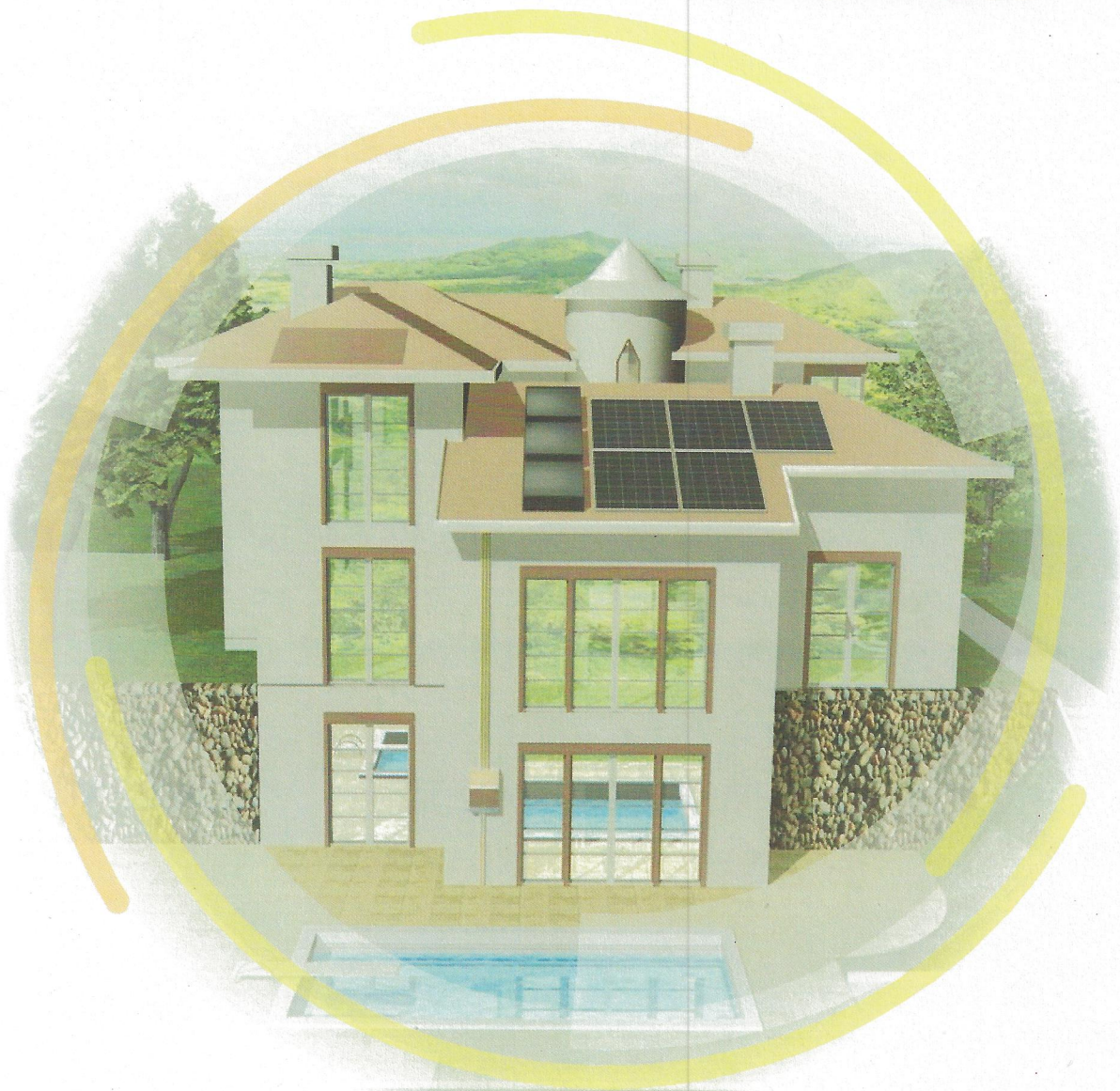


# Going Solar

## A Homebuilder's Guide to



Why go solar in your homes? Simply put, solar makes sense. When you choose solar options, you

- Differentiate yourself from other builders
- Sell your homes as much as two times faster (compared to homes without green options)
- Save money with shorter sales cycles and less inventory
- Complement your intriguing designs and high-quality construction
- Enhance your corporate image as an environmentally responsible builder.



