My Solar Casita

Solar Pumping, Heating, Cooking, & More!

Samuel Gray

I stayed in a nearby inn during the early stages of building my adobe casita near Abiquiu, New Mexico. When the grid shut down for over fourteen hours during one of my visits, I learned a brutal lesson about the dangers of grid-powered electricity. What I never realized was that when the grid fails, rural water systems fail along with it. You can live a long time without electricity in New Mexico, but you can't live long without water anywhere. A fourteen-hour blackout was more than enough to convince me to go solar with my own water system.

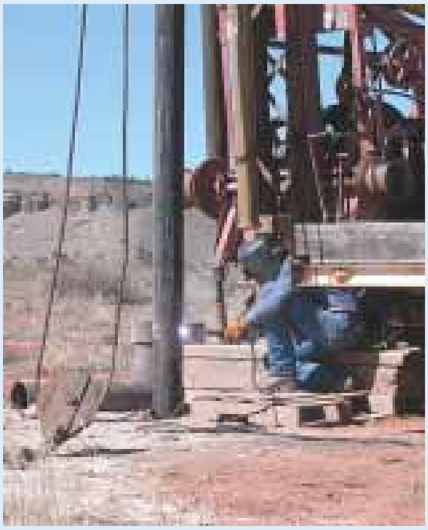
My casita is located 1 mile (1.6 km) west of Abiquiu on a 5 acre, worn-out potato field I bought ten years ago when I lived in Virginia. I didn't know anything about photovoltaics when I bought the property, but I did know that the property was perfect for passive solar heating. The land gently slopes to the south toward the nearby Chama River and has a spectacular, unobstructed southerly view of the river valley and the mountains beyond.

Adobe Construction

After moving to New Mexico, my wife and I wanted to build a casita on the property to use as a getaway. During our research, we were impressed with adobe and its potential for an owner-built, passive solar heated building. The adobe provides thermal mass that stores heat during the day and releases it at night when it is most needed. The solar-adobe concept seemed a no-brainer for us.

Once we had committed to an adobe casita, we realized we were in over our heads. I had previously done some standard frame construction, but knew nothing about adobe. Fortunately, Northern New Mexico Community College in nearby El Rito offers courses in all phases of adobe building. I signed up for an intensive three-week course, and my wife and I were laying adobe bricks on my casita by the end of summer. The professor, Quentin Wilson, has visited my casita many times since then to offer advice and encouragement. I also learned a great deal along the way from an Internet adobe discussion group, moderated by the very same Professor Wilson.

The casita is very tiny—just one room and slightly under 120 square feet (11 m^2). It's not yet finished, but quite livable nevertheless. It has a bed, a desk and a chair, a small kitchen counter, and lots of shelves. The building is constructed with 4 by 10 by 14 inch (10 x 25 x 36 cm) adobe bricks mortared with mud from the site. I oriented the structure 12 degrees east of magnetic south and used lots of glass on the south wall to collect free solar energy during the winter. The outside walls are cement stucco over 2 inches (5 cm) of rigid insulation.



By cutting the well casing into ten foot sections and then welding them back together in place, the driller was able to complete the well working alone.

His equipment was antiquated, but it did an excellent job.

The PV panels, pump house, and frost-proof hydrant were sited well away from the well head for convenience in servicing the well.

Water System

The well was drilled in April 2003 by a local drilling contractor. It is 115 feet (35 m) deep, with a 6 inch (15 cm) steel casing perforated for water veins at 30 feet (9 m) and 90 feet (27 m). The recharge rate tested at 40 gallons (150 l) per minute, and about 85 feet (26 m) of water stands in the well.

When the well was completed, I had the drilling contractor install an underground pump house to hold the 80 gallon (300 l) pressure tank and plumbing. I also wanted to temporarily put my PV system's batteries and controls in the pump house. Later on, they'll have their own structure.

By building the pump house underground, we avoided the necessity of heating that space in the winter to prevent frozen pipes. Our contractor built the pump house out of a piece of 5 foot (1.5 m) diameter corrugated steel culvert set upright. The floor is 3 inches (7.6 cm) of pea gravel, and the roof consists of a 4 inch (10 cm) thick slab of poured concrete with a 32 inch (81 cm) access cover.

