Choose the Right Site

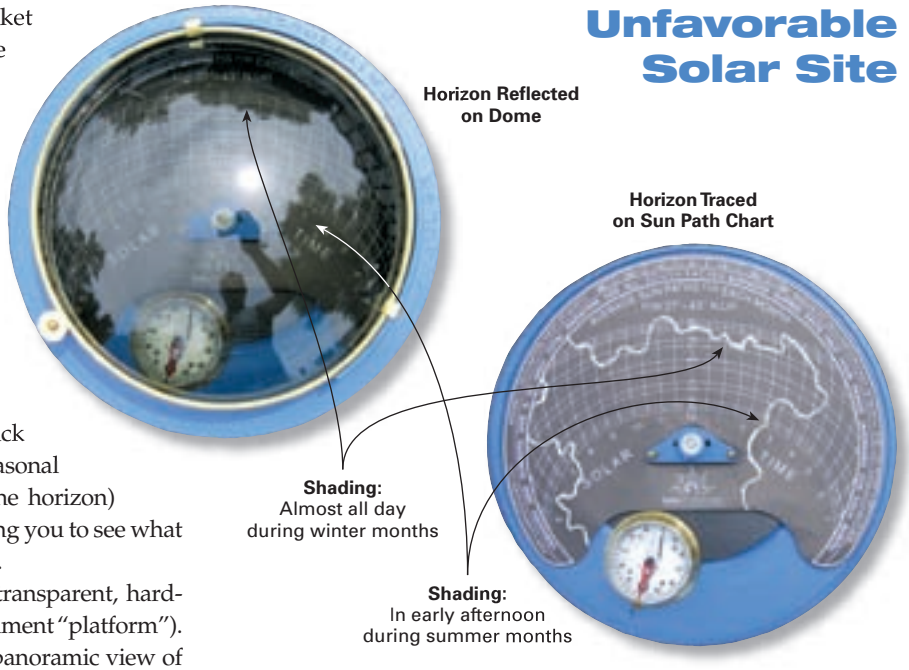
To Maximize Your Solar Investment

Tehri Parker

For maximum output, solar-electric (photovoltaic; PV) modules or solar thermal collectors need to be located where they receive the most sunshine. Ideally, hills, trees, buildings, or other obstructions shouldn't shade a system site at any time during the year, so figuring out the best place to install a system can be tricky. The good news is that the Solar Pathfinder is one tool you can use to ensure that your system is sited correctly to get the most out of your investment.

Even the best system equipment on the market and a highly trained installer can't compensate for poor solar exposure. PV systems are extremely sensitive to shading, and even a small amount of shade can reduce a system's performance. Although solar water heating systems are less sensitive to shading, they are still affected by even partial shade.

Unfavorable Solar Site



How It Works

The Pathfinder is an easy-to-use tool that accurately measures the shading of any site over the course of a year—in just one quick visit. Its unique design accounts for the seasonal changes of the sun's altitude (angle above the horizon) and azimuth (its path through the sky), allowing you to see what could shade your system throughout the year.

A key component of the Pathfinder is a transparent, hard-plastic dome set on top of a solid base (the instrument "platform"). The user looks down onto the dome to see a panoramic view of the site reflected on the dome's surface. All of the obstacles to sunshine at that location can be clearly seen in this reflection.