**U.S. Department of Energy**  
**Energy Efficiency**  
**and Renewable Energy**

Bringing you a prosperous future where energy  
is clean, abundant, reliable, and affordable

## Using This Guide

As a homebuilder, chances are you're already considering solar options for your upcoming projects. You know it's the right thing to do for the planet. You know that solar options are readily available on today's market. You know that the price of solar continues to drop as technology advances rapidly and rebates and incentives become commonplace. And because your customers tell you they want green features in their homes, it won't surprise you to learn that homes with solar options **sell as much as two times faster** than homes without.

But whether you build solar into your homes from the outset or make them ready for solar down the road, you need to understand what's involved. You need information. You need to know where to find that information and how to tailor it to your location and circumstances. You need to know how to assemble your solar team and to understand what you should expect from each of those professionals.

That's where this guide comes in. *A Homebuilder's Guide to Going Solar* brings together

information from various studies of builders who have successfully integrated solar into their operations (see, for example, Volume 6 of the *Building America Best Practices Series, High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems* in the Exploring Additional Resources section). We've augmented this information through conversations with builders, solar installers, and other solar professionals.

We view this guide as a work in progress. As you explore ways to go solar and gain experience working with solar installers, we welcome your feedback. Send a message to [solarbuilderfeedback@nrel.gov](mailto:solarbuilderfeedback@nrel.gov) and tell us about your experiences.

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## Discovering the Types of Solar

*The SWH system on the White House uses solar absorber plates from SunEarth, Inc., in a low-profile, site-built, building integrated installation designed to blend with the historically appropriate copper standing-seam roof.*

**Solar water heating (SWH)** systems are designed to heat water for residential use. These systems typically consist of collectors, a controller, a storage tank, a delivery system, and—in most parts of the country—some sort of freeze protection. These components can be combined in different ways. There are two types of systems: active, which have circulating pumps and controls, and passive, which don't. Most SWH systems require a well-insulated storage tank, which has an additional outlet and inlet

connected to and from the collector. SWH systems are both reliable and economical, usually paying for themselves in a few years.

Some manufacturers have developed packaged systems and streamlined installation processes that make it much easier to incorporate SWH into your building schedules.

**Solar electric (photovoltaic or PV)** systems are made up of modules containing PV cells that generate direct current (DC) electricity when exposed to sunlight. An inverter converts the DC power to the alternating current (AC) electricity that's necessary to power the home. These PV systems have been tested to rigorous standards by public and private organizations. They have no moving parts, require almost no maintenance, and last for decades. A solar energy system will have nearly the same output in year 25 as it did on day 1.

Today's PV systems come in a range of efficiencies and configurations. PV systems with modules that are mounted on top of existing roofing are still the most common, but building integrated photovoltaic (BIPV) systems are gaining in popularity. In a BIPV system, the modules do double duty—they generate electricity AND can replace traditional building materials such as roof shingles and window awnings.



Courtesy of Solar Design Associates/PIX15609

# Understanding Solar Economics

The costs of solar energy systems have decreased greatly during the last 15 years. And solar systems are eligible for a number of federal, state, local, and utility financial incentives that can reduce the up-front cost by 40% to 50% or more. If you buy in bulk—as you do when you're building a neighborhood of homes—you may receive wholesale discounts, too.

## LANDMARK LEGISLATION MAKES SOLAR SIGNIFICANTLY CHEAPER

In October 2008, historic legislation for the solar industry was signed into law, making solar significantly cheaper. Experts believe that the *Emergency Economic Stabilization Act of 2008* paves the way for dramatic growth in the U.S. solar market. Some studies project that solar energy will supply more than 28 gigawatts (GW) of electricity by 2016—enough to power more than 7 million homes.

Here are the law's key provisions:

- Establishes a 30% tax credit for all residential solar electric installations for 8 years (for property placed in service after December 31, 2008).
- Allows utilities to benefit from the credit.
- Allows Alternative Minimum Tax (AMT) filers, both businesses and individuals, to take the credit.

The law is expected to create about 440,000 permanent jobs and spur roughly \$325 billion in private investment in the solar industry.

