Welcome to the 22nd Annual National Solar Tour

ASES NATIONAL SOLAR TOUR GUIDE

AMERICAN SOLAR ENERGY SOCIETY

October 2017

- Top Ten Solar Energy Myths
- Solar Homes Have More Value
- Investment Tax Credit (ITC) Reduces after 2019
- Solar, Wind and Energy-Efficiency Basics
- National Solar Tour: Then and Now

Solar Is Contagious!

Why Do People Go Solar? Because Other People Go Solar. By CARLY RIXHAM

Research shows that the installation of one additional solar photovoltaic rooftop project within the past six months increases the average number of installations within a half mile radius by almost one half[1]. The National Solar Tour helps to spread this solar contagion, where homes, businesses, schools, and other organizations across the country open their doors and roofs to neighbors who are looking to learn more about how they can utilize renewable energy in their own lives and communities.

This year marks our 22nd National Solar Tour, the largest annual grassroots solar event in the nation! It is taking place in neighborhoods nationwide during October 2017, in conjunction with National Energy Awareness Month. The American Solar Energy Society (ASES) coordinates the tour in collaboration with dozens of outstanding partner organizations. See opposite page for a listing of local tours, and for dates and details go to nationalsolartour.org.

Attending the tour will allow communities across the country the opportunity to informally tour innovative green homes and buildings, and see affordable and practical technologies locally that will benefit the environment and are part of the solution to our global energy challenges. We have a choice in how they get their energy.

The tour inspires people across the nation to make sustainable energy choices that reduce costs, support energy independence, protect against power outages, and reduce carbon emissions.

The premise of the tour is to get neighbors talking about local incentives, local installers/contractors, local laws, returns on investements. If you are thinking of going solar, now is the time. The 30% Investment Tax Credit has been extended through 2019, the sooner you go solar, the more energy savings you will enjoy.

Carly Rixham is the Executive Director of ASES.

Please join ASES in enabling a 100% renewable energy society. It starts with conservation and efficiency and ends in solar energy. We may not be able to stop climate change from happening, but we can make easy choices to lessen its impact. Thank you for joining the National Solar Tour and joining the conversation to address the growing need for clean energy.

1. Graziano and Gillingham, *Spatial patterns of solar photovoltaic system adoption: The influence of neighbors and the built environment.* Journal of Economic Geography, 2015.

Top Ten Solar Energy Myths

By Florida Renewable Energy Association

1. **Solar Energy Systems (thermal or solar electric) are too expensive.** System installations are more affordable than they have ever been in 40 years. Photovoltaic (solar electric) modules' cost per watt, installed, started at $32/watt, now at an all time low of under $4. Solar incentives cover a minimum of 30% all the way up to 85% of the costs of a system.
2. **Typical homeowners won't live in their home long enough to make their solar investment back.** A solar system actually increases the value of a home. For every $1,000 that has been saved in annual electric costs, your home's value rises $15,000 (per U.S. Department of Housing and Urban Development), not including the benefit of lower electricity bills.
3. **Solar systems are ugly, large and bulky.** Now, modules have become virtually seamless with solar shingles. Solar cells can be combined with slate, metal, fiber-cement, and asphalt roofing. They can be used as skylights and windows or other architectural components.
4. **Solar panels require constant maintenance.** In some places, solar panels need occasional cleaning, but the rest of the system rarely requires attention.
5. **Solar panels do not work in cold, cloudy places/states.** Germany, who ranks low in sunny days similar to Washington State, is the solar energy capital of the world. In fact, when the solar panels are cold, they are able to better conduct electricity. Even with clouds, solar produces electricity though less than on sunny days.
6. **Solar modules require more energy to manufacturer then they will ever generate in their lifetime.** According to a U.S. Department of Energy study that analyzes several different module technologies, solar modules will generate more energy in their lifetime then was required to produce them. At modern photovoltaic module efficiencies, energy production payback is generally with in 4 – 6 years, based on local utility rates.
7. **The solar panels cannot withstand harsh climates (snow, hail, winds, sleet, disasters).** Solar panels built to code can withstand most climates and applications. The color of solar panels is dark which aides in melting snow. They can withstand the forces of a hurricane when made and installed to latest codes.
8. **Solar systems are unreliable and inconsistent.** On the contrary, solar electric systems can be more reliable than utility power. Typical solar modules warranty lasts 25 years or more. They have no moving parts and off-grid systems are not subject to power outages, as energy storage provides continuous operation. In fact, solar technologies are used to power many vital systems: aircraft warning lights, railroad crossing signals, navigational buoys, etc.
9. **I cannot use solar energy because have insufficient sunlight or no southern roof exposure.** East/West roof exposure can be effective, as well as ground-mounted systems. If your roof is shaded or you're a renter, your electric utility may offer a way to support renewable energy. Also, Community Solar projects are popping up in many places, or you could help start one.
10. **Solar energy is inefficient and does not produce enough energy.** According to the U.S. Department of Energy, photovoltaic module efficiency has more than quadrupled since the 1970's. With an average between 14-20%, it sits in the same efficiency range as the gas in your car.