Even though the well head is above ground, the water line from the well to the pump house is buried 4 feet (1.2 m) underground to prevent the delivery pipe from freezing. A very clever

Gray System Loads

AC Loads	Qty.	Avg. Hrs. / Day	Watts	Avg. WH / Day	Max Inverter Watts
Laptop	1	4.00	40	160.00	40
Battery chargers: tools	3	3.00	15	135.00	45
Compact fluorescent lights	2	2.00	25	100.00	50
Fluorescent bug light	1	2.00	17	34.00	17
Battery chargers: cell phone, camera, PDA	3	2.00	5	30.00	15
			Total AC	459.00	167
DC Loads					
Inverter	1	24.00	5	120.00	
Shurflo submersible pump	1	1.50	72	108.00	
Pump house fluorescent light	1	0.05	1	0.05	
			Total DC	228.05	
			Grand Total	687.05	

device called a "pitless adaptor" was used to make it easy to remove the pump for maintenance and repair. The submersible pump wire travels to the pump house via a 1 inch conduit.

The pump is a 24 volt Shurflo submersible with a maximum flow rate of about 2 gallons (7.6 l) per minute. I installed it myself, working alone, by using 8 foot (2.4 m) threaded sections of 1/2 inch PVC drop pipe. The pump is designed for pumping into a storage tank or water tower rather than a pressure tank. Since my water needs are small and my pump is only 40 feet (12 m) below ground, I decided to try it with a pressure tank.

The drawdown on the 80 gallon (300 l) pressure tank is about 35 gallons (132 l), more than I anticipate needing at any given time. After the drawdown, it takes about 20 minutes for the pump to recharge the tank back to 50 psi. When I move here permanently, I will have to install a bigger pump or a storage tank with a booster pump to supply the pressure tank. For my current needs, what I have works fine.

PV System

The primary purpose of the PV system is to supply 24 volts DC to the submersible pump. Many PV systems for rural water supply are designed "PV direct"—the pump runs only when the sun shines. That is the most efficient system if you're pumping into a storage tank with an additional pressure pump or an elevated tank that relies on gravity for pressurizing. Pumping directly into a pressure tank, however, requires access to continuous electricity.

I used two Siemens SM55 PV panels, rated at 55 watts each, that I purchased on eBay. The Siemens modules have excellent tolerance for the hot temperatures in Abiquiu's summers, when water needs are the highest. The PV panels' output is regulated by a Trace C40 controller, and used to charge four, 6 volt, golf cart batteries connected in series. On the recommendation of *Home Power's* John Wiles, I grounded the system directly to the 115 foot (35 m) steel well casing. A Link 10 digital meter, power disconnects, a pump switch, and fusing complete the DC part of the installation.

DC electricity is supplied to the submersible pump via a two-conductor, #10 (5 mm^2), submersible pump cable. The pump is switched on the control panel and also through a pressure switch set to turn the pump on at 30 psi and off at 50 psi. The Shurflo draws about 1.8 amps at open flow and about 3.4 amps at 50 psi.

While my main purpose was to supply water, I also wanted a small amount of AC for the casita, located

Technical Specifications

System overview

System type: Off-grid PV

Location: Abiquiu, New Mexico

Solar resource: 6.2 average annual peak sun hours

Production: 14 AC KWH per month average

Photovoltaics

Modules: 2 Siemens SM55, 55 W STC, 12 VDC nominal

Array: 110 W STC, 24 VDC nominal

Array disconnect: Square D general duty safety switch, 30 A

Array installation: UniRac top-of-pole mount

Balance of System

Charge controller: Trace C40, PWM

Inverter: Exeltech XP 250, 12 VDC nominal input, 120 VAC nominal output

System performance metering: Link 10 digital meter

DC-to-DC converter: Solar Converters EQ 12/24-20, 95% efficiency

Pump: Shurflo 9300 submersible, 24 VDC nominal, 1.8 amps draw open flow to 3.4 amps at 50 psi, 2 gpm at open flow, about 1.5 gpm at 50 psi.

Energy Storage

Batteries: 4 Interstate, U2200 Workaholic, flooded, lead-acid, 6 VDC nominal, 220 AH at 20 hour rate

Battery pack: 24 VDC nominal, 220 AH total

Battery/inverter disconnect/overcurrent protection: DC-rated 30 amp fuse

The control panel after installation in the pump house. All switches and controls are mounted at eye level.

about 150 feet (46 m) away. I already owned a 250 watt Exeltech sine wave inverter, and decided to adapt my system to it. Since the inverter I had requires 12 volts and my battery bank is wired for 24 volts, I had to install a DC-to-DC converter to make the design work. This setup is not ideal, since the converter adds another 5 percent efficiency loss to the system. I ran the AC wires to the casita in an underground conduit. I planned this long ago, and the casita was already wired for AC and ready for an electricity source.