### Are You in the Solar Ballpark?

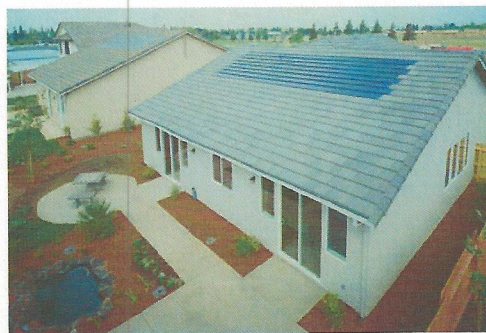
You can use a simple equation to obtain a ballpark estimate of solar electric system costs. Note that the equation assumes that you're looking to maximize the south-facing roof area in the proposed home. The average energy usage per square foot is 10 watts (W)/square foot (ft<sup>2</sup>), and the average retail cost of a typical solar system (installed) is \$8/W. Finally, this equation calculates costs BEFORE any rebates, incentives, or wholesale discounts are applied.

(Number of homes) × (south-facing roof area in square feet per home) × (10 W/ft<sup>2</sup>) × (\$8/W) = estimated total retail installed cost

You may also be eligible to take advantage of the new tax credit and subtract 30% from your estimated total retail installed cost.

### INVESTMENT IN SOLAR HELPS SELL HOMES

Solar homes sell at up to twice the rate of their conventional counterparts. Although the best



Courtesy of Premier Homes/PIX 15610

All the homes in this entry-level home development near Sacramento, California, include a BIPV system as a standard feature.

data to date is from California, solar-equipped homes are proving popular in other parts of the country, even in depressed housing markets.

SWH systems cost roughly \$2,000 to \$6,000, depending on the size and type of the system.

Solar electric systems cost approximately \$8/W installed or about \$24,000 for a 3-kilowatt (kW) residential system. The costs vary depending on the system size and rating; the choice of a roof-integrated system or a system mounted on top of an existing roof; and the manufacturer, retailer, and installer.

The table shows the estimated costs after rebates and incentives for a 3-kW solar electric system at the national average installed cost (\$8/W).

Cost of Installed 3-kW Solar Systems after Rebates and Incentives\* (minimum 300-ft<sup>2</sup> roof area)

	Seattle, WA	San Diego, CA	Columbia, MO	Denver, CO	Concord, NH	Tampa, FL
Initial Cost (\$)	24,000	24,000	24,000	24,000	24,000	24,000
Cost after Incentives (\$)	22,000	16,500	22,500	13,500	24,000	12,000
Cost after Federal Tax Credit (30% of installed cost)	15,400	11,550	15,750	9,450	16,800	8,400
Utility Incentive \$	0	0	1,500 (0.5/W rebate)	10,500 (2/W rebate, plus 1.5/W energy credit)	0	0
State Incentive \$	2,000 (max incentive/year)	7,500 (2.5/W one-time buydown)	0	0	0	12,000 (4/W rebate, max 20,000)
Local Electricity Rates (¢/kWh)	6.1	12.1	7.4	9.1	13.6	9.5
Increase in Property Value (\$)	2,580	9,060	4,200	5,820	7,440	5,820
Average Annual Utility Savings (\$)	216	761	353	489-811	624	489
Greenhouse Gases Saved (tons)	62	92	75	81	68	78

\*All costs are in U.S. dollars unless otherwise indicated. This information was compiled to provide a general comparison of the costs and benefits of a 3-kW solar system on a single home. Consult [www.dsireusa.org](http://www.dsireusa.org), your local utility, and a local appraiser for specific data in your area.

In addition, builders' experiences indicate that **making solar equipment standard is more profitable** than offering it as an option because it simplifies the home buyer's decision-making process, which in turn **streamlines your sales process**.

In one California development, for example, all 306 homes included SWH systems and 120 homes included PV systems.

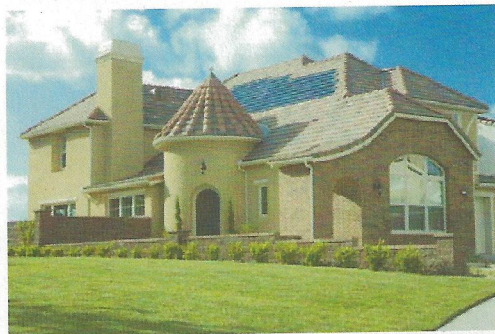
### NEW FINANCING TOOLS BOOST SOLAR

**Power purchase agreements (PPAs)** are relatively new on the solar horizon. Under these legal agreements, which can last from 5 to 25 years, customers purchase solar power from a specific energy provider at pre-agreed rates that are often equal to or less than market rates. When the agreement is in place, the PPA provider (typically a solar company or utility) secures funding for the project, then installs and maintains the solar equipment and monitors its energy production. Customers pay only for the power generated by the facility—not for the solar equipment or the installation. Experts believe that the PPA approach has been instrumental in bringing a broad range of new customers to the commercial solar industry in the past year, and that it can maintain growth and diversification in solar installations.

