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Tracker Accuracy

There are two methods commonly used to control solar trackers: 1) optical sensing and 2) calculated sun position. Optical sensing mechanisms only work if the skies are clear, and don't perform well if the sensors become dirty. They commonly use simple electronic circuitry; hence they can't be controlled remotely. Controllers based on a solar ephemeral equation typically calculate the solar position to 0.01 degree. During early morning and late afternoon, some solar beam deviation will exist due to the atmospheric water vapor deflection, amounting to as much as 1-2 degrees.

Solar tracker positional feedback is typically done through the use of encoders, limit switches, or inclinometers. Motor mounted encoders are typically most cost effective, but also introduce inaccuracies caused by the mechanical gears. For those systems, the gear slop can easily reach +/- 1 degree. Another variable is the tracker platform itself, such as bearings or the ductility of the construction materials.

Just how important is tracker accuracy? In the case of using PV modules, the modules are not particularly sensitive with respect to the incoming solar beam, as much as exposing the maximum surface area. For instance, a solar tracker that is consistently off by 2.5 degrees is operating at 99.9% of its optimal output. Similarly, a tracker operating at 10 degrees deviation from the optimal solar beam will operate at 98.5% of the optimal output. Thus, it should be apparent that constructing a PV solar tracker with emphasis on accuracy may yield a poor value proposition. The table below shows this theoretical relationship:

Deviation of orthogonal solar beam	**Relative output w.r.t. orthogonal beam**
0.0 degree	100.00%
0.1 degree	100.0%
1.0 degree	99.98%
2.5 degree	99.90%
5.0 degree	99.62%
10.0 degree	98.48%
20.0 degrees	93.97%

Concentrated PV solar trackers require by nature very different tracking accuracies. First, the receivers typically have an acceptance angle of less than +/- 1.0 degree. Even within the acceptance angle, there's usually some degradation as the solar beam deviation approaches the limits of the acceptance angle. As a result, CPV solar trackers typically have very high electro-mechanical design standards. Similarly, encoder and/or inclinometer feedback is typically not sufficient to guarantee optimum positioning.

During the winter at noon time at middle latitudes the apparent motion of the Sun can be on the order of 2 to 3 degrees every ten minutes, while during the summer, the movement can be as great as 10 degrees. For PV based trackers, it is generally a good idea to minimize motor starts and stops in order to promote longevity of the electro-mechanical systems. Such algorithms will take into account both a movement time interval and minimum angular adjustment.

The energy gain of PVsystems based on trackers versus stationary is dependent on location and season. Estimates and actual measurements indicate, on an annual basis, single axis trackers gain ~20% additional power compared to a fixed angle system, while dual axis tracker systems can gain ~40%. Single axis trackers typically follow the sun by elevating the modules around a North-South axis. While dual axis trackers typically rotate panels around the horizontal axis and adjust for elevation in the vertical axis. If a field of trackers is being used, backtracking can eliminate the effect of panels shading each other.

Both linear actuators and fully enclosed slewing drives are frequently used to control either a dual or single axis solar trackers.