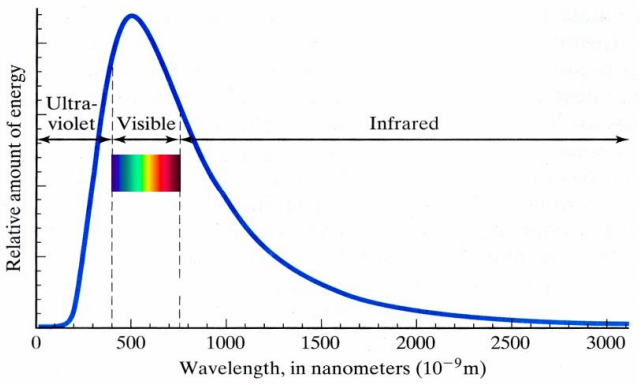
Chapter 2
Solar Intensities

Solar Spectrum

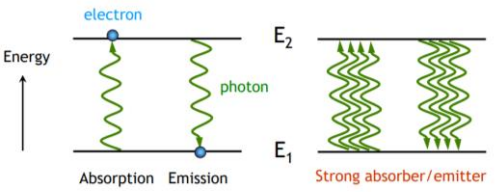
- Solar energy originates with the thermonuclear fusion reactions occurring in the sun.
- The sun has its strongest output in the green.
- Three primary colors red, yellow & blue



Dr. A.T.M. Saiful Islam
Assistant Professor
Dept. of ETE, BSMRSTU

Solar Spectrum

- A hot body (such as the Sun) emits electromagnetic radiation ($3x10^8$ m/s) with a characteristic spectral shape.
- The peak frequency of the spectrum is proportional to the absolute temperature T. And the peak wavelength is inversely proportional to T, since $\lambda = c/f$.
- The surface of the Sun radiates at 6000K & its thermal radiation peaks in the visible (green).
- The surface of the Earth radiates at 300K & its thermal radiation peaks in the far infrared.
- A strong absorber of light is also a strong emitter.
- A weak absorber either reflects or transmits light.

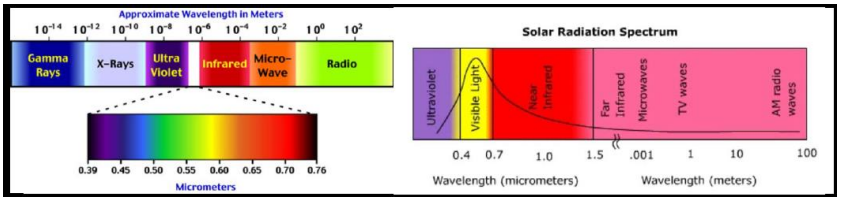


Light is absorbed or emitted by electrons jumping up or down between two energy levels E_1, E_2.

8 minutes and 20 seconds

**What are the advantages and disadvantages of the solar energy?*

Solar Spectrum

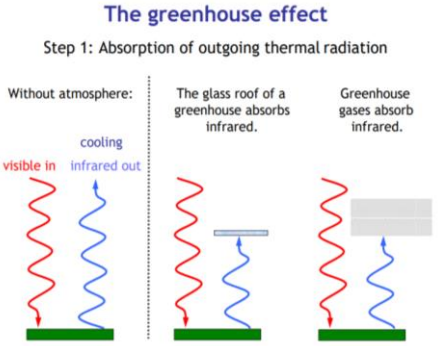


- Visible light has a wavelength of between 0.40 to 0.71micrometers (μm).
- The sun emits only a portion (44%)of its radiation in this range. Solar radiation spans a spectrum from approximately 0.1 to 4.0 micrometers.
- About 7% of the sun's emission is in 0.1 to 0.4 micrometers wavelength band (UV).
- About 48%of the sun's radiation falls in the region between 0.71 to 4.0micrometers (near infrared : 0.71 to 1.5 micrometers; far infrared: 1.5 to 4.0 micrometers).
- Solar radiation incident outside the earth's atmosphere is called extraterrestrial radiation. On average the extraterrestrial irradiance is 1367 W/m^2. This value varies by ±3% as the earth orbits the sun.

Dr. A.T.M. Saiful Islam
Assistant Professor
Dept. of ETE, BSMRSTU

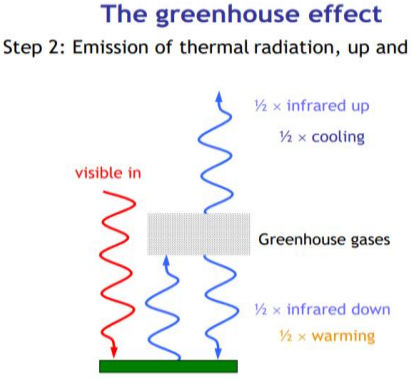
Greenhouse gases

- Greenhouse gases consist of molecules that absorb and emit radiation in the far infrared, similar to the thermal radiation of the Earth.
- These molecules contain two types of atoms with opposite charges. They oscillate like the electrons in an antenna (which absorbs and emits radio waves).
- The earth absorbs visible light from the hot sun and emits it into space as infrared (thermal radiation).
- Greenhouse gases absorb part of the thermal radiation and prevent it from getting lost in space.



