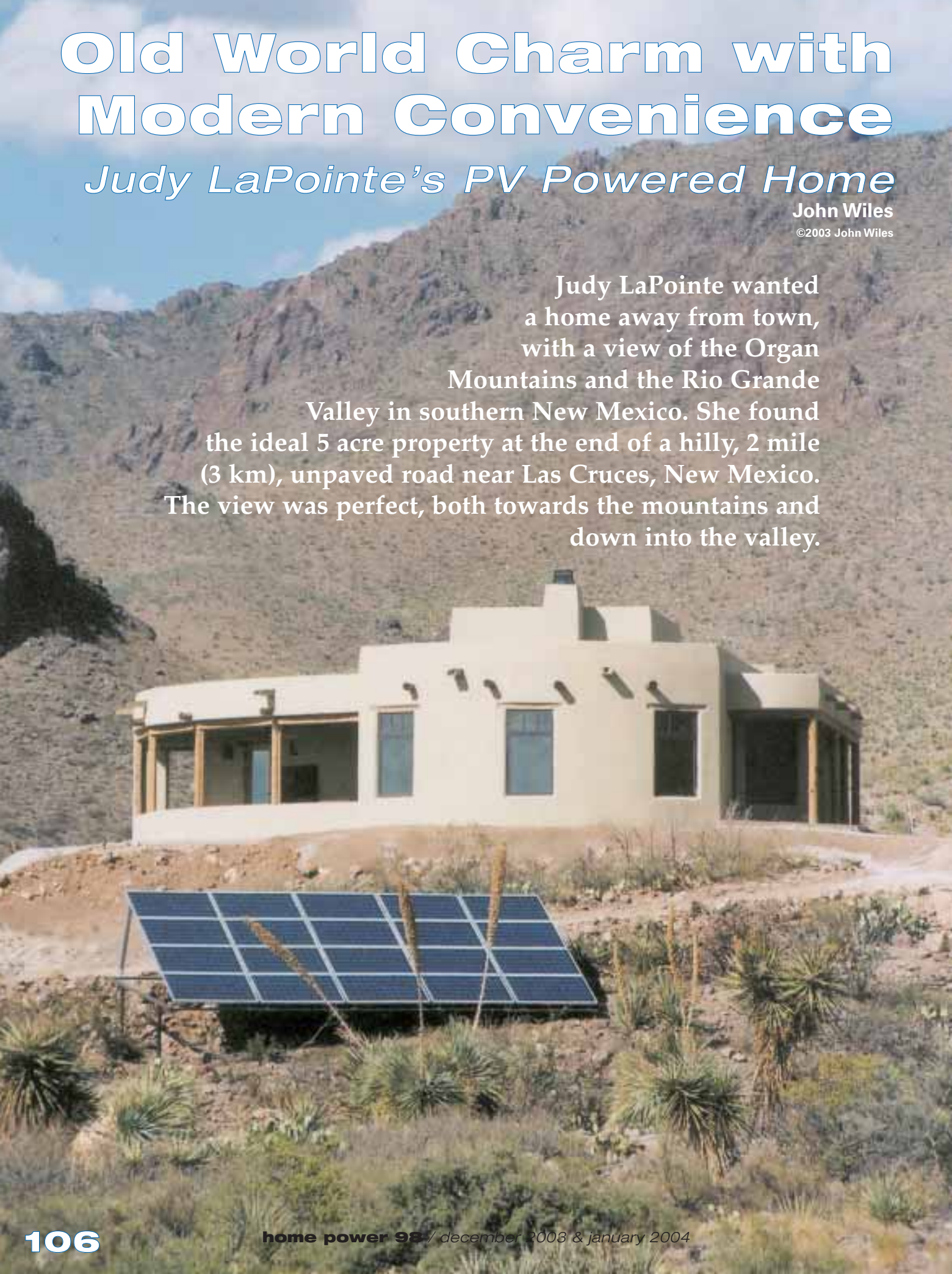
Old World Charm with Modern Convenience

Judy LaPointe's PV Powered Home

John Wiles

Judy LaPointe wanted a home away from town, with a view of the Organ Mountains and the Rio Grande Valley in southern New Mexico. She found the ideal 5 acre property at the end of a hilly, 2 mile (3 km), unpaved road near Las Cruces, New Mexico. The view was perfect, both towards the mountains and down into the valley.



Judy LaPointe in front of the PV power panel.

Judy's pueblo-style home is about 1,800 square feet (167 m²), plus a two-car garage, and is made with Perform Wall. Perform Wall is made of 85 percent recycled Styrofoam and 15 percent Portland cement. It looks and stacks like long cinder blocks (10 feet long by 10 inches wide by 15 inches high; 3 m x 25 cm x 38 cm), and has cores filled with rebar and concrete. The 10 inch Perform Wall has a laboratory tested (real) R-value of about 11. The high thermal mass due to the concrete mixture and concrete core may yield a higher effective or dynamic R-value that may be as high as 30 in some climates.

