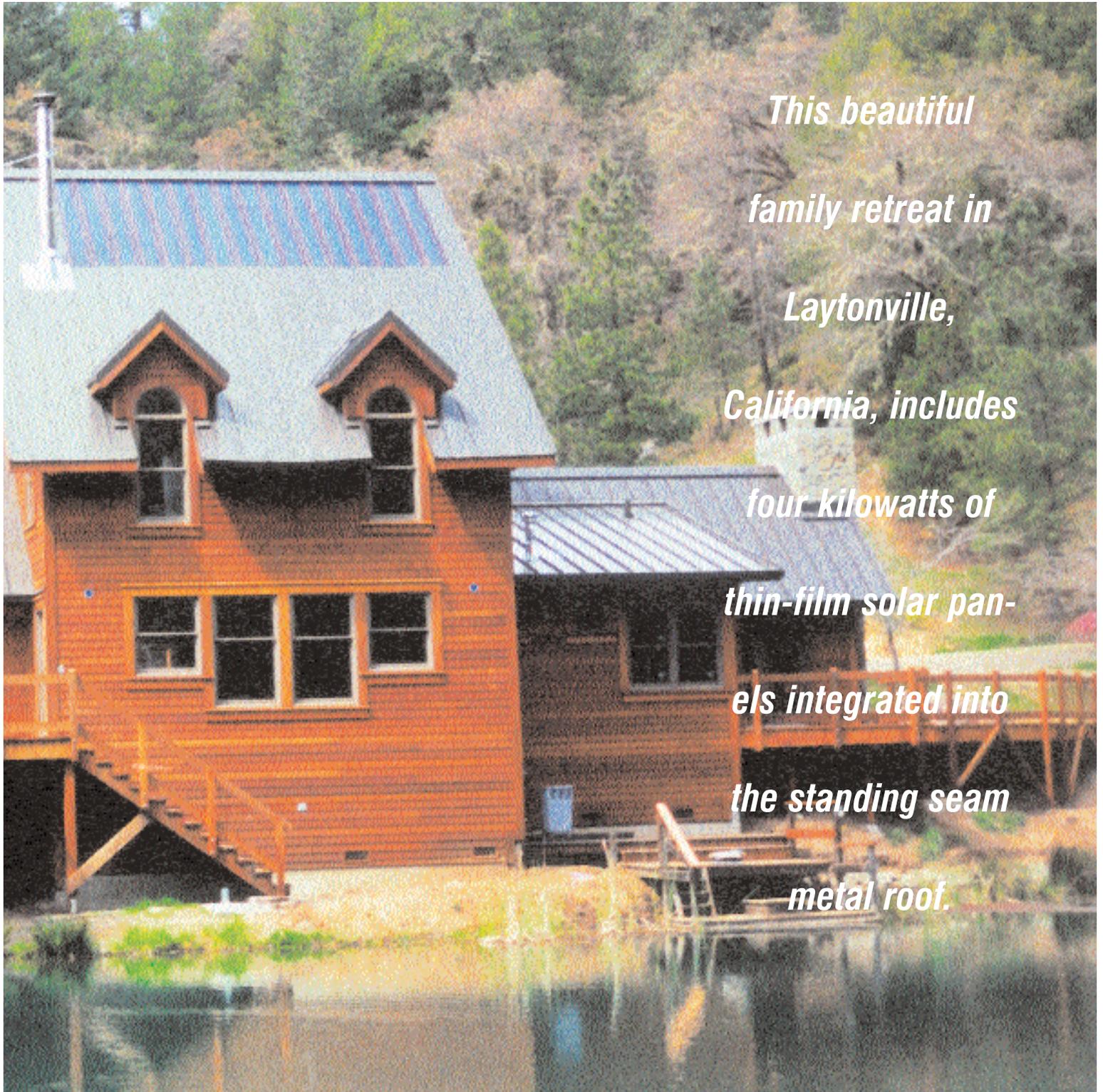


Eliminate Your Electric Bill

GO SOLAR

Be secure

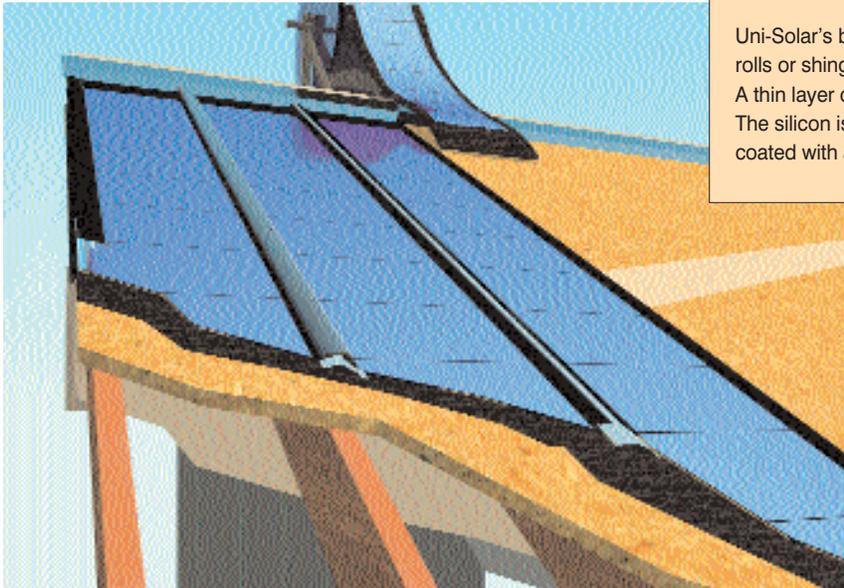
By Terri Suess and Cheryl Long



This beautiful family retreat in Laytonville, California, includes four kilowatts of thin-film solar panels integrated into the standing seam metal roof.

COURTESY DANIEL MARINO

This story is about a choice that can make you, and the world, more secure. It's about how you can install a solar photovoltaic (PV) roof, which will generate your electricity from the free, unlimited supply of sunshine. With your very own solar-electric roof, you'll be protected from rising electricity prices. You'll also be taking a major step away from our national dependence on polluting, unsustainable fossil fuels and dangerous nuclear reactors.



Uni-Solar's breakthrough solar electric roofing comes in rolls or shingles and can be applied directly over plywood. A thin layer of amorphous silicon generates the electricity. The silicon is applied to a stainless steel foil and then coated with a flexible, weatherproof polymer.

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"Solar PV is too expensive," you're probably thinking. Or maybe, "Our neighbors might think solar panels are ugly." Well, advances in solar PV technology are rapidly resolving both of those concerns.

A new kind of PV panel, called thin-film amorphous silicon, is dramatically bringing costs down. Government rebate programs are also cutting homeowners' costs by as much as 60 percent in some states. And in some cases your solar roof can generate excess power during peak daylight hours that you can sell back to your utility company (or use to recharge an electric car or bike). Regarding aesthetics, the thin-film PV panels are now being produced as shingles and standing-seam roofing panels that closely resemble regular roofing materials, so you don't even realize the home's roof is actually a solar-electric power plant!

These new solar-electric systems are called building-integrated photovoltaics (BIPV), because the photovoltaic panels become the roof itself. BIPV installations eliminate the need for expensive racks and trackers, as well as the additional labor costs associated with them.

Ready to sign up? To get started, all you need is a few hundred square feet of south-facing roof that receives full sun all day. You can start small if you want and add more panels later. A solar roof system is actually simple—the right number of panels to produce the number of watts you want, wired to an instrument called an inverter. The in-

verter changes the solar direct current (DC) into the alternating current (AC) used by most household appliances.

Unless you already know a lot about electricity, you will want to find a local so-

lar dealer or contractor to install your system. If possible, obtain bids like you would for any other home construction project. If you want to install the system yourself, or just want to learn as much as possible before you choose a system, we highly recommend the magazine *Home Power*; (800) 707-6585; www.homepower.com. The *Home Power* Web site also lists renewable energy dealers in a database that can be searched by state.

