4109

Home Solar Designs

WASHINGTON STATE ENERGY OFFICE

Washington Energy Extension Service

Wise Use of Resources Through Education

Can You Use Solar?

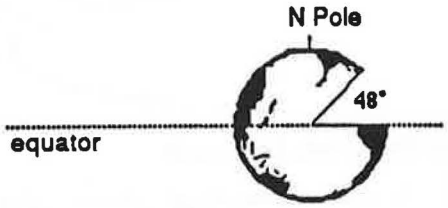
Solar systems can heat water, convert sunlight into electricity, or directly heat the home. They can, in many cases, be wise investments for residents of Washington. Unfortunately, there are examples of individuals who paid for the installation of solar systems on their homes only to find out that they did not perform as expected. Accurate assessment of the energy potential of a particular solar investment can help one avoid the disappointment of a poor investment. Two things limit the amount of energy available from a given solar technology:

- The technology's efficiency at converting sunlight into the desired form of energy, such as electricity or heat for the home; and
- The amount of solar energy available to the site.

This Factsheet will introduce those factors affecting the amount of solar energy available to a particular location, and explain the role of a solar site survey.

The amount of solar energy delivered to a particular site is a function of three things:

- **The site's latitude:**



Washington's latitude is about 48°N. It is measured as the angle between the plane of the equator and a line drawn from the center of the earth to the Washington portion of the earth's surface.

Figure 1: Latitude

Latitude affects both the intensity of solar energy and the amount of time it is available. The greater the latitude, the shorter the length of winter days and the "weaker" the intensity of sunlight.

- **The site's climate:**

Climate factors, such as intermittent clouds, dust, fog, and smog, have a tremendous impact on both the seasonal and day-to-day amount of solar radiation delivered to a site. Measurements of incident solar radiation -- insolation -- on horizontal surfaces at ground level are available for a number of U.S. locations. Calculations (based on this data) of the available average monthly insolation for surfaces of different angles from the horizon are available for a number of locations in Washington.

- **The site's geometry:**

A number of phenomena specific to a given site can impact the amount of available solar energy by direct obstruction. Mountains, trees, and existing buildings are the obvious obstacles, but potential buildings and trees must be taken into consideration, as well as limitations regarding acceptable orientations of a solar structure -- such as a passive solar home that must face the street.

This information can only be obtained by measurements at the site; hence the necessity of a solar site survey which measures the extent of local obstruction to solar energy. When information obtained from the solar site survey is integrated with latitude and climate data, you will be able to complete your assessment of the amount of solar energy that will arrive at a given location during the useful life of a potential solar energy investment.

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GRAPHING THE SUN PATHS

In order to understand how a solar site survey is performed, it is necessary to understand the seasonal variations of the sun's position in the sky. The sun path across the sky is a function of two things: the earth's daily spin and its annual orbit around the sun. On December 21 the sun path is at its lowest altitude and of shortest duration.

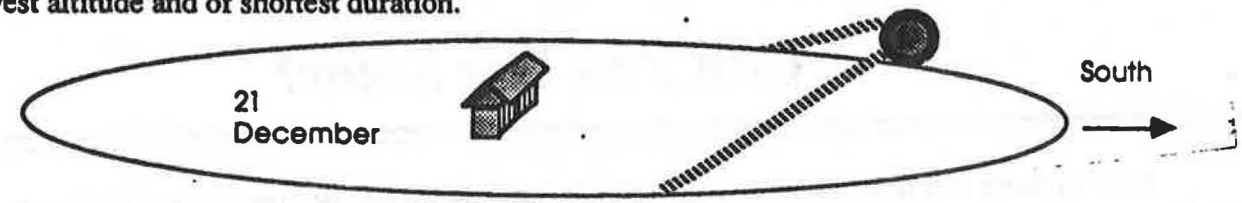

Figure 2. Lowest and shortest winter sun path

As summer approaches the sun path gets higher and of longer duration until it peaks on June 21, when the sun path attains its highest altitude at noon of that day, the longest day of the year.