### PV + SWH + ENERGY EFFICIENCY = SUBSTANTIAL SAVINGS FOR THE HOMEOWNER

Buying a new, energy efficient home that incorporates SWH, PV, or both as standard features and rolling the cost into the mortgage increases the homeowner's monthly payment only slightly.

In addition, making the solar investment with energy efficiency upgrades often results in an immediate positive cash flow for the home buyer. In other words, **the higher mortgage payment is offset by lower utility bills from day 1**. Some mortgage products even credit a home's energy efficiency in the mortgage itself, giving borrowers the opportunity to stretch debt-to-income qualifying ratios on loans to qualify for a larger loan amount.



Shea Homes included BIPV as standard equipment on homes in this California development.

Courtesy of GE Energy/PIX15614



Courtesy of BP Solar/PIX15612

In some parts of the country, notably parts of California, solar homes sell more quickly than other homes.

Based on an analysis of utility bills, energy costs in a California development of solar homes were 14% to 54% lower than those of a comparable community.

Solar homes with energy efficiency upgrades also have higher resale values and appreciate more quickly. According to the *Appraisal Journal*, home value increases \$20 for every \$1 reduction in annual utility bills. A solar energy system that saves \$200 per year, then, would also add \$4,000 to the value of a home.

### LOOKING BEYOND THE ECONOMICS

Costs and profitability will always be the bottom line for your business. But you should also consider the more intangible—but just as compelling—reasons to choose solar.

Studies indicate, for example, that solar homeowners are more satisfied, and satisfied homeowners recommend their builder to others twice as often as neutral owners. Even when neighboring houses are energy efficient, consumers in communities that include solar equipment are more satisfied with their home purchases.

And home buyers are increasingly concerned about the environment, national security, and health, which in turn sharpens their interest in solar energy. In a recent survey conducted by Japan's Sharp Electronics Corporation, eight of ten Americans want builders to offer solar power as an option for new homes. Half of those surveyed said they would pay up to 10% more for a solar-equipped house.

Heating water and generating electricity with the sun help homeowners **manage the risks associated with future energy price hikes**. Part of the cost of a home equipped with solar systems includes a locked-in energy price over the life of the solar equipment. After all, the "fuel"—sunshine—is free.

What does all of this mean to you and your customers? That there's never been a better time to install solar!

## Selling Solar

By now, you're likely to be sold on solar. Next, you'll want to educate your staff (especially your sales staff), your subcontractors, and your customers about the benefits of solar. We've compiled the following sales tips from builders who've had success promoting the advantages of solar.

Use walk-throughs, models of house features, and model homes as education and sales tools. Hand out summaries of sample solar systems for browsers to examine. If net metering makes it possible in your area, let visitors watch the electric meter spin backward. It's a proven crowd pleaser!

Hold training sessions for consumers and tradespeople. Generate traffic through your models and educate potential customers at the same time. Manufacturers and installers often have excellent sales and training tools that they will share with their customers.

Show your customers and sales professionals that lower utility bills can offset a higher mortgage payment.

Hand out publications or CDs detailing the benefits of energy efficiency and solar technologies. Reprints of articles about the benefits of going solar—especially if they mention you or your company—are powerful sales tools. Include this information on your Web site, too.

Advertise! Energystar.gov has information about designing advertising. Emphasize your energy efficiency and solar features to set you apart from the competition.

Go for free publicity. Offer your expertise to print, radio, and TV journalists as an interviewee. Issue press releases and invite the press to your events. Editorial mentions are often far more powerful publicity than paid ads. And don't forget to publicize your affiliations with green building and solar organizations.

**Offer energy efficiency guarantees.** Some builders guarantee that their customers' utility bills will stay below a prescribed maximum. See [www.eflhome.com](http://www.eflhome.com) for an example.

