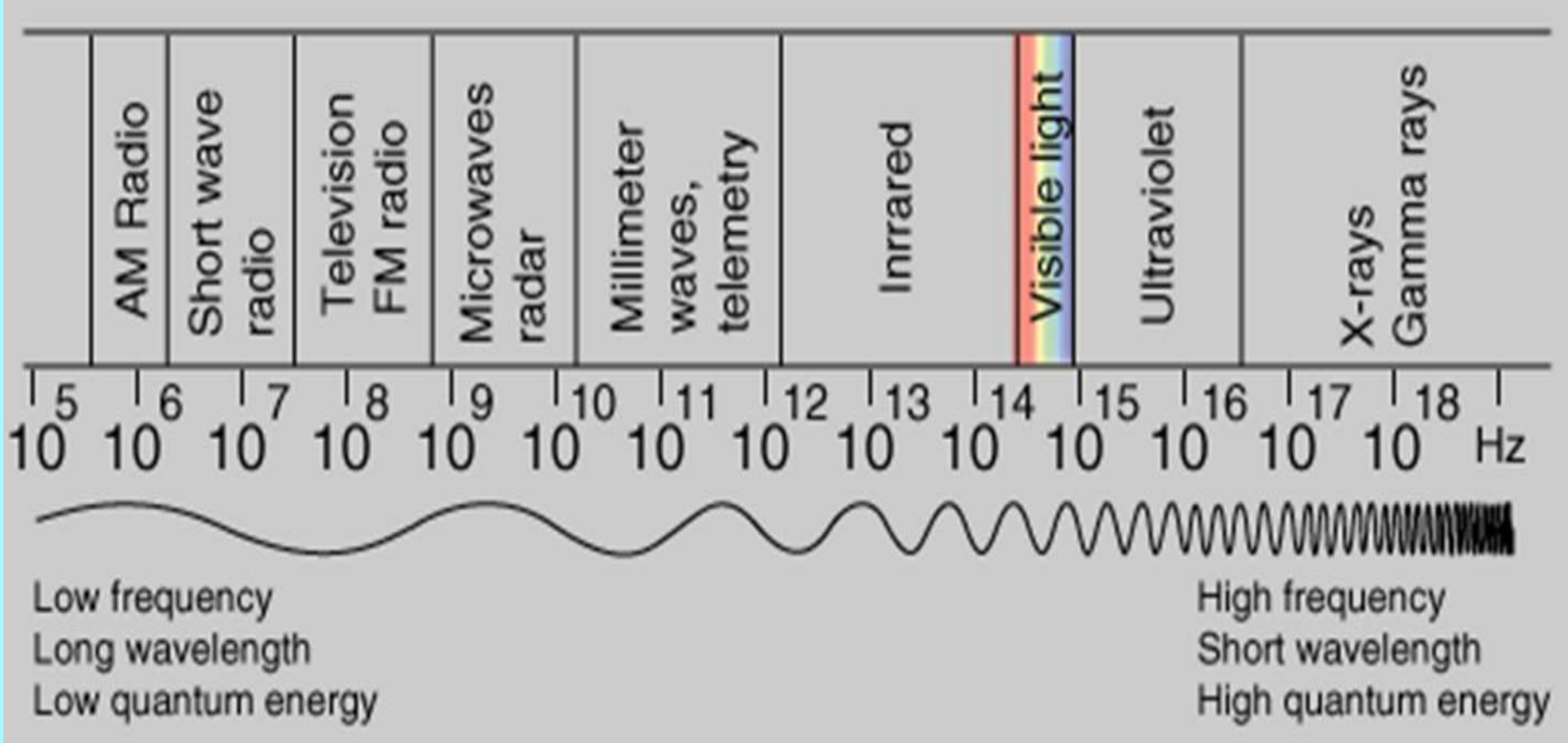


Solar Photovoltaic Energy

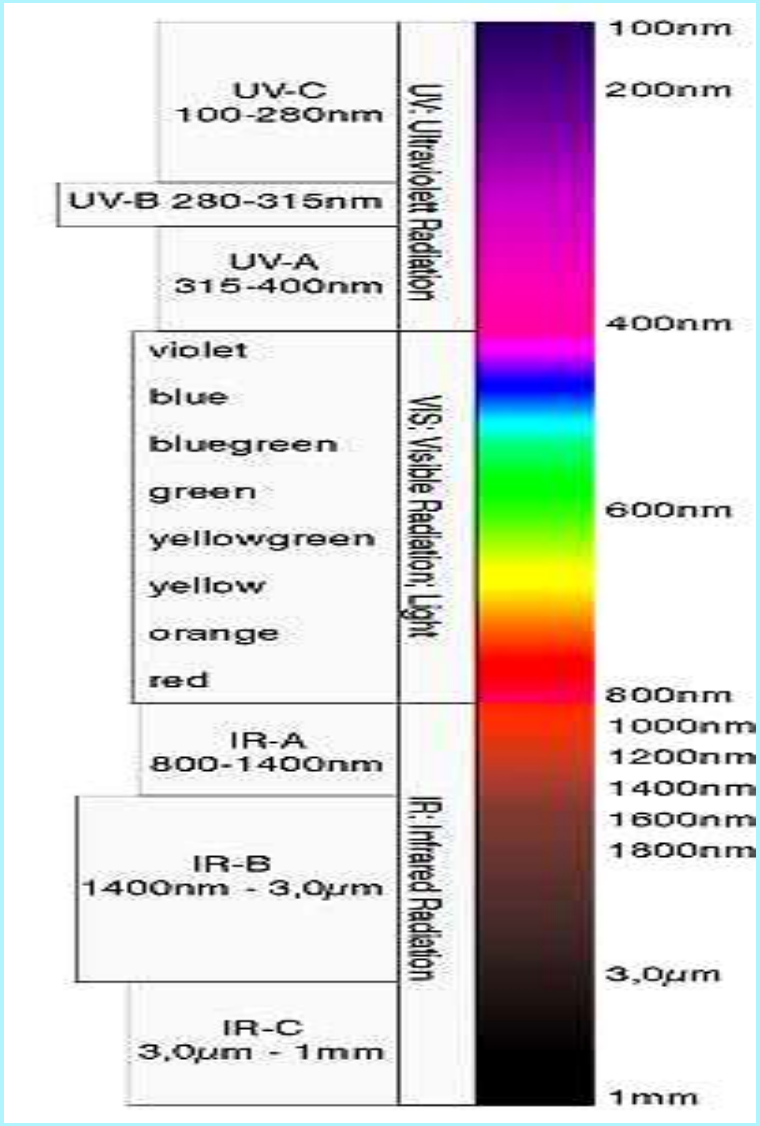
Solar energy…

- The sun generates its energy by **nuclear fusion** which is emitted as radiation
- Radiation emitted by sun is in the form o f Gamma rays, Visible rays, Infrared rays etc.
- Sun's total energy is composed of **7% UV radiation, 47% Visible radiation, 46% Infrared radiation**
- Photovoltaic cells primarily uses irradiation of wavelength **300-3000 nm,** the range for SPV (Solar Photo Voltaic)
- SPV plants utilizes **only light component of sunlight to generate electricity**

Solar Radiation..