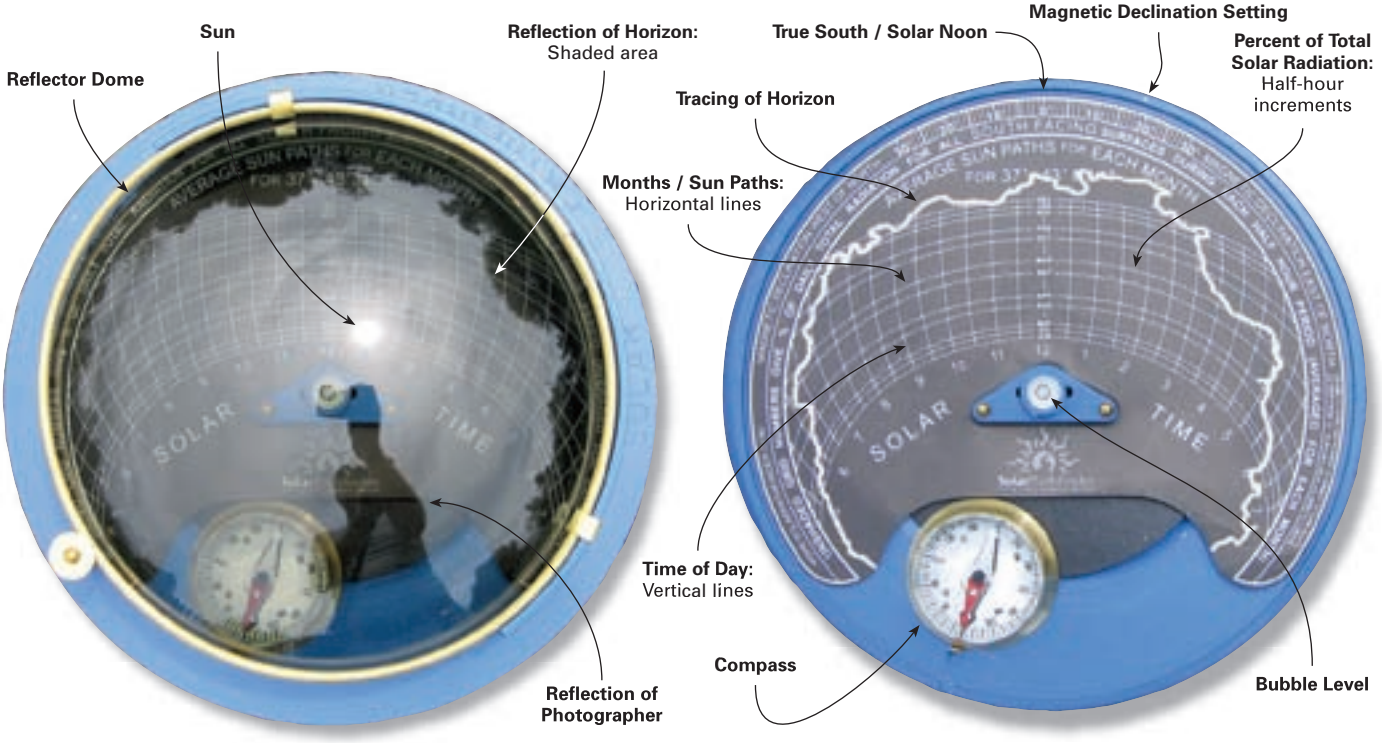
A paper sun-path diagram, which shows the sun's route through the sky for every month of the year and every hour of the day, is placed underneath the dome. Slots in the side of the dome allow the user to trace the outline of the reflected obstacles onto the diagram, revealing exactly what obstacles will shade the selected site and when.

The complete Pathfinder kit contains the plastic dome, instrument platform, tripod legs, base section, sun-path charts for various latitudes, and comprehensive user instructions. All of this is housed in a very lightweight and durable plastic carrying case.

Getting Started

The Pathfinder setup is quick and easy, and usually takes just a few minutes. Start by securing a paper sun-path diagram to the instrument platform. Align the triangular hole in the center of the chart with the raised bubble level, and push down. The bubble level base holds the chart in place, so it doesn't move while you're conducting the site analysis.

Favorable Solar Site



A Smarter Solar Assistant

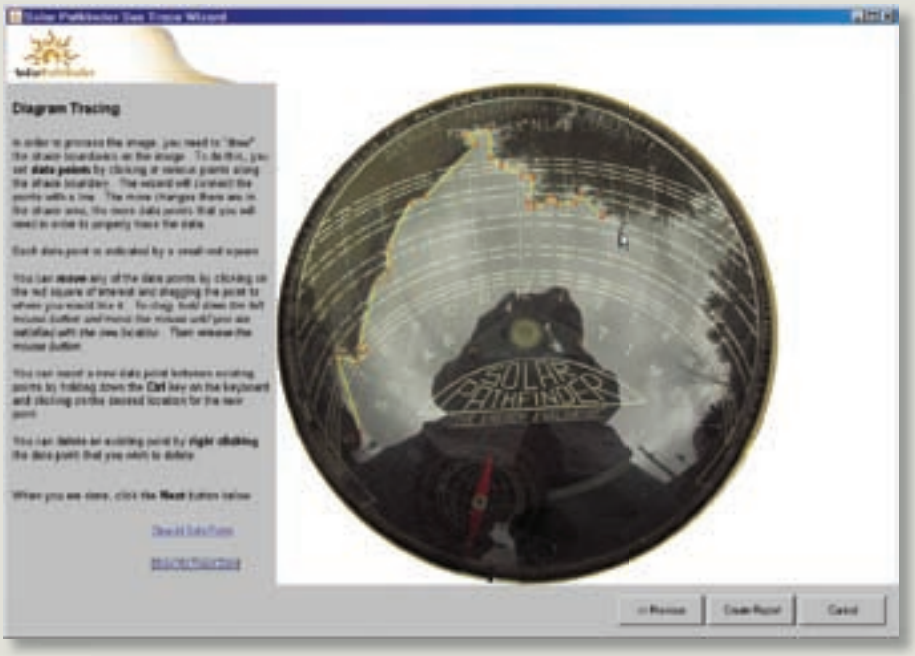
If you want an even more precise analysis of a site's solar resources, as well as the ability to subject data you collect in the field to various "what-if" scenarios, Solar Pathfinder now offers its Assistant software. Paired with the Pathfinder and your own digital camera, this software allows you to analyze site data and determine with accuracy the best siting of a PV system.

