Small-Scale System

for an On-Grid Island Getaway

by Ian Woofenden

Rod and Barbara Brown live busy lives in California's San Francisco Bay Area, and travel the world on business. When they want to relax, they head north to Guemes Island in northwest Washington, to a beach cabin they've owned for the last five years. They love the island for its natural beauty, and recently decided to make their cabin's electricity with natural energy—sunshine.

A small, rooftop-mounted solar-electric array provides all of the Brown family's annual electricity needs for their vacation cabin.

Rod was looking to slow the pace of his life and devote more time to his family. "I have spent many years working many hours," says Rod, "and I sometimes feel that my family paid a price for that.

"An island getaway—with a focus on nature, the sea, the air, and a slower pace—seemed the best place to begin," he says. "I wanted my children to know about boats, the cycles of the sea and tides, and food from the sea. These are things they cannot learn from school, television, and video games."

Renewable Decision

Rod and his family were introduced to Guemes Island through a friend with long-term ties to the island. In 2001, they found and purchased their modest place, a 1950s-era, 1,000-square-foot cabin on the island's stunning West Beach.

The Browns have been fixing up their cabin for the last few years. They have added a two-bay garage/shop to house their boat, sports equipment, washer and dryer, and some bunks for friends and family who visit on occasion. The home's electrical loads are modest and seasonal, and with Rod's long-term interest in the environmental and technological aspects of renewable energy, installing a solar-electric (photovoltaic; PV) system seemed like a great fit.

"I want to help further the technology, and the best way to do that is to buy the equipment and support those generally smaller firms that are leading the way," says Rod. "I felt that my own purchase and use of a system would help me to learn and understand more, and also help the entire cause in some minute way. Although I am pleased to get some tax credits and some relief from our own energy bills, that was not the point. I wanted to know more, and to start on a path of renewable energy progress. This was a brilliant, easy, and fun first step."

A rack mounted to the metal roof supports the photovoltaic modules.

A batteryless grid-tie system is relatively simple—all components, except for the solar-electric array, are pictured here.

Small Design, Satisfying Rewards

Rod and Barbara's island home is small, and their lifestyle on the island is not extravagant. They use electricity for lighting and water heating, and to power basic appliances and their laptop computers. They have no TV or video game consoles at the cabin, preferring to spend their time enjoying the beach and sea.

But the largest reason their annual electrical usage is so low is that they only use their beach home four to five weeks during the year. Their visits also coincide with a season when the house needs no heating, no cooling, and little lighting. When they head back to California, they close up the cabin, shut off all electricity to the house, shut off the water, and drain the water lines. A radiant heating system in the garage floor is set to maintain temperatures just above freezing, and all electrical devices in the shop that have phantom loads are unplugged. Meanwhile, even while the Browns are away, the grid-tied PV system keeps producing electricity, meeting the minimal loads, and sending excess electricity to the grid, which is credited to the Browns' electric bill.

From my standpoint as an RE consultant, designing the Brown's system was easy and exciting. Guemes Island experiences occasional utility outages, but these normally occur in the winter, when the Browns are living at their California home. A batteryless, grid-tied system was determined to be the best approach, compared to an off-grid system or one with battery backup.

With off-grid systems, a complete load analysis is vital to make sure that the PV array and battery are sized appropriately. With battery backup systems, installers need to make sure end users have realistic expectations about how much backup energy they need, for what loads, for how long—and at what price. Both off-grid and on-grid battery-based backup systems require periodic maintenance, and eventual replacement of the batteries. The increased cost, maintenance, and somewhat lower efficiency of these systems mean that people should take a hard look at their needs. In

Excess length is trimmed off the array rack's rails for a neat, streamlined installation.