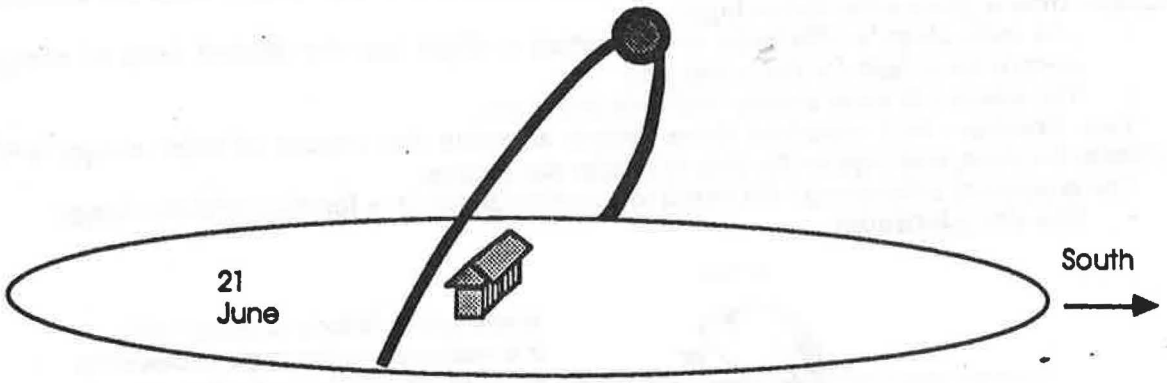

Figure 3. Highest and Longest Summer Sun Path

After June the sun path gets increasingly lower and the days increasingly shorter until the cycle is completed on December 21 and begins all over again.

If we face south we can visualize the paths that the sun would follow on the 21st day of four months of the year and begin to generate a graphic representation of the sun's various positions in the sky.

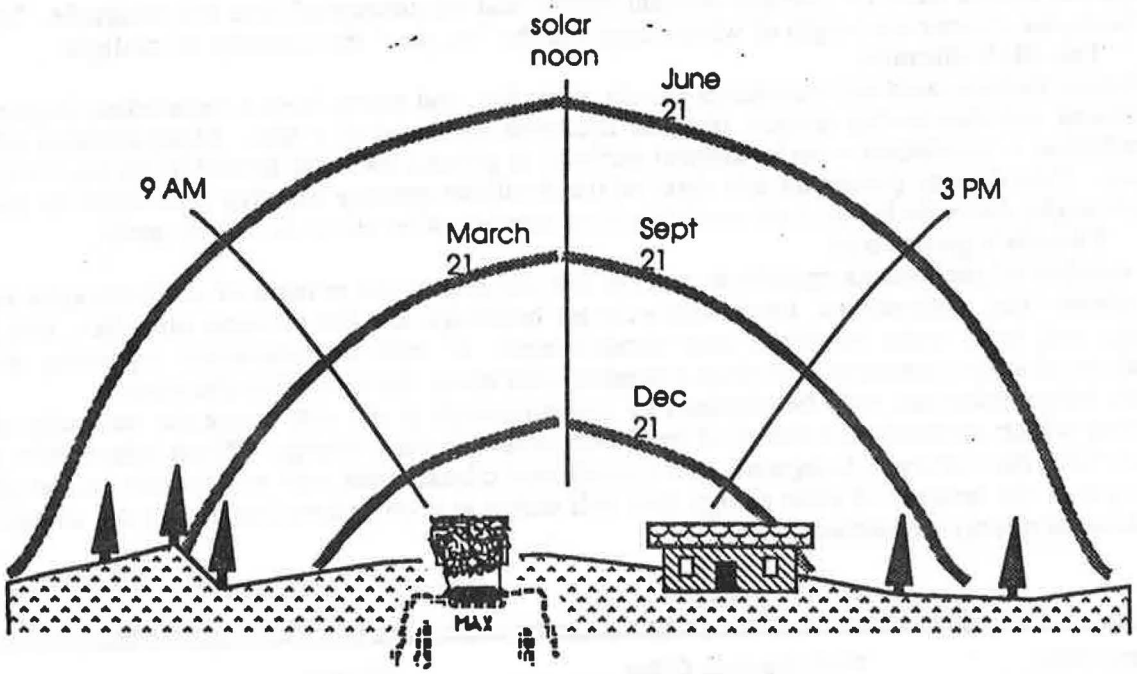

Figure 4. Four Specific Sun Paths

Note that due to the symmetry of earth's orbit the sun path for September 21 is the same as that for March 21. This holds true for other months as well. The sun is always highest at solar noon when it is due south. Though solar noon is not usually "clock" noon it always marks the time that is midway between sunrise and sunset. Notice, too, that we can represent the sun's position for 9 a.m. and 3 p.m. -- or any other time of day.