## Assembling Your Solar Team

Now you're ready to pull together your solar team. Consult the sidebar for tips on choosing the MVP on your team—a certified solar energy system installer. The importance of making a good choice here can't be overstated.

Once you've selected your MVP, that professional should run with the ball in a number of areas. You'll know right away if you have indeed chosen a valuable team member, because your installer should demonstrate experience and initiative in these areas from the outset.

Specifically, your solar installer should

- **Begin handling rebates, permits, training, and utility interconnection.** Your installer should already be familiar with DSIRE ([www.dsireusa.org](http://www.dsireusa.org)). This database, organized by state, contains regularly updated information on federal, state, local, and utility incentives that promote renewable energy and energy efficiency.
- **Consult a tax professional** if necessary for financial matters, including rebates and incentives.



Courtesy of Sam Garett/PX15624

*For some homeowners, solar systems are an indication of their commitment to environmental protection and national energy security.*

- **Check with your local utility** about specific requirements for connecting to the grid (interconnection and net metering). Some local electric and gas utilities also offer rebates or incentives for installing solar equipment. Your solar installer should already have or be able to quickly establish a relationship with the utility.
- **Talk with city officials**, who will be able to outline the local code requirements for solar. Some local government and utility personnel offer accelerated building permit processing and other green building and solar incentives.
- **Recommend and get in touch with a manufacturer** for specific costs, including bulk discounts.

In addition, any green building and solar organizations in your area will help you to identify available resources and training, along with certification requirements and processes if applicable. A study released by the American Institute of Architects in 2007 reports that nearly 40% of the U.S. population lives in a city with a green building program. In some locations, green builders and affiliated businesses have joined forces to share best practices.

## Finding Your Installer

Teaming up with a reliable, experienced solar installer is the single most important strategy for solar success.

Do your homework and choose an experienced local installer. Check references and professional certifications, credentials, and affiliations for the solar companies you're considering. Ask the installers what training courses they've taken or certifications they've earned.

Local green building, trade, or solar organizations can also be valuable resources for finding established solar installers. Talk to other building professionals in your area. Patterns will emerge identifying the most professional and reliable solar companies.

In addition, check with community colleges and manufacturers for certification and/or training programs for solar professionals.

Finally, many local and national organizations maintain databases or membership directories of solar professionals.

The Web is home to a wealth of resources to help you find your solar installer. Please see the Exploring Additional Resources section on page 8 for details and links.

# Selecting Your Site, Planning, and Breaking Ground

Whether you intend to install solar as a standard feature or offer it as an option, following a few simple steps will help to ensure that your solar installations are successful.

Once you've found your solar installer, turn to this professional first to help you with your planning. Because it's always cheaper to tweak the energy design of a home before construction begins, have your installer model your project for performance, system sizing, and economics. You should expect your installer to have access to and be expert with these models, but consult [www.eere.energy.gov/buildings/tools\\_directory](http://www.eere.energy.gov/buildings/tools_directory) for free and available-for-purchase energy models and estimators if necessary. These models can calculate how much energy a given home requires and how much it will cost to obtain some or all of that energy from solar equipment. Computer models take a number of other important variables into account as well, including rebates, tax credits, and other financial incentives; and the current cost of electricity and natural gas or propane.

**Introduce the solar installer(s) and related subcontractors.** Ideally, get all the related subcontractors in the same room for a planning session.

**Plan your site.** This is one of the most important aspects of a solar project. Your team should work to orient streets and houses to make the most of the available solar resource.

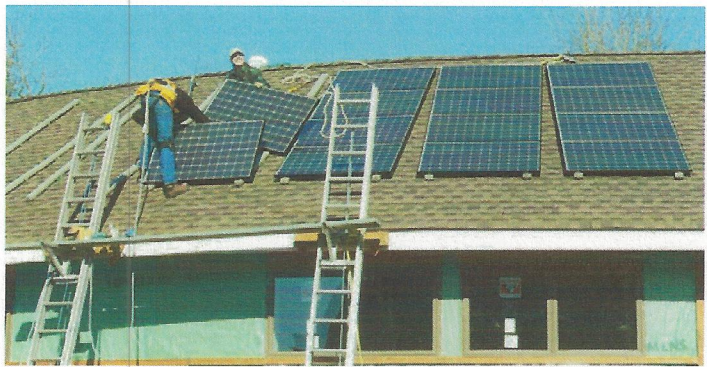
**Plan to keep solar roof areas unobstructed.** A south-facing orientation with no shade during the peak solar window (approximately 9:00 a.m. to 3:00 p.m.) is best, but a solar system will perform adequately at a less than optimal orientation and tilt.