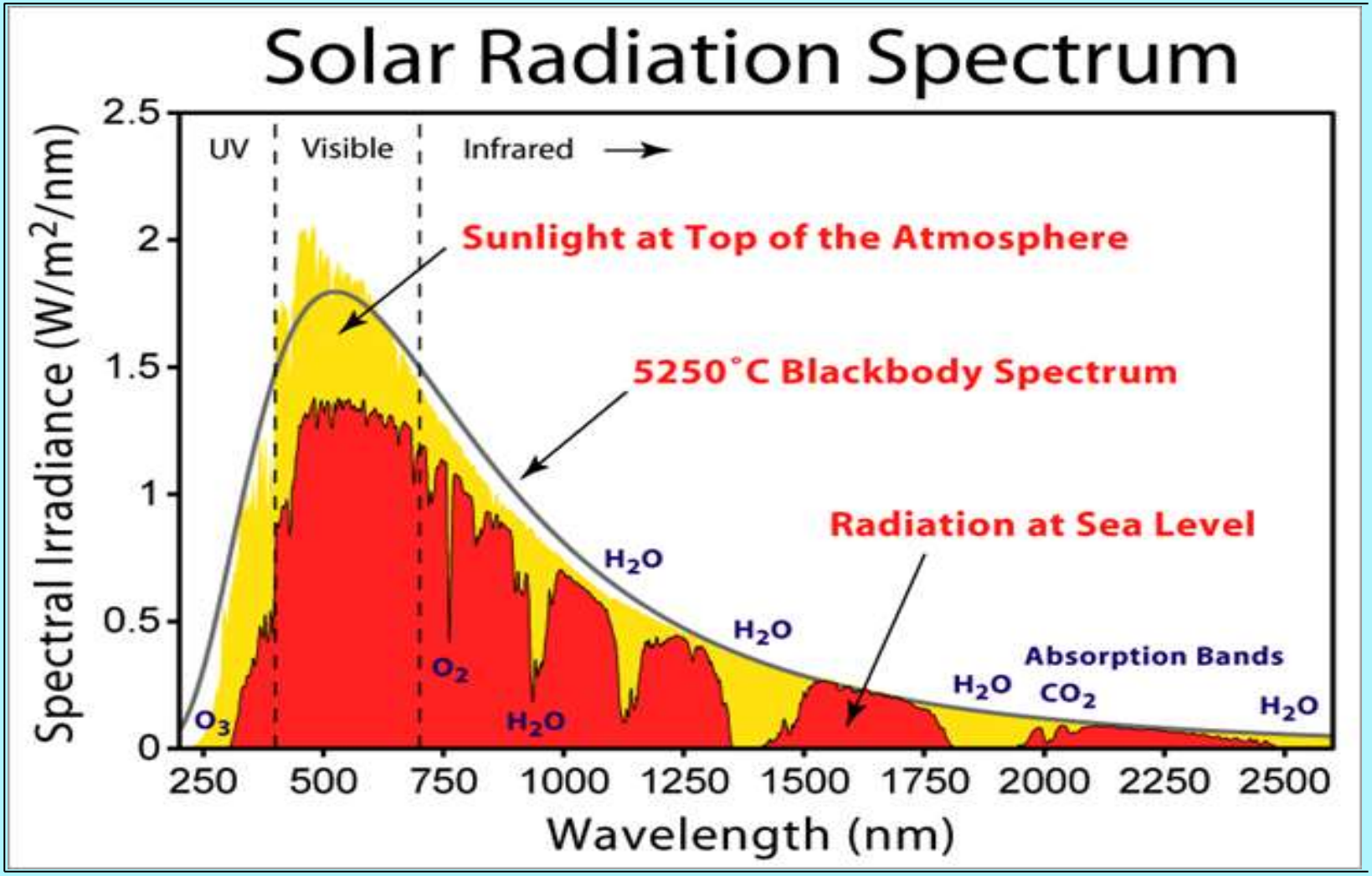


Solar Radiation..



Light is small portion of electromagnetic spectrum
380nm to 760nm visible range
Light is radiant energy

Solar Radiation..

