

# USING SOLAR POWER

## to view the stars

*This cutting-edge home and observatory showcase optical astronomy and sustainable technology.*

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**N**ow more than ever, the global production and consumption of energy pose challenges to everyday living. Whether it is sky-high costs, questionable availability due to unstable political situations, or storm-related outages overburdening an antiquated power grid, the modern reality of energy uncertainty seems to be here to stay for the foreseeable future.

Groups and individuals have made efforts to mitigate this volatility by considering more sustainable energy sources. Being mindful of the environment should be important to those with a passion for astronomy because low-energy, dark-sky conditions are crucial to the observing experience. At the Midkiff home in north-west New Jersey, I have tried to minimize our dependence on outside energy sources to create an environment that not only uses

sustainable technologies for day-to-day living, but also enhances our astronomy-related activities.

We are fortunate to live in one of the few remaining relatively dark-sky sites in the tri-state area (New Jersey, Pennsylvania, and Delaware). Although light pollution has deteriorated our night sky during the past decade, on occasion we still enjoy a horizon-to-horizon Milky Way panorama. I grew up in the area and became involved in astronomy in my youth; thus, incorporating an observatory within my home has been a long-term goal.

### Breaking ground

In 1995, with help from friends and family, I began constructing the first of two homes on a 31-acre hilltop lot. Although the 750-foot (229 meters) elevation is not impressive by western standards, the location is high enough to afford a view of the Delaware Water Gap to the west and the Jenny Jump State Park observing site of the United Astronomy Clubs of New Jersey ([www.uacnj.org](http://www.uacnj.org)) 4 miles (6.4 kilometers) to the south. Unique features of this house include a two-well geothermal heating/cooling



**The first telescope housed in the rooftop observatory was this 16-inch f/5 equatorially mounted Newtonian reflector. After a few years of using it, Midkiff sold it and purchased a 25-inch reflector.**

**The first observatory sits atop a 25-foot-high (7.6 meters) concrete tower in the center of the house but isolated from it to prevent vibration. You can see the secondary cage of Midkiff's 25-inch reflector sticking straight up at center before he relocated the scope.**

system and a 4 by 7 by 25 foot (1.2 by 2.1 by 7.6 meters) concrete tower constructed through the center of the house, which serves as a footing support for the telescopes in the rooftop observatory.

Designing an observatory that operates in an environment replete with the full







**Co-author Emily A. Mailhot poses atop an observing ladder to lend a sense of scale to the 25-inch Newtonian reflector.**

range of normal household activities required careful consideration. I isolated the concrete tower from the house framing and other structures to uncouple the telescope mounts from vibrations induced by running children and dogs. Likewise, to keep the air mass over the roof thermally stable, I used off-white shingles that minimize re-radiation after sunset and inserted R-38 insulation between the roof rafters.

Two solid concrete anchor piers cap the tower. Originally, I mounted a 16-inch f/5 Newtonian reflector for deep-sky work to

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one of them and a 7-inch f/7 apochromatic refractor for planetary and double-star viewing to the other. It didn't take long for local schools to become aware of the facility, and although the 11 by 13 foot (3.4 by 4 meters) roll-off roof observatory could hold approximately a dozen observers comfortably, there were times when 30 or more people packed in. The larger groups started with the apparition of Comet Hyakutake (C/1996 B2) in the winter of 1996.

## Modest power needs

The geothermal system extracts heat from well water at a temperature of 50° Fahrenheit (10° Celsius) and produces 70° F (21° C) air by employing an expansion/compression cycle. The 37° F (3° C) discharge is returned to a second well located about 100 feet (30.5m) from the first, then cycled back through the aquifer. Because geothermal systems use compressors and pumps that require significant electricity, I supplemented the home's utility consumption with a photovoltaic (PV) power system, which converts sunlight into electricity.

The initial PV installation produced a modest 3.6 kilowatts (kW), but at the time there were few like it. After site visits by representatives from both the state energy commission and the local power company, it became the prototype for the New Jersey solar rebate incentive program. More recent PV system component upgrades include a 150 kW/hour battery bank and charge controllers that can supply house loads for up to three sunless days. A dual inverter system changes the 48-volt DC panel/battery bank voltage to 220-volt AC power.