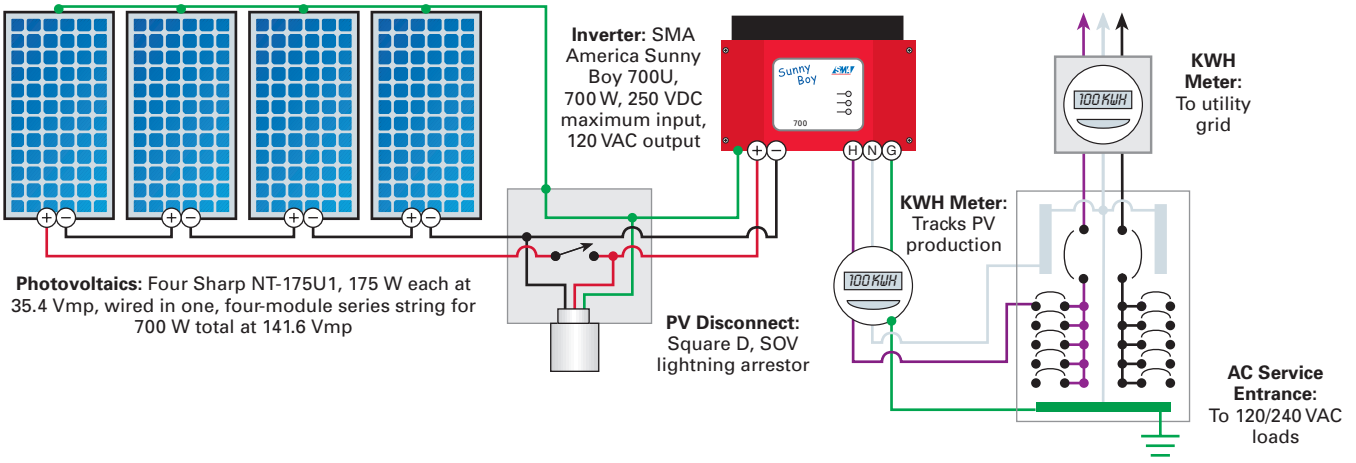
Brown System Costs

Item	Cost
4 Sharp NT-175U1 PV modules, 175 W	$4,132
Labor	1,940
Sunny Boy 700U inverter with LCD display	1,573
Misc. electrical	362
UniRac PV mounts	203
Square D disconnect, 30 A	148
Miscellaneous hardware	80
Delta LA602DC DC lightning arrestor	38
Delta LA302R AC lightning arrestor	34
Multi-Contact module cables/connectors	30
Total	$8,540
Less federal tax credit	-$2,000
Less utility rebate	-403
Grand Total	$6,137

contrast, sizing the Browns' system was straightforward—by analyzing their utility bills, it was easy to calculate their average daily usage. The figure was a pleasant surprise—a year-round average of only 2 kilowatt-hours (KWH) per day.

The potential of showcasing this small system to other seasonal islanders was particularly exciting to me. Most people buy vacation homes on Guemes Island because they love the area's natural beauty. Using clean, renewable energy fits within this value system, and helps offset a household's environmental impacts due to energy use. Plus, about half of the homes on the island are only occupied during the summer months, which means seasonal needs for electricity come at a time of abundant sunshine—a perfect pairing for a solar-electric system, especially when the utility's annualized net metering program is considered. This, coupled with a relatively small up-front investment, makes installing similarly sized systems a very viable option for other vacation-home owners.

Brown On-Grid Photovoltaic System



On Grid, No Maintenance

Rod and Barbara's system was installed as part of a Solar Energy International (SEI) workshop, with the help of a local solar contractor, Kelly Keilwitz of Whidbey Sun & Wind. The installation was completed and commissioned in one day, after two days of classroom instruction by electrician Carol Weis of SEI.

With only six major components—PV modules, racks, wiring, inverter, disconnects, and metering—system installation was straightforward. The direct current (DC) output of the PV array is routed to an inverter, which produces grid-synchronous alternating current (AC) electricity. This feeds the house loads as needed, or is sent back to the utility grid.

The 2 KWH per day average consumption allowed using the smallest available batteryless inverter, SMA America's Sunny Boy 700U, which has a 700-watt rating. An array of four, 175-watt Sharp solar-electric modules feed the inverter. This combination may produce somewhat more than the 2 KWH per day needed to meet average loads, but that's OK—the goal here is more renewable energy. The Browns will likely have a slight energy surplus when the utility zeroes their net metering account on January 1 of each year. But that fits with Rod and Barbara's environmental goals too—they want to reduce their impact on the environment while enjoying their lifestyle.

PV Payoff

Although western Washington has a reputation for being cloudy and rainy, the sun shows its face all summer and frequently during other times of the year, with an average of 4 peak sun-hours (1,000 watts per square meter equivalent) per day in the islands. This is roughly the same amount of average peak sun-hours that New York City, Indianapolis, or Boston receives. The Browns' grid-tied PV system helps them put this seasonal advantage to good use through an annualized net metering agreement with the utility.