By measuring the position of the sun at each hour for the 21st day of the 12 months we can complete graph sun paths for any latitude. Sun path charts, such as the one in Appendix 1, are exactly such graphs. They were developed simply by measuring the sun's position at the appropriate time.

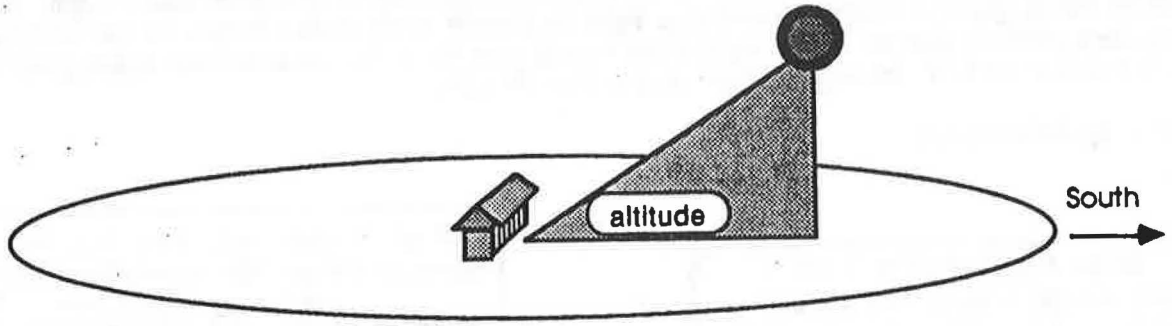

Figure 5. Altitude Angle

Only two measurements are necessary to characterize the sun's sky position at any given moment. We need to know the altitude angle, which is a measure of the sun's height above the horizon. We also need to know the azimuth angle, a measure of how far east or west of true south the measured position lies.

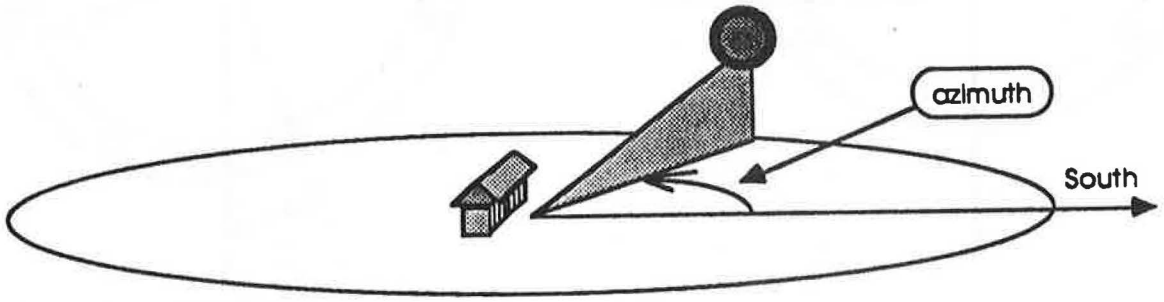

Figure 6. Azimuth Angle

The sun path chart in Appendix 1 is a complete sun chart for 48°N. latitude, which is generally appropriate for Washington. Note that this sun path chart labels the angles to the east and west of true south along the bottom, and the altitude angles are listed along the vertical axis on the right side. Note that we could use these scales to plot on the sun chart the position of any object for which we knew both the altitude and azimuth angles. In fact, this is exactly what is done in a solar site survey.

In order to complete a solar site survey, the position of each potential obstruction to a particular solar site must be measured and then plotted on the sun chart. Once all obstructions have been plotted, it is possible to estimate:

- The percentage of time the solar site will be shaded,
- When over the course of the year the shading will occur, and,
- When during the day it will occur.

All of this information is essential to our assessment of the amount of solar energy available to the potential solar site.

Performing a solar site survey does not require expensive equipment, and is relatively easy to do. If you would like to do a solar site survey, you may obtain detailed instructions from Performing The Solar Site Survey, a WEES Technical Publication currently available.

Meanwhile, if you would like to perform a rough preliminary estimation of the solar potential for a particular site, you can do so by using the following "quick and dirty" techniques. This method can also enable you to compare a few potential sites and select the best one or two alternatives before performing a complete solar site survey.

Three fists (knuckles vertical, arms extended) above the horizon (level) is about the sun's height at noon December 21. After finding south you can walk around and "eyeball" potential obstructions. Stay away from obstruction within 45° of south by a distance equal to about 3 times their height. If you can't measure the height of a nearby obstruction, sight its altitude angle with a protractor and weighted string. If the obstruction is due south, its angle must be less than about 20° to avoid any shading on December 21. If it is S.E. or S.W., its angle should be less than 7°-10°.