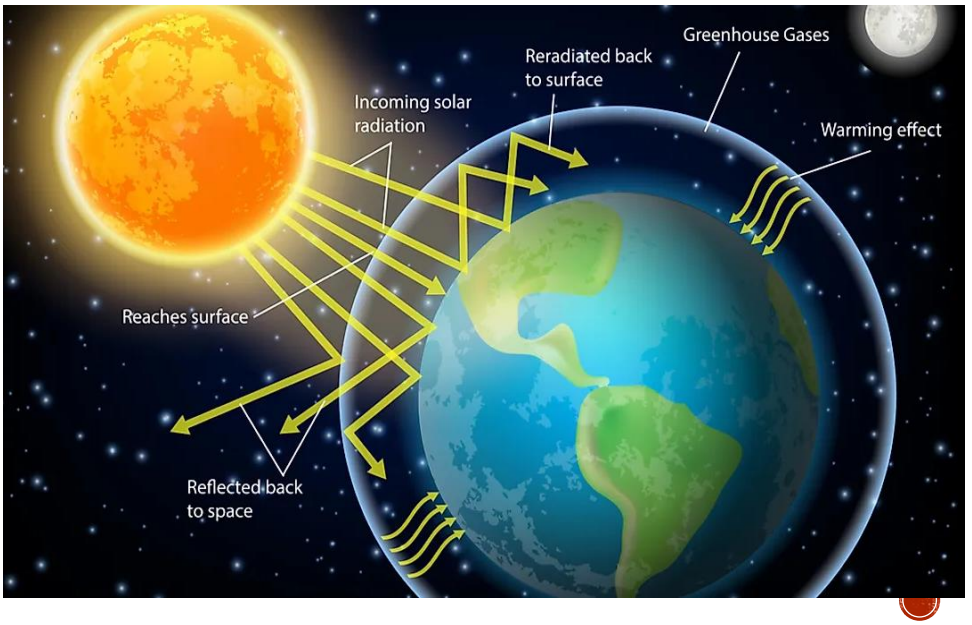
Greenhouse gases

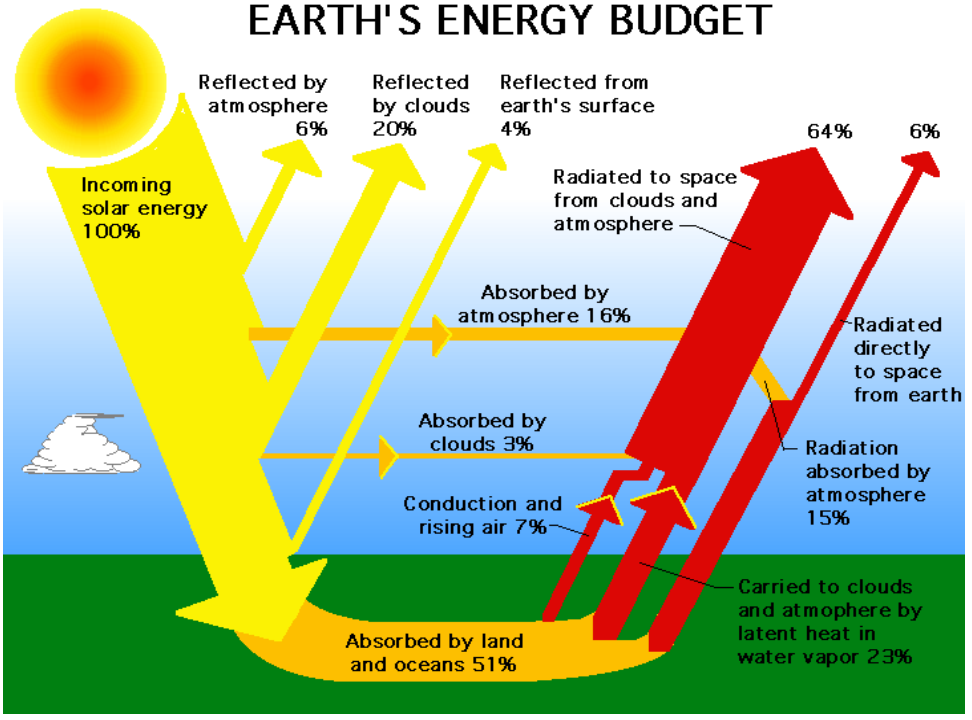
- Greenhouse gases also emit thermal radiation, since a strong absorber is also a strong emitter (Slide 3).
- Half of the heat radiation goes up into space to be lost, but the other half comes back to the ground. So we still get half of the warming out of it.
- Adding more greenhouse gases increases this warming.



Dr. A.T.M. Saiful Islam
Assistant Professor
Dept. of ETE, BSMRSTU

Solar energy

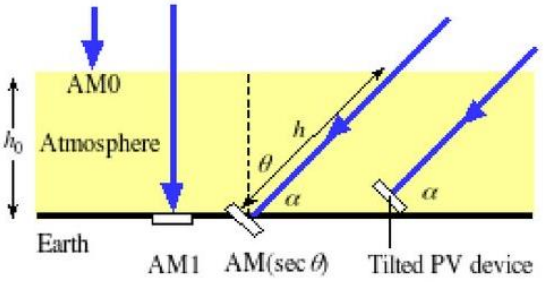




Dr. A.T.M. Saiful Islam
Assistant Professor
Dept. of ETE, BSMRSTU

Solar Intensities

- On sunny day, light intensity on earth's surface is about 70% of the intensity above atmosphere.
- Absorption and scattering effects increase with the sunbeam's path through the atmosphere.
- The shortest path through the atmosphere is when the sun is directly above the location and the received spectrum is called air mass one (AM1).
- Air mass m (AMm): the ratio of the actual radiation path h to the shortest path h_0, $m = {}^{h}/_{h_0}$, since $h = h_0 sec\theta$, AMm is AM$sec\theta$



Dr. A.T.M. Saiful Islam
Assistant Professor
Dept. of ETE, BSMRSTU