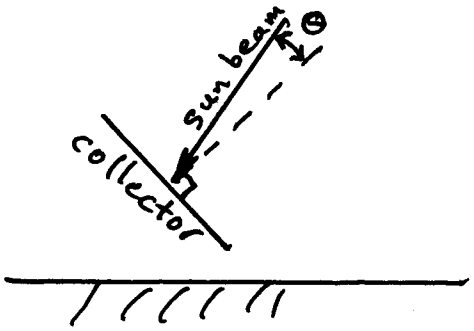
Addendum to Lecture 5

Solar energy received by a collector.

Solar collectors are usually tilted relative to the ground in order to improve the harvesting of solar energy.

The addendum to Lecture #4 gave the angle of the sun beam relative to the normal of the collector surface:



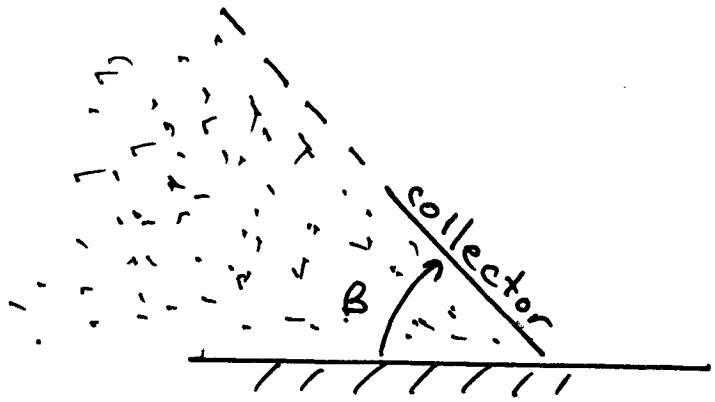
The component of the beam solar energy flux falling on the collector is

$$G_{bc} = G_b^* \cos\Theta$$

In order to ascertain the diffuse solar energy flux falling on the collector, we note the following:

The collector "sees" less of the sky as it is tilted from the horizontal position.

See the picture below:



The collector does not see the sky behind it -- this is denoted with the dots.

The fraction of the sky seen is:

$$\left[\cos\left(\frac{\beta}{2}\right)\right]^2$$

If we assume that there is no directional preference to the diffuse radiation, then the diffuse solar energy flux falling on the collector is

$$G_{dc} = G_{dh}\left[\cos\frac{\beta}{2}\right]^2$$

This is not the whole story.
The collector also "sees" radiation reflected from the surface in front of the collector.
This is:

$$G_{rc} = \rho G_{th} \left[\sin \frac{\beta}{2}\right]^2$$

where ρ = reflectivity of surface.
The typical value for ρ is 0.2.
However, for snow, ρ can be 0.8.

Thus, the total solar energy flux received by the collector is:

$$G_{tc} = G_b^* \cos\theta + G_{dh}\left[\cos\frac{\beta}{2}\right]^2 + \rho G_{th}\left[\sin\frac{\beta}{2}\right]^2$$

Tracking the sun:

There are several options for tracking the sun.

1) No Tracking.
   The collector is set at fixed tilt angle. Sometimes this can be selected so as to maximize the solar energy collected over a given period of time

2) The collector tilt is reset a few times a year -- say summer, autumn/spring, and winter. Generally, this is cost effective for flat-plate collectors.

3) The collector is rotated about one axis, e.g., a N-S axis. This is necessary for some concentrating (parabolic) collectors.

4) The collector fully tracks the sun beam by rotation about two axes. Generally, this is the most expensive type of tracking. It is used with dish collectors.