**Carefully assess present and future shading.** Shading by maturing trees or nearby construction is far more likely to affect solar system



*Although a south-facing orientation is best, solar systems will perform well at different orientations, as this Ohio home demonstrates.*

Courtesy of Decker Homes/PIX15617



Courtesy of Sam Garst/PIX15616

performance than less-than-optimal orientation and tilt.

**Always plan for optimal energy efficiency at the outset.** It's the most cost effective way to reduce utility bills and improve comfort, and the less energy a house requires, the smaller and less expensive the solar equipment will be.

**Require quality assurance inspections.** Inspections greatly reduce failure rates with solar thermal and solar electric systems, just as they do with all other energy technologies.

**Spray paint or otherwise mark collector areas on the roof to alert other trades.** Roof vents, chimneys, gables, or other obstructions should all be located to the north of the planned solar installation.

**Install collectors after the roof and painting are completed if possible.** If this isn't possible, protect them from overspray with plastic sheeting, and make sure to assign someone the responsibility for removing the plastic.

**Place solar equipment parallel with and close to roof decks.** Careful design and installation can reduce both aesthetic impact and wind loading.

**Take advantage of the dual purpose of BIPV systems.** BIPV products offer the convenience and economy of functioning as a building material—usually roofing—AND generating electricity.

**Install only SWH systems that are certified by the Solar Rating and Certification Corporation (SRCC).** Effective January 1, 2009, SWH systems with a minimum efficiency rating and an OG-300 certification from the SRCC will be eligible for the ENERGY STAR® label. The SRCC provides independent certification of solar water and swimming pool heating collectors and systems. Some states (Florida, for example) require their own certification.

**Install the simplest SWH system that will work in your climate.** In most areas of the United States, SWH must incorporate freeze protection.

*Puget Sound Solar has NABCEP-certified installers on its staff.*

# Making Houses Solar-Ready

If you decide to make your homes solar-ready, you'll save your customers time and hassle later when they decide to install solar equipment. A solar-ready house will be easier to sell if energy prices rise and as consumers become more aware of the environmental and climate consequences of various energy technologies. By making a home solar-ready, you're giving your customer an opportunity to increase the value of their investment. Here are some important considerations in making a home ready for solar.

- ✓ Design and plan the home as if you were going to install the solar equipment during construction.
- ✓ Consider paying a local solar professional as a consultant to help with this process.
- ✓ Leave unobstructed roof space for the collectors and/or array.
- ✓ Plan ahead with various trades to avoid shading from vents and chimneys.
- ✓ Clearly label all end points of wires or pipes.
- ✓ Clearly label the location of structural reinforcements.
- ✓ In the homeowner's manual, document the intended placement for future solar equipment, including arrays, collectors, tanks, inverters, and switches.

To prepare a home for PV . . .

- ✓ Design space for inverters and disconnects near the main service panel.
- ✓ Leave space in the main service panel to handle a power input breaker.
- ✓ Pre-wire or install empty metal conduit from the roof to near the main service panel.
- ✓ Install conduit from the inverter location to the main service panel.

*This Massachusetts development features PV systems on each house as standard equipment.*



Courtesy of R. Carter Scott/PIX15619



Courtesy of Namaste Solar Electric/PIX16520

- ✓ Leave space in the breaker box for a double-pole 30 A breaker (solar electric feed).
- ✓ Provide a vertical wall area to mount an inverter in the mechanical area of the house.
- ✓ Minimize the distance (wire run) from the array to the inverter.
- ✓ Install an electric disconnect switch for the future solar electric system.
- ✓ Leave a copy of the wiring notes and diagrams in the electrical panel.
- ✓ Post a sign or label on the electrical panel door indicating that the home is SOLAR READY.
- ✓ Include system schematics, manufacturer's literature, installer's contact information, and any other pertinent paperwork in the homeowner's manual.

*Retrofitting solar equipment to an existing house is easier and less disruptive if the original builder makes the house solar-ready.*

And to get ready for SWH . . .