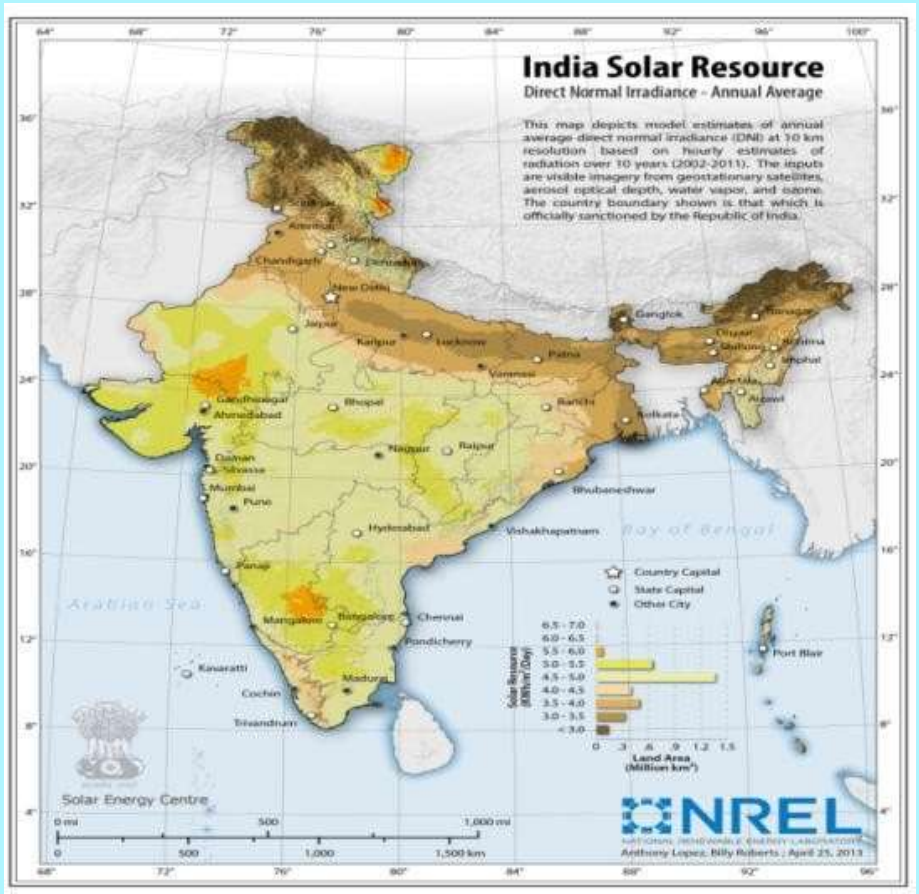


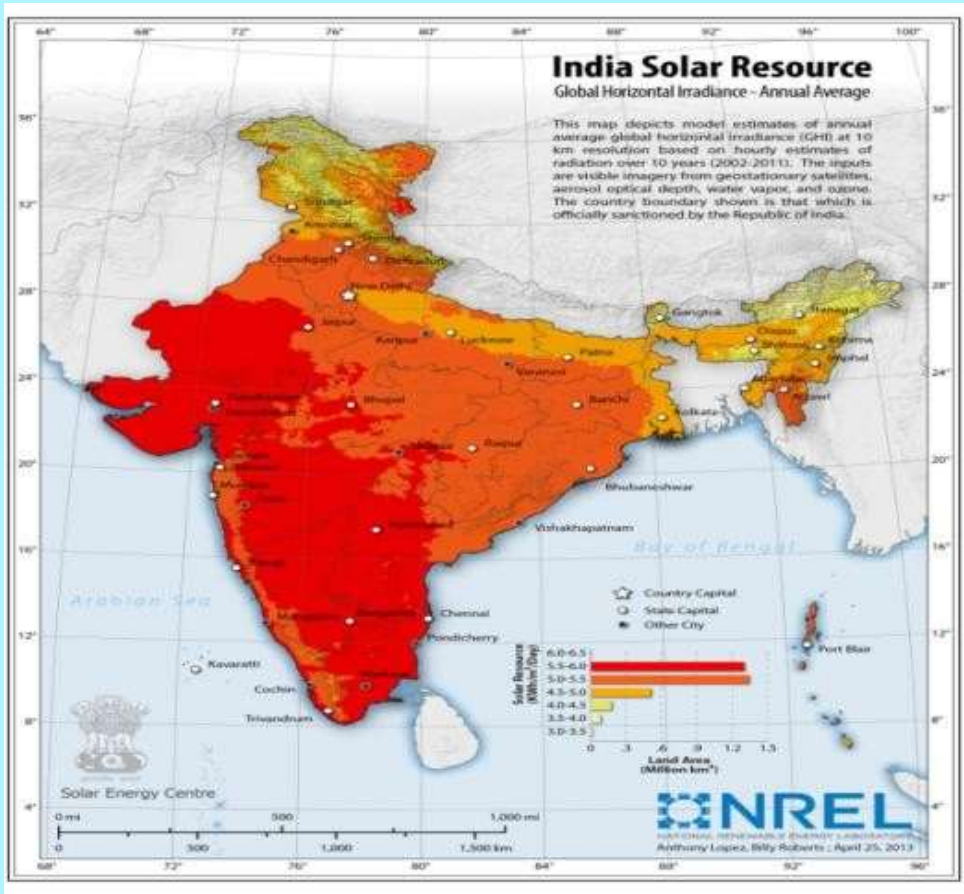
Solar irradiance Global Horizontal irradiance & Direct normal irradiance …

Global (total) **Horizontal** solar **irradiance** is all radiation that strikes a flat surface that faces the sun,

while **Direct normal** solar **irradiance** excludes all radiation that does not come from the direction of the sun **in the** sky.