The system also ties into the grid to sell back daytime overproduction to the utility company. Finally, because the battery bank backs up all the circuits supplying the



**Midkiff's geothermal system produces 70° Fahrenheit (21° Celsius) air from well water at a temperature of 50° F (10° C).**

observatory, visitors can enjoy in-house nighttime viewing of the darker skies that power outages offer. Lately, these seem to be occurring on a more frequent basis due to unpredictable grid availability.

## More power, more aperture

Both astronomy and solar power involve capturing energy. In the case of each system, the performance rises in relation to the area of the collectors. And just like in astronomy, it's easy to get energy-based "aperture fever," which leads to increasing array sizes and power production. Within a few years of the initial installation, I added 2 kW to the PV array to help offset the energy demands of a second home I constructed on the property.

My observing appetite also motivated me to pursue larger astronomical instruments. I sold the 7- and 16-inch telescopes and used the proceeds to purchase a 25-inch f/4.9 JMI NTT Newtonian reflector. Within a year, I upgraded the alt-azimuth drive system to Byers gears and Comsoft PC-TCS telescope control. I bolted the 25-inch to the north pier, but, due to



**This observatory, which Midkiff built to house his 25-inch reflector, has wheels that let the whole building roll off. This design allows celestial views closer to the horizon and accommodates larger groups.**





**This photo shows the inverters (that convert the direct current that the photovoltaic array produces to more usable alternating current) and the battery bank that stores power for evening or cloudy-day use.**



**The newest energy-saving addition is this hybrid solar hot-water system. On sunny days, it can heat both houses on the property. Here, a visiting school group poses underneath it.**

space limitations, some of the sky was cut off. This led to the next upgrade.

## Moving out, maxing out

Increases in both the size of the telescope and the visiting public groups led me to construct a larger observatory building in one of the hayfields. When I finished it, I moved the 25-inch reflector there. To accommodate bigger crowds, the observatory's design lets the entire building roll away. A 220-volt service runs through a 400-foot (122m) underground conduit, which, like the rooftop facility, ties to the inverters for uninterrupted power.

During the past few years, I expanded the PV system to 25 kW, which fully balances our consumption and eliminates any reliance on fossil fuels. In addition, I have installed a hybrid solar hot-water system to offset the heating load of the geothermal units. Three hundred evacuated solar hot-

water tubes and 200 square feet (18.6 square meters) of flat-panel collectors harvest enough energy on sunny days to satisfy the heating requirements of both houses. They also store enough excess heat in a 550-gallon (2,082 liters) insulated tank to delay activation of the geothermal units typically until late evening.

## Current activity

In the past five years, I joined Emily A. Mailhot to expand our public outreach by establishing an astronomy club, the North West Jersey Amateur Astronomers ([www.nwjaa.org](http://www.nwjaa.org)), which oversees a student chapter at the local high school. Both operate under a 501c(3) nonprofit corporation we formed, the Star View Hill Education Center ([www.starviewhill.org](http://www.starviewhill.org)). Meetings take place at the observatory, with presentations by accomplished amateurs and university researchers followed by observing.

Recently, we established a collaborative relationship with Michael Person of the Planetary Astronomy Lab at the Massachusetts Institute of Technology to provide light-curve data for use in binary asteroid research. In addition, when favorable shadow path conditions exist, we conduct occultation timings used in conjunction with data from other area observatories.

## Future plans

To enhance our research activities and ongoing public outreach, we plan to construct a larger domed observatory at the field site that will accommodate a larger telescope and allow remote observing. On the energy side, our year-round average wind speed of 11 mph (18 km/h) should be able to keep a wind turbine producing sufficient power to enable us to harvest energy even at night while we observe the heavens from a "green" observatory. ☼



**Alan Midkiff's photovoltaic system initially produced 3.6 kilowatts of power. After several upgrades, it now yields 25 kilowatts.**