- ✓ Install 3/4" copper pipe for both cold and heated water from the roof to the location of the hot water storage tanks.
- ✓ Cap the pipe and install so that it is accessible on the top.
- ✓ The bottom should dead end until the solar system is installed.
- ✓ Insulate the pipe.
- ✓ Run sensor wires parallel to the copper pipe if required.
- ✓ Install electric cable if required for a future pump.
- ✓ Leave space near the water heater for hot water tanks, valves, pumps, heat exchangers, expansion tanks, and other needed equipment.
- ✓ Include system schematics, manufacturer's literature, installer's contact information, and any other pertinent paperwork in the homeowner's manual.

# Seeing Solar In Action

Builders across the United States are making breakthroughs in the design and construction of energy efficient homes. Working with their solar partners, these builders streamlined installations and demonstrated energy effectiveness along with consumer acceptance. Here are but a few examples.

- **Pleasanton, California**—Centex's Avignon development is the first all-solar, energy efficient community built in Alameda County. The 3.5-kW PV systems use SunPower's integrated SunTile®, which matches the dimensions of the cement roof tiles it replaced to blend in seamlessly with the roofing. Other energy-saving measures like R-49 attic insula-



*Let prospective home buyers see for themselves that solar installations need not detract from the appearance of a home.*

Courtesy of groSolar®/PIX15622

tion and R-15 wall insulation; high-efficiency windows and appliances; and caulking, sealing, and independent air leakage testing have helped achieve energy savings of up to 70%.

- **Tucson, Arizona**—A southwestern style development by John Wesley Miller Companies includes rooftop solar panels for an integrated solar water heater and a 1.5-kW PV system standard on each of its 99 units. Steel-reinforced masonry walls with rigid insulation under a three-coat stucco finish, R-38 ceiling insulation, and low-emissivity dual-pane windows ensure a tight thermal envelope. In addition, high-efficiency appliances and ducts in conditioned space help to reduce energy usage.
- **Columbus, New Jersey**—Builder Mark Bergman pioneered the first all-solar development of market-rate homes in New Jersey, with 39 homes built to be at least 60% more efficient than code. The heavily insulated, tightly sealed homes use energy efficient appliances and lighting to cut energy use. To ensure maximum solar gain for his 2.64-kW photovoltaic systems, Bergman located the panels on detached garden sheds, situated anywhere on the lots, for ideal orientation to the sun.

Additional case studies are available in *High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems*.

## Exploring Additional Resources

It's always helpful to maintain an informational or professional support system (or both). Many local and national organizations maintain databases or membership directories of solar professionals. In some cases, the organizations have local or regional chapters you can join. We've put together a list to get you started.

U.S. Department of Energy (DOE) Solar Energy Technologies Program (SETP) [www.solar.energy.gov](http://www.solar.energy.gov)

DOE Building America Program [www.buildings.energy.gov](http://www.buildings.energy.gov)

Free download of Volume 6 of the Building America Best Practices Series, High-Performance Home Technologies: Solar Thermal & Photovoltaic Systems [www.eere.energy.gov/buildings/publications/pdfs/building\\_america/41085.pdf](http://www.eere.energy.gov/buildings/publications/pdfs/building_america/41085.pdf)

National Renewable Energy Laboratory (NREL) [www.nrel.gov](http://www.nrel.gov)

Solar Energy Industries Association (SEIA) [www.seia.org](http://www.seia.org)

Solar-Estimate.org [www.solar-estimate.org](http://www.solar-estimate.org)

American Solar Energy Society (ASES) [www.ases.org](http://www.ases.org)

National Association of Home Builders [www.nahb.org](http://www.nahb.org)

Green Building Initiative [www.thegbi.org/residential](http://www.thegbi.org/residential)

U.S. Green Building Council [www.usgbc.org](http://www.usgbc.org)

Interstate Renewable Energy Council (IREC) [www.irecusa.org](http://www.irecusa.org)

North American Board of Certified Energy Practitioners (NABCEP) [www.nabcep.org](http://www.nabcep.org)

Solar Rating and Certification Corporation (SRCC) [www.solar-rating.org](http://www.solar-rating.org)

Solar Electric Power Association (SEPA) [www.solarelectricpower.org](http://www.solarelectricpower.org)

To submit feedback on this document or your solar experiences, please e-mail [solarbuilderfeedback@nrel.gov](mailto:solarbuilderfeedback@nrel.gov)

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