After setting up the Pathfinder at the site, you'll use your digital camera to take a photo of the reflected pattern on the Pathfinder's dome, instead of manually tracing the pattern on the paper chart. Assessing various locations on the site is as simple as moving the Pathfinder and snapping more photos. And once you've finished your fieldwork, you can analyze the data at your leisure on your computer.

The Assistant software works with any modern Windows operating system; I installed mine very easily on Windows XP Pro (sorry, there's no Mac version yet). Once you've installed the software and taken your first Pathfinder photo, you're ready to go.

Start the program and import the photo using standard "Open" dialog boxes. The first time you use a particular camera, you will need to calibrate the program, since camera lenses can vary quite a bit. Simply follow the instructions to mouse-click on a few specific reference points in the imported photo. Done once, camera calibrations can be saved for future uses of the specific cameras.

Next, set the reporting parameters, including zip code (which accesses the proper insolation data), proposed system size, derate factor (for system efficiency), azimuth (orientation of array), and the cost of grid electricity. Then calibrate the size and orientation of the photo by clicking on the compass and bubble level in the imported photo. Finally, trace the edges of the pattern reflected on the dome by clicking the mouse on points that represent the outline.



Mouse-clicking to trace the horizon line using Solar Pathfinder's Assistant software.

Once you've finished tracing, you can easily generate a report. This report includes data similar to that shown by the well-known, online PVWATTS calculator (see Access), except the Assistant knows how to subtract just the right amount at just the right times of the year to give an accurate description of the available energy at that site. The report and traced outline can be saved for further "what-if" analyses, and printed for your use or to share with potential customers.

The software contains a large data set on solar energy insolation for locations throughout the continental United States. Entering your site's zip code is usually enough to tell the Assistant what data set to use, although you can override this set with data you enter. The data can be further manipulated by adjusting the parameters and generating new reports to reflect the changes.

I was a beta tester for the Assistant, and think that it is a great addition to the Solar Pathfinder. Renewable energy installers will find it especially helpful in accurately estimating the performance that their customers can expect from a PV array. The Solar Pathfinder Assistant is a valuable customer education and sales tool, and a good investment at US$89 ($69 with Pathfinder purchase).

—Michael Welch

Solar Analysis Report

Report Title	Sweet Home Ground Mount
Image File	PICT1378.JPG
Report Date	Friday, May 05, 2006
Declination	15d 41m
Latitude/Longitude	40.564 / -123.936
Analysis Site	ARCATA, CA, Zipcode: 95521
Weather Station	ARCATA, CA, Elevation: 69 m
Station/Site Distance	30.22 miles
Array Type	Fixed
Tilt Angle	40.56 degrees
Cost of Electricity	13 cents/kWhr
DC Rate	1.00 kW
Derate Factor	0.77
Azimuth (180 = south)	180.00 degrees

Month	Exposure % Ideal/Effective	Solar Radiation (KWH/m^2/day)	Energy Value ($)
January	27.6%/27.6%	0.86	$2.58
February	42.0%/42.0%	1.49	$3.99
March	85.6%/85.6%	3.76	$11.35
April	90.7%/90.7%	4.94	$14.39
May	95.7%/95.7%	5.22	$15.68
June	95.7%/95.7%	5.00	$14.31
July	96.9%/96.9%	5.34	$15.75
August	93.5%/93.5%	4.67	$13.61
September	86.8%/86.8%	4.40	$12.53
October	50.3%/50.3%	2.09	$6.08
November	30.1%/30.1%	1.07	$3.09
December	16.6%/16.6%	0.53	$1.58
Totals	**67.6%/67.6%**	**39.38**	**$114.92**