Another excellent resource is www.renewables.com, a Web site written by sustainable-energy pioneer and solar designer Stephen Heckeroth. He estimates a typical home requires about two watts of PV power per square foot of floor area, but that amount can be cut in half, to about

Advantages of Thin-Film Solar PV Panels

Most people know solar photovoltaic (PV) panels as large, heavy, rectangular panels mounted onto a roof or sometimes on a special rack with a tracking system that turns the panels to keep them facing the sun. These older style panels are made of crystalline or polycrystalline silicon modules. In contrast, a new kind of PV panel is now available, called thin-film amorphous silicon. Here's how the new thin-film panels compare to the crystalline modules:

- The older crystalline and polycrystalline modules are fragile and need to be mounted in an aluminum frame between a layer of glass and a stiff-bottom material. In contrast, the newer thin-film amorphous PV panels use a thin stainless steel foil and a weatherproof plastic "elastomer polymer" coating. As a result, thin-film panels are unbreakable, much lighter and less expensive than the crystalline products, since they don't require glass covers and metal framing.
- The crystalline panels lose efficiency and produce less electricity when temperatures rise, while thin-film panels are not bothered by hot, sunny conditions.
- Crystalline panels stop producing electricity when even one portion of a panel is shaded, while thin-film panels still produce energy when partially shaded. Thin-film panels are also more efficient than crystalline in indirect or diffuse light, making expensive tracking systems unnecessary.
- The production process for the thin-film panels requires much less energy (and thus cost less) than crystalline panels.
- When used as roofing shingles, thin-film panels actually are the roof, so you can save the otherwise additional cost of regular roofing. New quick-connect features and large panels are making thin-film roofing faster, and thus less costly, to install.

8 Compelling Reasons to Buy a Solar Roof

1. Personal and national security. The more we tap solar and other renewable energy sources, the less dependent we are on utility giants and nonrenewable fossil fuels. Solar roofs can even be used to charge electric vehicles, which will reduce pollution and decrease our need for foreign oil.

2. Protection against price increases. Electricity prices in many states are increasing. In California a combination of deregulation, population growth, increased consumer demand and construction of fewer new power plants caused electricity costs to skyrocket. Other states are watching similar trends and expect prices to increase in the coming years. With nuclear power plants being decommissioned or phased out because of the high costs and high risks related to nuclear waste disposal, and with the best hydroelectric sources tapped, new sources of electricity are needed. Even though many new gas-fired power plants have been constructed, some analysts see natural gas shortages emerging that will require expensive drilling and pipeline construction. This points to higher natural gas prices rippling across to electricity prices.

3. Rebates. Some states are finally getting serious about supporting renewable energy options. Government rebates, tax credits and grants can cut the cost of your solar roof by up to 60 percent in some areas. To learn what's available in your state, go to the Database of State Incentives for Renewable Energy (DSIRE), www.DSIREUSA.org.

4. Selling back peak power to the grid via net-metering. Net-metering rules and regulations are in place in 34 states, allowing homeowners to run their electrical meters backward when they to send electricity to the grid from a solar-electric rooftop. When the homeowner uses electricity from the grid at night or on cloudy days, the meter runs forward. The monthly bill is based on the net difference.

Distributed electrical generation provides more security for homeowners and for the electrical network (the grid). Generating cleaner, locally produced electricity reduces the load on the grid and can also jump-start the formation of local public utilities. These nonprofit utilities are run by a locally elected board for public benefit, in contrast to investor-owned utilities that are run for private profit.



COURTESY DAN MARINO

5. Global warming reductions. According to the Department of Energy (DOE), electric power plants emitted 40 percent of all carbon dioxide (CO₂) emissions in the United States in 1999, making them the largest single-source contributor to global warming. Fifty-one percent of all the electricity produced in the United States in 1999 was generated by coal-fired plants, yet these plants produced 80 percent of all the CO₂ emissions resulting from electricity power generation. DOE also reports one-quarter of all types of air pollution emissions nationwide are caused by burning fossil fuels (coal, natural gas and oil) to generate electricity.

6. A response to "Not in my back yard" Conventional power plants and transmission lines take years to plan, site and build—and most people do not want them in their back yards. Power distribution systems feeding metropolitan areas are operating near capacity during peak demand periods. Onsite power production via home solar-electric installations, part of a "distributed generation" scenario, offers a positive solution for elected officials seeking to prevent blackouts and brownouts, improve air quality and enhance the economy by producing jobs.