Net metering laws require utilities to pay renewable electricity producers at the same rate they are billed for electricity, up to the level of the their usage (net). This utility rate structure, now in 40 states (plus Washington, D.C.), allows consumers to use the utility grid as a sort of "battery," banking excess energy credits when their homes don't use all of the solar electricity being produced, and drawing from that credit when they do.

Most net metering agreements stipulate a "zeroing" time, when the energy balance is settled. Any energy surplus produced by the consumer's RE system is either forfeited or, in some cases, paid for (generally at a lower rate). This

High Quality, Low-Power Batteryless Inverters

Low-power, batteryless inverter options for small, grid-tied solar-electric systems are limited. Trace's somewhat-popular, 90-watt MicroSine batteryless PV inverter went out of production several years ago, and Exeltech's module-based inverter is still under development. At the time of writing, SMA America's 700-watt SB700U inverter is the lowest power batteryless PV inverter on the U.S. market. And while some end users may be waiting for even lower power inverters that can be directly coupled with PV modules, the SB700U offers high performance, reliability, and design flexibility, making it a great choice for small grid-tied PV systems.

The SB700U's main selling point, other than its low-power design focus, is three field-selectable PV voltage ranges. This allows you or your installer to design a small, batteryless PV system with as few as three 24 VDC nominal modules and, depending on the voltage and wattage rating of the modules you're using, add up to about five 24 VDC modules. To determine the exact PV string configuration for your particular SB700U system, use the string-sizing calculator at www.sma-america.com.

While modularity is a great aspect of the SB700U inverter—and of PV systems in general—before you get started, it's always a good idea to determine your ultimate goal for PV array size. In residential systems, multiple, low-power inverters will typically have a higher cost per watt when compared to a single, larger unit. For example, the SB700U has an MSRP of about $1,600 ($2.29 per watt), while a 2,500-watt batteryless inverter will have an MSRP of about $2,300 ($0.92 per watt). In this example, if you used multiple low-power inverters, you'd end up paying roughly 2.5 times as much per rated watt of inverter capacity if you were to eventually install 2,500 watts of PVs. However, if you're planning to keep the size of your PV array within the wattage specifications of the low-power inverter, it will be cost effective, even though the cost per watt is higher.

Sunny Boy 700U Voltage Specs

Configuration (VDC)	Rated AC Amps	Maximum AC Amps	Maximum AC Watts
75–150	3.8	4.3	460
100–200	5.0	5.7	600
125–250	5.8	6.6	700

zeroing time is crucial to the usefulness of the net metering policy, and to how systems are designed. With monthly net metering agreements, if a household's RE system generates more energy in a month than the household uses, no credit may be given for that surplus. In places that are sunny year-round, this may not be a drawback. But overall, annualized net metering is much more useful, since a surplus in one season builds up a credit for another.

In addition to the advantages of net metering, the Browns are eligible for a $2,000 federal tax credit and a $403 up-front rebate from the local utility, Puget Sound Energy. They can also apply for a 15-cent-per-KWH incentive from the state of Washington, and a 5-cent-per-KWH "green tags" incentive from a regional organization promoting renewable energy.

Small Steps

"I believe it is very important for our country and the world to be using renewable sources of energy," says Rod's wife Barbara, "for the sake of the planet and for national security. Many Americans discuss this matter, but do nothing to begin to solve the problem. We decided to take the first steps toward creating our own household energy with the sun."

"We must all take steps, even small ones, to help further the effort toward environmentally sound electricity production," says Rod. "For me, purchasing the solar-electric system is my family's first step." The next steps for Rod and Barbara are a rainwater catchment system for their island home, and solar energy systems for their home in the San Francisco Bay area.

Access

Ian Woofenden, PO Box 1001, Anacortes, WA 98221 • ian.woofenden@homepower.com

Kelly Keilwitz, Whidbey Sun & Wind • 360-678-7131 • www.whidbeysunwind.com • Project contractor

Solar Energy International • 970-963-8855 • www.solarenergy.org • Workshop project coordinator

PV System Components:
Sharp Electronics, Solar Systems Division • 800-SOLAR06 • www.sharp-usa.com/solar • PVs

SMA America Inc. • 530-273-4895 • www.sma-america.com • Inverter

UniRac Inc. • 505-242-6411 • www.unirac.com • Module rack