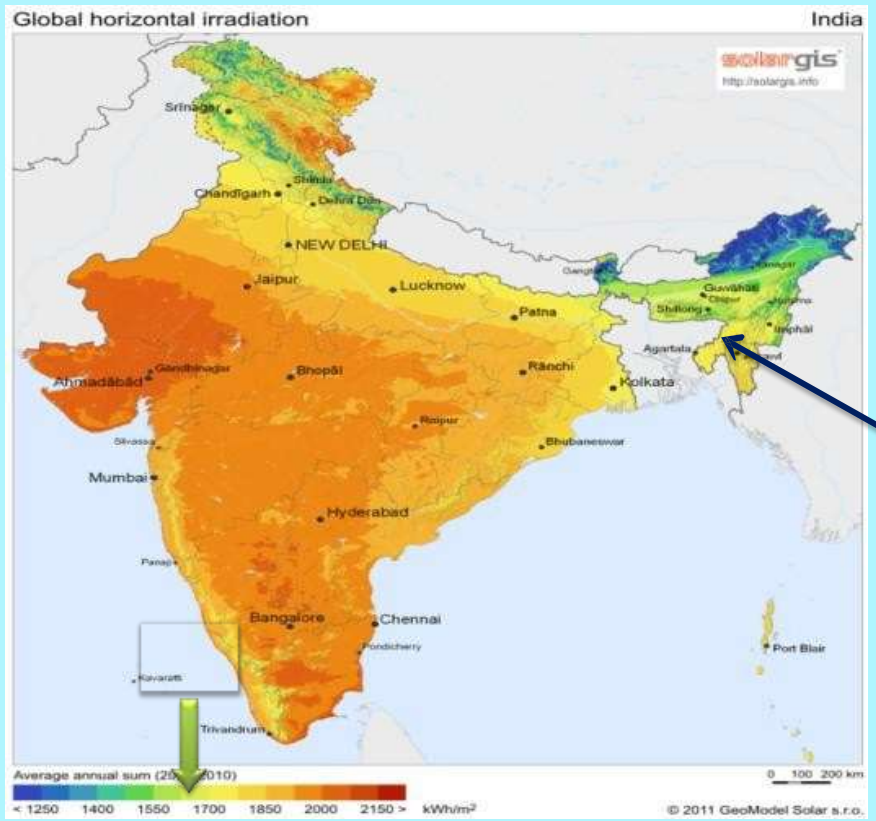
Solar irradiance

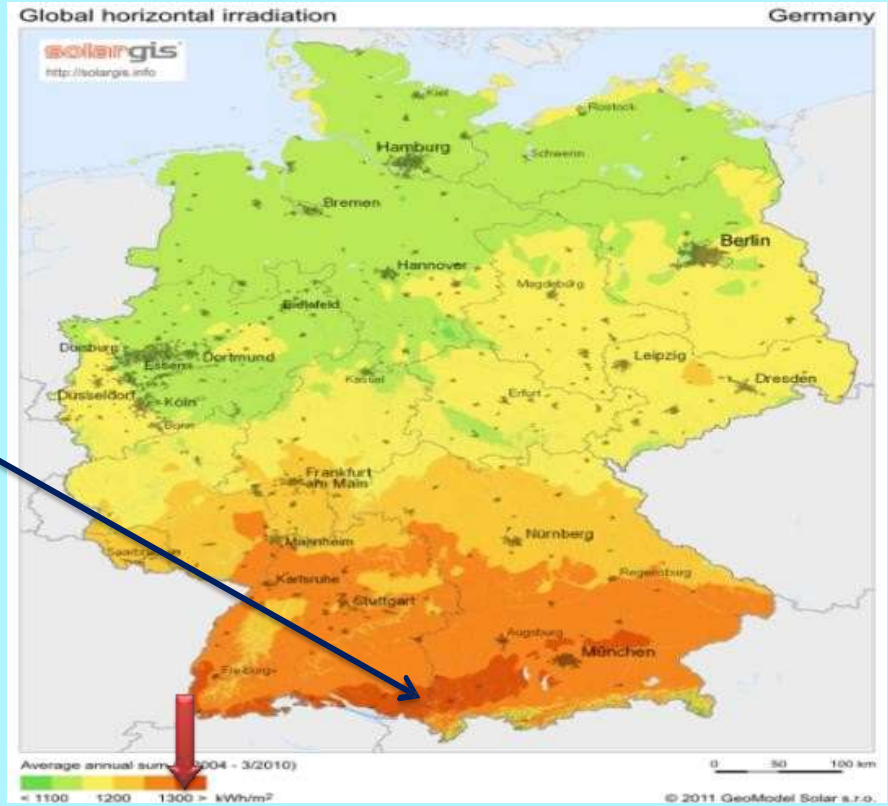




DN **GH**

Solar irradiance





The average solar irradiation in India is roughly double than in Germany

Why? Solar Energy as a Renewable…

1 MWp of Solar PV Installation

↕

CO_2 avoided/a = 1,159 t*

↕

No. of passenger vehicles with equivalent annual emissions = 241*

↕

Area of forest required to sequester equivalent carbon = 950 Acres*