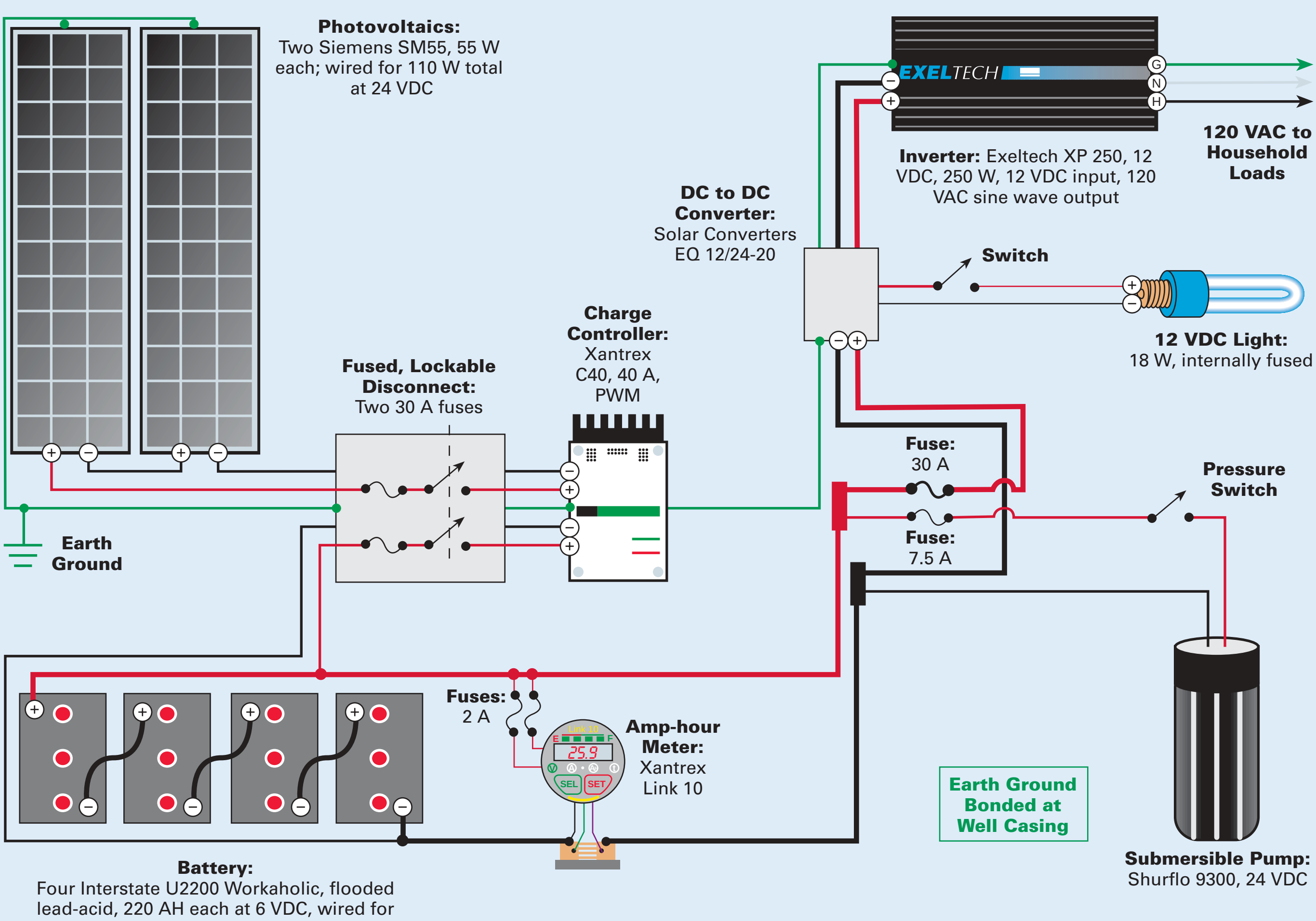
A 250 watt inverter is not much, but I don't need much. I have more than enough AC electricity to run three fluorescent lights, my laptop, a radio, and battery chargers for my cell phone, digital camera, PDA, and cordless tools. If I run all these devices at the same time, I am still well under 250 watts.

The water pump and the casita use more electricity than the two Siemens modules can produce on an average day. That's not a problem, since I only spend one week per month at the casita. When I leave at the end of the week, my batteries are drawn down perhaps as much as 50 percent. They then have three full weeks to recover before my next trip. When I build a permanent home here, however, this PV system will be dedicated to supplying electricity to the pump.

The *National Electrical Code* requires a safety placard attached to battery boxes.