7. A beautiful, distinctive, high-tech, home design element. Technological developments have resulted in more appealing and affordable systems, designed to complement a home's architecture. With Building-Integrated Photovoltaics (BIPV), the solar-electric system is the roof.

8. Supporting the future of solar power. The PV market is worth \$2 billion today, and is expected to grow to \$10 billion by 2010. The annual growth rate of solar PV products has increased by 20 percent annually and is expected to double every three years for the next 20 years. This growth should spur additional investment, contribute to economies of scale in the industry and help make systems even more affordable.



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Types of PV Systems

There are several ways a solar photovoltaic (PV) roof system can be designed:

Grid Connected, without battery backup. In this system, the PV roof is connected directly into the commercial utility grid. When the PV roof generates more electricity than the house needs, the electric meter spins backward, and the power flows into the utility grid. At night or on cloudy days when the PV roof can't produce enough power for the home, the system draws electricity from the grid. (See "About Net Metering," Page 80.) Without batteries, these systems do not provide homeowners power when grid power goes out.

Grid Connected, with battery backup. This is identical to the system above, except it includes a bank of batteries that can be used when the utility grid power goes down. Special switches must be included to assure the home is completely disconnected when the grid power goes down and battery backup is used. While batteries can be installed to supply power when the grid is down, they are expensive and require more maintenance than a simple grid-connected system.

Stand-Alone, Independent or Off-Grid System. In this design, surplus power from the PV roof is stored in a group of batteries, and the system is not connected to the grid. Although the battery component of this system increases the cost and requires more maintenance, a complete off-grid system is usually a competitive choice in remote locations where new and extremely expensive power lines would need to be installed.

one watt per square foot, by using energy-saving appliances, such as compact fluorescent lightbulbs. So let's say you have a 2,000-square-foot home and you've taken full advantage of energy-conserving options. This means a 2,000-watt (two kw) PV roof should be able to satisfy your electricity needs (not counting heating, cooling or hot water—there are better non-electric options for these functions; see www.renewables.com). So what will it cost to install two kw of PV panels?

needs of a small, efficient home. (By the way, "long-term" means a 20- to 25-year warranty; there are no moving parts and these solar PV panels are very durable.) And the great thing is, the more of us who buy solar roofs, the faster the costs of production and prices will come down. All new technologies become less expensive as demand grows and production costs improve. Within the next two to three years, Heckerth predicts the installed costs of thin-film BIPV roofs (see "Advantages of



COURTESY DAN MARINO

Who would ever know this roof is a solar electric power plant?

CURRENT COSTS

Heckerth says a basic PV system in a net-metered grid-connected system (see "PV System Types," left), costs about \$8 to \$12 per installed watt, so a two kw system would come to \$16,000 to \$24,000. But if you are lucky enough to live in a state that offers rebates (see below) that cost can be cut in half to just \$8,000 to \$12,000.

So there it is: Right now it can cost as little as \$8,000 to install enough solar roofing to meet the long-term electricity

Thin-Film," Page 74) will drop to as little as \$6 per installed watt for reroofing projects, and costs could fall to \$5 or less per watt in new homes designed specifically to maximize the advantages of this exciting new technology.

In areas where electric rates are already high, solar PV systems are a pretty good bet at \$8 per installed watt, even without a rebate and without adjusting for future electricity rate hikes or declining costs per PV watt (see "How Much Will Electricity Cost?" Page 79).



The landmark thin-film building-integrated solar roofing project built by the National Association of Home Builders in Maryland in 1996.

GOVERNMENT INCENTIVES

Some states need solar electricity so badly they're not waiting for the costs to come down naturally. They are offering cash rebates and other incentives that will slash the price tag for residential solar roofs by up to 60 percent. More states may join in this year, as policy-makers work to meet increased electricity demand by promoting clean renewables and distributed generation—installing many small power-generating systems close to where the energy is needed. These officials understand people don't want polluting coal plants or dangerous nuclear plants near their homes, and people do not much like living next door to high-tension wires or natural gas pipelines, either.