Written by Mike Nuess

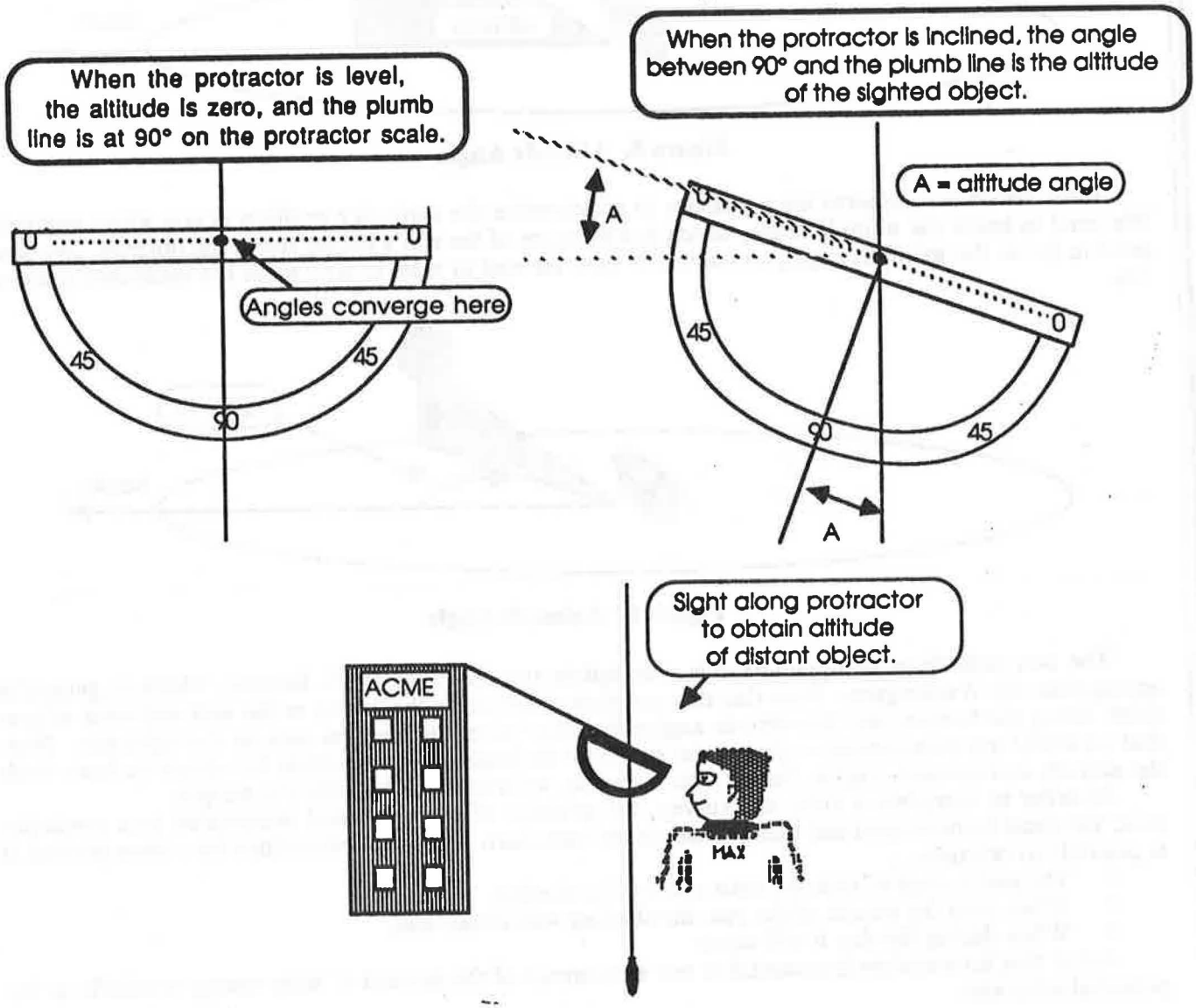

Figure 7. Using and Inclinometer

REFERENCES

WEES Factsheets.

Assessing Solar Potential (FS-1602).

Washington Energy Extension Service, a Seattle University and Washington State Energy Office program, is funded by the Bonneville Power Administration and the U.S. Department of Energy.

You can obtain free copies of this and other fact sheets by contacting a WEES office listed on page one of this document, or:

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Sun Path Chart (48°N)