More Solar Applications

I don't have, or want, access to unlimited electricity from a utility grid. My casita in Abiquiu has given me the opportunity to experiment with several solar applications other than passive heating and photovoltaics. I heat water for washing and showering in a portable 5 gallon (19 l) plastic solar water heater, available for about US$10



Note: All numbers are rated, manufacturers' specifications, or nominal unless otherwise specified.

Gray System Costs

PV System	Cost (US$)
2 Siemens SM55 PV Panels	$480
Misc. wiring, conduit, battery box	325
4 Interstate U2200 batteries	270
SCI EQ 12/24-20 DC–DC converter	165
Exeltech XP 250 inverter	160
Link 10 digital meter	145
Xantrex C40 controller	128
UniRac top-of-pole PV mount	109
2 Safety disconnects with fuses	85
Pump house light, 12 V	35
Total PV	$1,902
Well	
Contractor for well & pump house	$3,770
Pressure tank, 80 gallon	530
Shurflo submersible pump	520
Misc. wiring & plumbing	290
Total Well	$5,110
Grand Total	$7,012

from various suppliers. It takes three hours of direct sunlight to produce hot water. A future project will be to add a more permanent and larger batch solar water heater that will supply pressurized hot water.

I heat water for tea and coffee in a device called a solar thermos. It consists of a black thermos bottle with parabolic reflectors on either side to concentrate sunlight on the thermos. Twelve ounces (59 ml) of cold water and thirty minutes of New Mexico sunlight yield boiling water for hot beverages or cereal.

Small rechargeable batteries such as size AA and AAA can be easily charged in inexpensive solar chargers. I have two of these chargers and use them continuously when I am at the casita. I also use a solar powered flashlight. For entertainment, I watch DVDs on my solar powered laptop or listen to a solar powered radio. For my occasional trips to the nearby store in Abiquiu, I can use my electric ZAP bicycle and charge its battery from my PV system.

My favorite solar device is my Sun Oven. I do almost all my cooking using only direct sunlight as an energy source. I have successfully cooked beans, rice, biscuits, bread, cookies, stew, and soup in the Sun Oven. Although it's difficult to prove, food seems to taste better cooked this way. The Sun Oven quickly produces temperatures of over 350°F (177°C).

Self-Sufficient Comfort

All in all, my solar-adobe casita is a self-sufficient system requiring no purchased energy. It is comfortable inside even on the coldest of winter days. The sun provides all my needs for electricity, pressurized water, cooking, space heating, water heating, entertainment, transportation, and battery charging during my visits to Abiquiu. For the seven days per month that I spend at the casita, I am quite happy just taking what the sky gives me.

Access

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eBay • www.ebay.com • PVs, inverter, and Link 10 meter

Gaiam Real Goods, 360 Interlocken Blvd., Suite 300, Broomfield, CO 80021 • 800-762-7325 or 303-222-3600 • Fax: 800-456-1139 or 303-222-3750 • customerservice@realgoods.com • www.realgoods.com • DC-DC converter, 12 V pump house light, Square D safety disconnects, submersible pump wire

Adobe Discussion Group • Subscribe: adobe-subscribe@yahoogroups.com • http://groups.yahoo.com/group/adobe

Northern New Mexico Community College Adobe Program, El Rito, New Mexico, 87530 • 505-581-4156 • Fax: 505-581-4130 • qwilson@mail.nnmcc.edu • www.quentinwilson.com • Adobe workshop

Mr. Solar, PO Box 1506, Cockeysville, MD 21030 • 877-226-5073 or 410-308-1599 • Fax: 410-561-7813 • sales@mrsolar.com • www.mrsolar.com • PV mount, charge controller, pump

John C. Wiles, Southwest Technology Development Institute, New Mexico State University, Box 30,001/MSC 3 SOLAR, Las Cruces, NM 88003 • 505-646-6105 • Fax: 505-646-3841 • jwiles@nmsu.edu • www.nmsu.edu/~tdi/pv.htm • Grounding consultation

ZAP Electric Vehicles, 501 Fourth St., Santa Rosa, CA 95401 • 707-525-8658 • Fax: 707-525-8692 • zap@zapworld.com • www.zapworld.com • Electric bicycle

Northern Arizona Wind & Sun has an excellent on-line reference site for solar powered pumping applications at www.windsun.com/Water/solar_water_pumping.htm

Adobe: Build It Yourself, by Paul Graham McHenry, 1985, Paperback, 158 pages, ISBN 0-8165-0948-4 • US$24.95 from University of Arizona Press, 355 S. Euclid Ave., Suite 103, Tucson, AZ 85719 • 800-426-3797 or 520-621-1441 • Fax: 520-621-8899 • uap@uapress.arizona.edu • www.uapress.arizona.edu • Classic book on adobe construction