For information about rebates, loans and grants available in your state, consult the Database of State Incentives for Renewable Energy (DSIRE) at www.DSIREUSA.org, or call your local utility or state energy office. (If your state isn't yet offering rebates, we strongly suggest you get on the phone and make an appointment to have a chat with your state legislators.)

Here are summaries of solar energy incentives available in three leading states: New York, New Jersey and California.

NEW YORK

"In New York state, we are facing an energy crisis that is not going to go away simply because demand is exceeding supply," says Linda Anne Burtis, director of NY Shines, an organization dedicated to educating homeowners about solar and renewable energy systems. "There is a thirst for energy that is difficult to meet, particularly in New York City and Long Island, where the electricity infrastructure is old and pushed to its capacity."

Burtis says New York currently offers some of the best rebates in the country when homeowners purchase residential solar, grid-connected solar-electric systems. "Most people in the industry will tell you that it costs about \$10 per watt to install a solar-electric system on your home without batteries," she said. "In New York State,

In the last three decades, the cost of solar PV panels has dropped 80 percent, while at the same time the efficiency of the panels has more than doubled.



Renewable-energy specialist Stephen Heckerroth driving his electric tractor. He uses solar panels (including those visible on the barn roof in the background) to charge the batteries that power the tractor.

How Much Will Your Electricity Cost in 2026?



COURTESY DANIEL MARINO

Even a south-facing porch can provide homemade electricity.

Nobody knows exactly how much utilities' electricity rates may increase over the 25-year life of a solar roof, but they will certainly increase in most regions, while costs for solar roofing are expected to decline. Here are a few numbers to help you estimate the probable cost benefits of a solar roof:

1. An energy-efficient, 2,000-square-foot home needs about two kilowatts of solar roofing.
2. The cost to install two kw of roof:
Current cost: \$16,000
With rebate: \$8,000 (in some areas)
With predicted cost reductions: \$4,000 to \$6,000
3. Amount of electricity the roof will produce during its 25-year lifetime: **100,375 kwh** (2kw x 5.5 hours/day x 365 days x 25 years)
4. Value of 100,000 kwh from the grid, if average electricity rate for 25-year period was:
8 cents/kWh: \$8,000
20 cents/kWh: \$20,000
40* cents/kWh: \$40,000

*Rates in some areas of California hit 35 cents/kwh in 2001.

when homeowners tap into an array of rebate programs, they can cut that price by almost one-half.”

NEW JERSEY'S CLEAN ENERGY PROGRAM

In New Jersey, small solar-electric systems of fewer than 10 kw qualify for a rebate of \$5 per watt. The rebate covers up to 60 percent of the system costs under a program funded by the state and administered by utility companies. New Jersey also provides a sales tax credit for solar-electric system installations.

By fall 2001, there had been little publicity about this program, with most applicants finding out about it by word-of-mouth. One of the major utilities in the state reported in late August only 16 applications had been processed. Some of the impediments to the program included lack of publicity and early difficulties homeowners had locating solar contractors. Now a short list of utility-qualified contractors is provided to interested homeowners.

CALIFORNIA'S REBATE PROGRAMS

California has myriad state, local and utility-sponsored rebate programs, state property tax exemptions and other incen-



Pam Chang beams from the top of her new thin-film Building-Integrated Photovoltaic (BIPV) roof on her home in Berkeley, California.

tives to help homeowners install solar electric rooftops—and they are being used. Some solar programs in California reported receiving 250 inquiries a week.

The “Emerging Renewable Buy-Down Program” and “Self-Generation Program” both offer rebates of up to \$4.50 per watt or 50 percent off the price of purchasing the system, whichever is less.

The Los Angeles Department of Water and Power (LADWP) offers even more generous rebates as part of an effort to in-

stall 100,000 solar rooftops in the city of Los Angeles by 2010. Under the LADWP program, financial incentives include a maximum \$3 per watt for systems manufactured outside of Los Angeles, and a maximum of \$5 per watt for systems manufactured within the city.

TO FIND A SOLAR ROOF DEALER

The fastest way to learn what rebates are available in your area is to contact a local solar roof dealer. The dealer will know



from the utility grid and the electrical meter runs forward. The net difference between electricity exported to the grid and grid-electricity used forms the basis for the homeowner's electric bill. In many states, net metering is annualized. The utility credits solar electricity produced by the rooftop system during the summer against electricity needed from the grid during the winter.