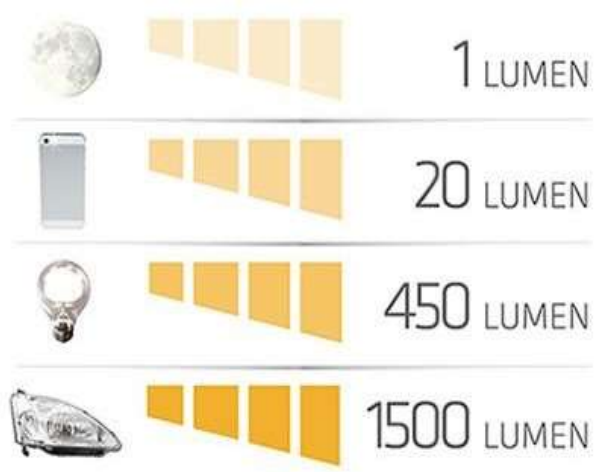
All data is calculated as per US environmental protection agency green house gas equivalence calculator

Why? Solar Energy as a Renewable…

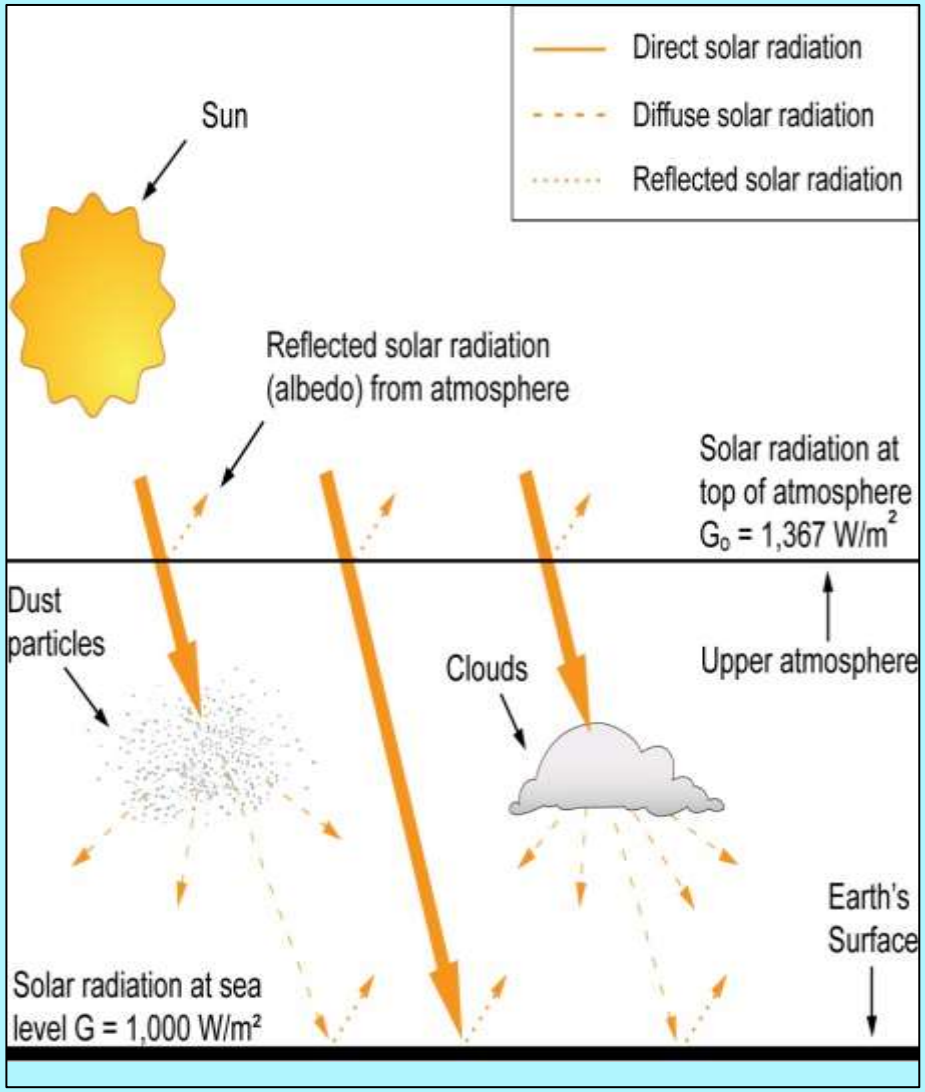
- SPV is very fast to install
- Consumer as well as utility friendly
- Good for off grid & On grid App
- Can be hybridized with any other IPP
- Fuel is free
- Sizable KWp to MWp
- Economically viable
- Virtually No recurring cost