The inside walls of the home are plastered and the outside walls are covered with stucco. This construction is quite solid, has a four-hour fire rating, is very quiet inside, and is insect and rodent proof.

Traditional & Contemporary

The house, designed and built by architect and builder Colleen Boyd, has traditional and contemporary features. A recycled basketball court floor was laid over the concrete slab in portions of the house for a beautiful and durable hardwood floor. Southwest-style ceramic tiles cover the rest of the floor. A *kiva* (Native American) fireplace, and high *vigas* (wooden beams) supporting an exposed wooden ceiling, coupled with restored antique doors, complete the great room. An enclosed porch has tiles, with a rustic ceiling of *latijas* (small sticks).

A modern kitchen (with a tin plate ceiling), two bathrooms, and a radiant floor heating system ensure comfort and convenience. The propane range is a Pro 30G by Premiere-Peerless, and uses a low-power electronic spark system to light the oven and burners. Most of the electrical appliances are Energy Star rated. Manual switches are installed on the satellite receiver, VCR, and other devices that represent significant phantom loads.

The radiant floor system uses DC circulating pumps rather than AC zone valves, and uses very little energy from the PV system. Potable hot water is heated by a Heliodyne GOBI solar hot water collector with a separate PV module for the circulating pump. The boiler used for the radiant floor heating system provides backup. A special controller provides low-energy AC and DC control to the boiler and circulating system. High quality, low-E windows are used throughout the house. The cooling system is set up for either an evaporative cooler (swamp cooler) or central air conditioning.

The potable water and radiant floor system components live in the garage.

Electricity & Water

When Judy bought the site, there was no electricity or water on the property. Utility lines were 0.5 miles (0.8 km) away, and the local utility wanted more than US$35,000 to provide electricity to the property on overhead lines. These poles and lines would spoil the magnificent view of the mountains. The utility was hesitant about even quoting the cost of underground service, which would involve trenching, blasting, and encasing the lines in concrete. Judy LaPointe opted to have a photovoltaic (PV) system installed to provide for her electrical needs. She asked me to design the system and supervise the installation.

Wells in the area are 800 feet (244 m) deep, with the water rising to about 700 feet (213 m). A well and 1.5 hp centrifugal pump would cost about US$20,000 or more. Judy elected to install a 1,700 gallon (6,435 l) storage tank and have her water hauled in by truck from a source about 3 miles (5 km) away. A Dankoff positive displacement pump, operating at 24 volts DC, was selected to pressurize the system and serve as a transfer pump to fill the storage tank.

PV System Design

The 3,300 watt PV system and the basic design and system schematic for this project were presented in *Code Corner* in *HP94.* The detailed code-required electrical calculations were described in *Code Corner* in *HP95.*

Twenty, Sharp NE-Q5E2U, 165 watt PV modules are connected at 48 volts in two sets of ten modules on a fixed ground mount, tilted at about 30 degrees from the horizon. The local latitude is 32 degrees north. Each set of ten modules is combined to a single source circuit in a Xantrex TCB-10 combiner box mounted on the array supports. The two source circuits from the PV array are connected to two RV Power Products Solar Boost 6024H maximum power point tracking charge controllers.

Sixteen, Trojan L-16HC batteries with Hydrocap recombiner caps are used for 24 volt storage, and are installed in sets of four in heavy-duty polyethylene toolboxes connected by conduit. A Xantrex SW4024 inverter is used for AC electricity for most of the house. An Onan Marquis Platinum 6.5 KW generator runs on propane and supplies backup as needed. The 24 volt battery bank is tapped at 12 volts to start the generator. DC electricity at 24 volts is used for the pressure pump and the radiant floor circulating pumps.

The original system design started with 1,800 watts of PV modules, but recent module cost reductions allowed the PV array to be increased to 3,300 watts without significantly exceeding the overall budget. The added output from the array makes it possible to consider putting in conventional air conditioning and a well with a submersible pump at a later date. Adding refrigerated (traditional, compressor driven) air conditioning may be desirable to cope with the windy, spring months when pollen and dust may pose allergy problems.

With the automated features built into the charge controllers and the inverter, the only routine maintenance will be adding water to the batteries every month or so. The Hydrocaps will minimize that watering need, since they return water to the batteries via the catalytic action of recombining the escaping hydrogen and oxygen gas produced when the battery is charged. Oil and filter changes will be required on the generator, but use is expected to be less than 100 hours per year, so this maintenance will be infrequent.

Grounding & Lightning Protection

Code-required grounding is accomplished by a main grounding electrode consisting of a 120 foot (37 m), bare, #4 (21 mm^2) copper conductor embedded in the concrete footing beneath the slab. Only a 20 foot (6 m) length is required to meet *National Electrical Code* (*NEC*) requirements. The additional length was used to provide a better ground for lightning protection in this very dry, rocky area.