Next, adjust the platform (with diagram in place) to account for the magnetic declination, the angle between true north and magnetic north. Due to metallic elements below the Earth's surface, compasses do not normally point to true north, but to *magnetic* north. To adjust the Pathfinder for this variable, find your location on the magnetic declination map in the instruction booklet or, for the most accurate declination figures, visit the Web sites listed in the manual. The map shows the declination of a site as either a positive or negative number of degrees. Unlock the instrument platform and rotate the chart holder the appropriate number of degrees, which are clearly labeled on the perimeter of each sun-path diagram, and then lock the platform again.

The next step is to set up the Pathfinder at the system's proposed location. Insert the ends of tripod legs into the base section of the Pathfinder, and place the platform on the base. Rotate it until the compass needle aligns with magnetic north. Then adjust the telescoping legs and level the unit by eyeing the bubble level. Place the plastic dome on top, and you are ready to go.

Site Evaluation

The Pathfinder makes it easy to compare several locations at your site for their solar suitability. Simply take your Pathfinder to each locale, set it up as described, and peer into the dome. Use the white pencil that comes with the Pathfinder to trace the outline of the objects reflected on the dome directly onto the sun-path diagram. Quick, preliminary "spot tests" to identify sites that would benefit from a tracing analysis can be performed by carrying the unit around without its legs .

For the most accurate results, the Pathfinder should be placed in the exact location of the proposed solar array. For a roof-mounted system, this will entail climbing onto the roof. To site a system to be placed on a tall pole-mount or for a house that has not yet been built, a ladder or scaffolding can be used to simulate the correct elevation. If it is not feasible to place the Pathfinder at the exact elevation of the proposed system, the next best option is to use the angle estimator spreadsheet on the Solar Pathfinder Web site (www.solarpathfinder.com/formulas.html). However, using the angle estimator tool is time-consuming because each obstacle on the horizon must be measured separately to compensate for its distance from the Pathfinder. If a home's proposed site looks good at ground level, generally solar access will also be as good—or better—at the pole or roof level.

After you have diagrams from two or three potential locations, it is time to interpret and compare the data. Each sun-path diagram has twelve arcs, one for each month, which represent the sun's path across the sky. Vertical lines, or rays, mark solar time in half-hour increments. Each half-hour increment, for each arc, is given a number that represents the relative solar energy, or radiation, that is available at that time. The numbers increase as they approach noon, when the most solar energy is available. The numbers along each sun-path arc add up to 100 percent, the total amount of potential solar energy available.

To find the percentage of solar energy that is available at each of your chosen locations, simply add up the numbers along each arc in the *unshaded* part of the diagram. For example, see the site tracing at the bottom of page 31. A solar array placed in this location would receive 57 percent of the total available energy for the month of December (6+7+8+8+8+7+7+6=57); 43 percent of the potential energy would be lost due to shading.

Using a white grease pencil to trace the horizon line under the Solar Pathfinder's reflective dome.

Comparing the charts from the different locations will show which has the best solar potential. In general, look for the location that has the highest percentage of solar energy available, is unshaded each day from 9 a.m. to 3 p.m. (the hours with the greatest solar potential), and has no shading during these hours in the winter, when every minute of sunshine makes a difference.

The Solar Pathfinder comes with a 34-page instruction manual, complete with all the charts you need to set up and interpret the results of your site analysis. Visual learners might want to purchase the demonstration DVD (US$10), which gives a quick overview of how to set up and use the Pathfinder. And if you still need more information, you can visit the Web site.

If you crack the plastic dome or need more sun-path diagrams, you won't need to buy a whole new Pathfinder. From new charts to bubble levels, all of the essential replacement parts are available.

Seventeen years ago, *Home Power* praised the Pathfinder as the best tool for solar site analysis. And although the price has increased since then, at US$250 it's still a good deal when you're considering maximizing your return from investing in a solar energy system.

Access

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Solar Pathfinder • 317-501-2529 • www.solarpathfinder.com

PVWATTS calculator • http://rredc.nrel.gov/solar/calculators/PVWATTS