Difference between Lumens Lux and Watts…

- Lumens (LM) are a measurement unit, which determines the total amount of light emitted.
- **Lux is a unit of light measurement where the area is also taken into account. 1 lux is equals to the 1 Lumen/m2,**
- **In other words - light intensity in a specific area**



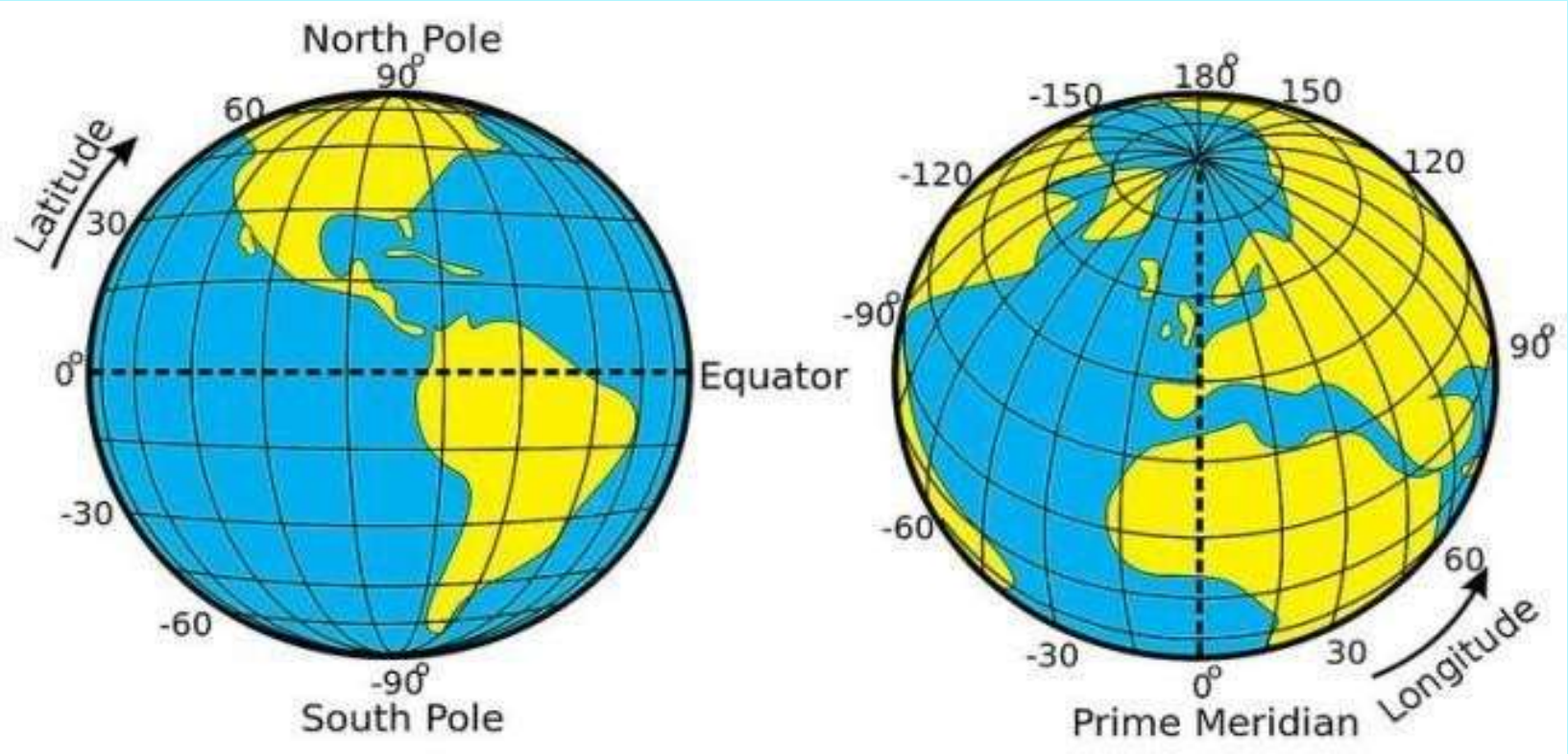
Solar Radiation…



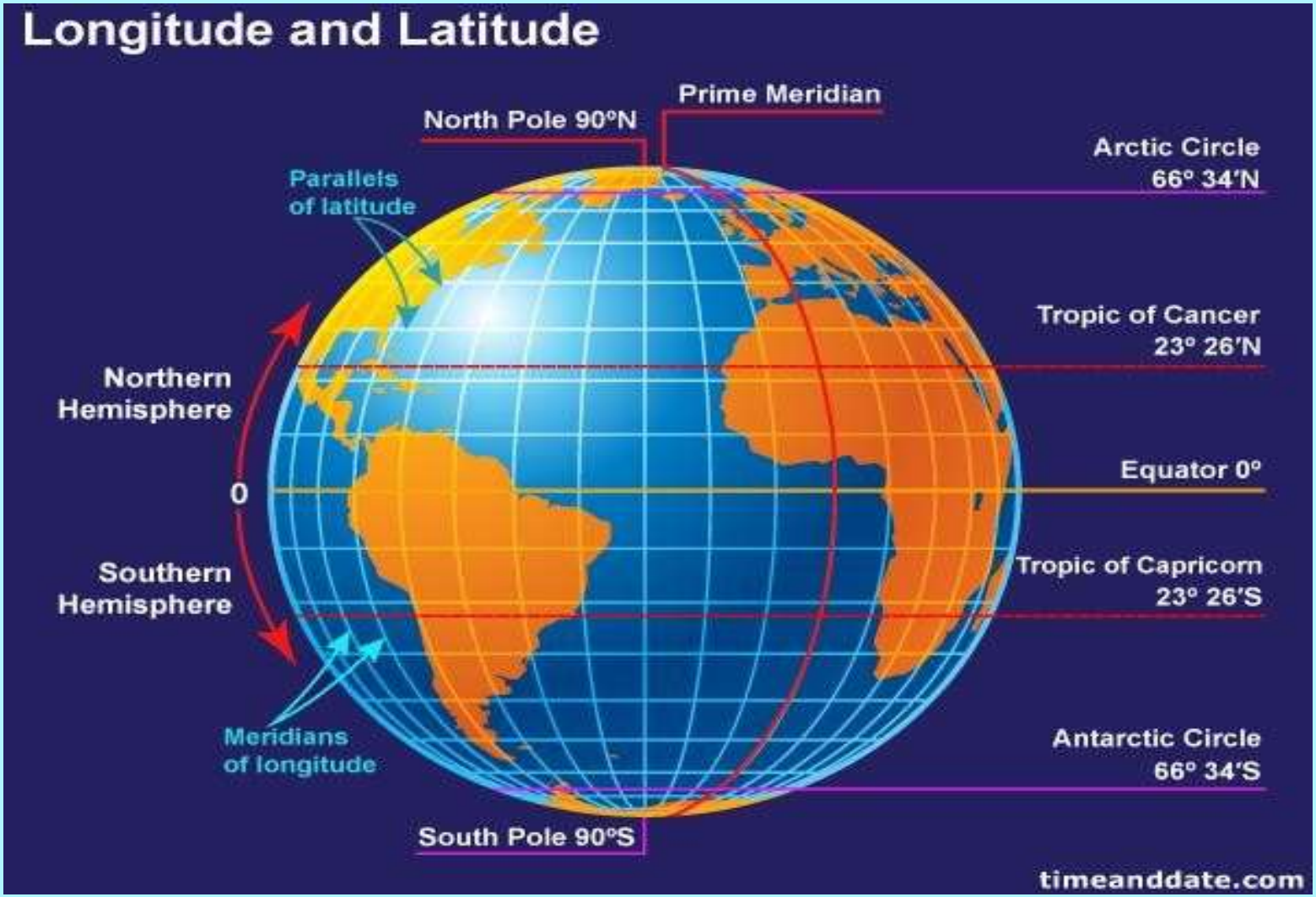
The radiation from sun is received by earth in
form of:

- **Direct beam:** The radiation beams which reach the earth's surface directly
- **Diffuse beam:** The radiation beams which hit the earth's surface after being scattered by clouds, dust etc.
- **Albedo:** Albedo is the measure of the diffuse reflection of solar radiation out of the total solar radiation
- **Global Irradiation = Direct + Diffuse + albedo**

Longitude & Latitude



Longitude & Latitude



Altitude & Temperature

- The term *altitude or elevation* is commonly used to mean **the height above sea level of a location, in *geography* the term *elevation*** is often preferred for this usage.

- The rate of decrease of temperature is **6.5 degrees C for each 1 km altitude change.**