Two, supplementary, 8 foot (2.4 m) ground rods were to be driven at the array location and tied to the equipment-grounding conductors that ground the module frames and the array mounting structure. The rocky terrain prevented driving them in vertically or at a 45 degree angle, so they were installed horizontally in trenches 30 inches (76 cm) deep. These ground rods, along with the concrete encased mounting poles for the array rack, make up a

La Pointe System Costs

Item	Cost (US$)
20 Sharp NE-Q5E2U Modules, 165 W	$13,200
Onan Marquis Platinum generator	4,170
Xantrex SW4024 inverter	3,200
16 Trojan L16HC batteries, w/ boxes, cables, & terminals	3,115
5 Power Fab module racks	1,250
2 RV Power Products SB6024HDL controllers & display	1,050
Conduit	650
Rack support structure	500
Electricity & data cables	500
Misc. hardware & supplies	500
2 Xantrex TCB-10 PV combiner boxes	440
Generator controls	341
Xantrex SWRC/50 remote display	290
Xantrex DC-250 battery disconnect	280
6 Delta LA302 surge arrestors	270
Grounding rods & cables	250
Xantrex TM500 battery monitor w/ shunt	225
2 RV Power Products SB50RD25 remote displays	190
Heinemann 175 amp PV main breaker	175
2 House interface enclosures, 20 x 20 x 8 inches	150
System labels	125
Xantrex SWBC conduit box	80
30 ILSCO grounding lugs & screws	75
2 Heinemann 75 amp CD PV input breakers	70
200 Module USE-2 interconnect cables	56
3 NSI PL4-4 connectors	51
2 RV Power Products 930-0022-20 battery temp sensors	50
Xantrex DCBB ground block	45
Xantrex battery temp sensor	35
Plywood back panel	32
20 Cable clamps, rubber/stainless	30
White enamel paint	30
Square D QO612L100S inverter bypass enclosure	25
Square D QO270 bypass breaker	25
Square D QO170 bypass breaker	25
20 Littelfuse TCF10 fuses, 10 amp	24
12 Heat shrink tubing	15
Square D QO2DTI interlock bar	15
Square D P7GTA ground bar	6
Total	$31,560

Technical Specifications

System Overview

System type: Off-grid PV

Location: Las Cruces, New Mexico

Production: 350 AC KWH per month average

Photovoltaics

Manufacturer and model: Sharp NE-Q5E2U

Number of modules: 20

Module STC wattage: 165 W

Module nominal voltage: 24 VDC

Array STC wattage: 3,300 W

Array nominal voltage: 48 VDC

Array combiner box: Xantrex TCB-10 with 10 A fuses

Array disconnect: Xantrex DC250 enclosure with one 75 A breaker for each subarray, and one 175 A main PV breaker

Array installation: Power Fab DP-RGM4-SH165 ground-mount, facing due south, tilted at latitude

Charge Controller

Manufacturer and model: Two RV Power Products SB6024 HDL

Features/Description: MPPT, step-down

Inverter

Manufacturer and model: Xantrex SW4024

Nominal DC input voltage: 24 VDC

Nominal AC output voltage: 120 VAC

Battery

Manufacturer and model: Trojan L-16HC

Battery type: Flooded lead-acid

Individual battery specifications: 6 VDC nominal, 390 AH at the 20-hour rate

Number of batteries: 16

Battery pack specifications: 24 VDC nominal, 1,560 AH

System Performance Metering

RV Power Products digital meters on two charge controllers; two remotes in house

Xantrex SWRC remote control for inverter in house

Xantrex TM500 battery monitor in house

Engine Generator

Manufacturer and model: Onan Marquis Platinum

KW rating: 6.5 at sea level; 6.0 as installed

AC output voltage: 120 volts AC

Average annual run time: 100 hours, estimated

Battery row—sixteen L16HCs in four polyethylene tool boxes.

supplementary grounding system for added safety and lightning protection.

A #6 (13 mm^2), bare conductor was attached to each module frame with outdoor-rated, direct burial connectors, and then routed without splicing to the nearest ground rod and to the combiner box for that subarray. A ground rod is also driven at the generator and connected to the generator frame.

In addition to the heavy-duty grounding, each PV source circuit has a lightning arrestor installed at the array end in the combiner box, and at the charge controller end of the circuits between the array and the charge controllers. The AC line from the generator also has a surge suppressor, as does the inverter AC output

Unspoiled View

Judy LaPointe has moved into her new home and is enjoying the view of the mountains and the valley, unspoiled by utility lines. The PV system has supplied all of her electricity this summer, and she expects only minimal use of the very quiet generator this winter. The solar hot water system is working well, and she is anticipating the comfort of radiant heated floors when it gets cold. Great

views unmarred by utility lines, with no worries about rate increases, brownouts, or blackouts—what more could a person want?

Access

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