About Net Metering

Net-metering is a “win-win” for the utility and the homeowner. The utility adds more clean power to its network from a power source located close to demand centers, reducing not only the need to build new plants to meet peak demands but also reducing the load on distribution lines. The process is a win for the homeowner, who doesn't need a bank of batteries to store electricity to power the household at night or during overcast days. Instead the system uses the utility grid as a storage battery.

When the solar-electric rooftop produces more electricity than the household needs (at midday when the family is away at work and school), electricity is sent to the utility grid and the home's meter runs backward. When the household needs more electricity than the system produces (at night), it is drawn

COURTESY STEPHEN HECKEROTH (2)

what's currently available and probably will know if any additional legislation is pending in your state. The dealer can explain, in detail, various solar roofing options and give you a bid on whatever system you choose.

To find a dealer check your yellow pages, state energy office, electricity regulatory agency or local utility. Or check *Home Power* magazine's dealer Web page at www.homepower.org.

MAKING A DIFFERENCE

"Each of us can decide how to make our own contribution to reduce our impact on the Earth," says Bill Lord, who lives with his wife, Debbi, in a custom-built solar house in southern Maine

"Ours happens to have been investing in a solar house. We have found that there can be a free lunch and dinner, but you need to pay for breakfast," he says, referring to the initial planning and investment needed to integrate solar technologies into one's home.

The Lords integrated passive solar design principles, solar thermal and solar electric technologies into their custom-built home in Maine more than five years ago. Since then they have been reaping the benefits of free sunlight that falls on their roof every day, reducing their utility bills to zero.

Working with Solar Design Associates of Harvard, Massachusetts, the Lords built their home to include super insulation, energy-efficient appliances, and a passive-solar design that welcomes the warm sun in the winter and shades the interior of the house in the summer. This reduced the energy load of the home while offering comfort levels exceeding those found in a comparable conventional home.

With a full south-facing solar rooftop comprised of a solar thermal system for radiant heating and hot water, and a solar-electric system to produce electricity, the home's solar systems provide nearly all the energy the Lords need.

"It takes some planning, but it is possible to make these investments incrementally to reduce the cost of living on Earth," says Lord. "The beauty of solar electricity is it is modular, so you can install some to meet a portion of your electricity needs and then expand the system as your budget allows." ☺

If this story inspires you to buy a solar roof, please send us a Report from the Field after your system's up and running.

—MOTHER

Learn More about Solar Power

Solar Products Manufacturers

These sites provide useful information about solar energy in general, about specific products and, in some cases, distributors and installers.

Bekaert ECD Solar Systems
(Uni-Solar thin film roofing)
ovonic.com/unisolar

BP Solar
www.bpsolar.com

Evergreen
www.evergreensolar.com

Astropower
www.astropower.com

Siemens Solar
www.siemenssolar.com

Kyocera Solar
www.kyocerasolar.com

Atlantis Energy Systems
www.atlantisenergy.com

PowerLight
www.powerlight.com

On the Bookshelf,
Pages 119 and 120

The New Independent Home
by Michael Potts
\$19.95

The Natural House
by Dan Chiras
\$35

General Information

**National Renewable Energy
Laboratories**
www.nrel.gov

**Energy Efficiency and Renewable
Energy Network**
www.eren.doe.gov
(800) 363-3732

**A Consumer's Guide to Buying a
Solar Electric System**
www.nrel.gov/ncpu/pdfs/26591.pdf

American Solar Energy Society
www.ASES.org
(303) 443-3130

Solar Today (publication of ASES)
www.solartoday.org
(303) 443-3130

California Energy Commission
www.energy.ca.gov

**Center for Renewable Energy and
Sustainable Technology (CREST)**
www.crest.org

**Real Goods Institute for Solar
Living**
[www.realgoods.com/renew/intertie/
index.cfm](http://www.realgoods.com/renew/intertie/index.cfm)

Florida Solar Energy Center
www.fsec.ucf.edu

**The Solar Electric Power
Association**
www.solarelectricpower.org