go on tour: locate an ASES local solar tour in your community

The ASES National Solar Tour is held in most neighborhoods in October, but tours can be organized any time of year. See tour listings at nationalsolartour.org.

ASES NATIONAL SOLAR TOUR

Alaska
- Alaska Solar Tour

Arizona
- Phoenix Solar Tour
- Flagstaff Sustainable Building and Water Conservation Tour

California
- Berkeley/Albany Solar Homes Tour — Organized by NorCal Solar
- So Cal Solar Amigos Tour – Los Angeles Co.
- So Cal Solar Amigos Tour – Ventura Co.

Colorado
- 27th Annual Crestone Energy Fair
- Boulder Green Home Tour
- Durango Solar Home Tour
- Metro Denver Green Homes Tour

Delaware
- Lower Delaware Tour of Solar Homes and Buildings

Florida
- Florida Regional Solar Tour
- Sierra Florida Tour

Illinois
- Heartland Solar Tour
- Illinois Solar Tour

Maryland
- Washington D.C. Metro Area Tour of Solar Homes

Michigan
- Detroit Solar Tour
- Michigan Solar Tour
- Self Reliant Energy Company Tour
- SolarYpsi Tour

Ohio
- Enright Ridge Urban Ecovillage tour
- Greater Akron Solar Tour
- Green Cincinnati Education Advocacy Tour
- Kent State University's Sustainability (Fuel Cell) Laboratory
- Kent Green Energy Ohio Tour: Kent Cooperative Housing – Franklin House
- Oberlin Guided Tour
- Old Trail School Solar Array
- Residential Solar Vanatta
- Sinclair Community College
- West Shore Unitarian Universalist Church Solar Array

Pennsylvania
- State College Solar Tour by ASES PSU

Rhode Island
- South Kingstown Solar Tour

Texas
- Bluebonnet Solar Tour
- DFW Solar Tour
- Hill Country Solar Tour
- Houston Solar Tour
- Solar Fest 2017

Virginia
- 2017 Harrisonburg-Rockingham Solar Tour
- Shenandoah Energy Services Tour
- Washington D.C. Metro Area Tour of Solar Homes

Washington D.C.
- Washington D.C. Metro Area Tour of Solar Homes

Wisconsin
- Northwest Wisconsin Tour of Solar Homes
- Wisconsin Solar Tour

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American Solar Energy Society Programs

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ases.org/tour

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ases.org/solartoday

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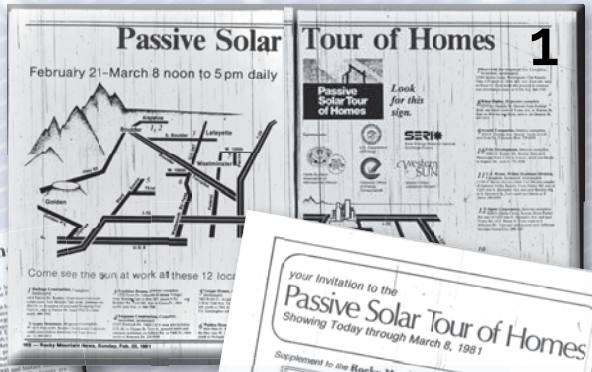
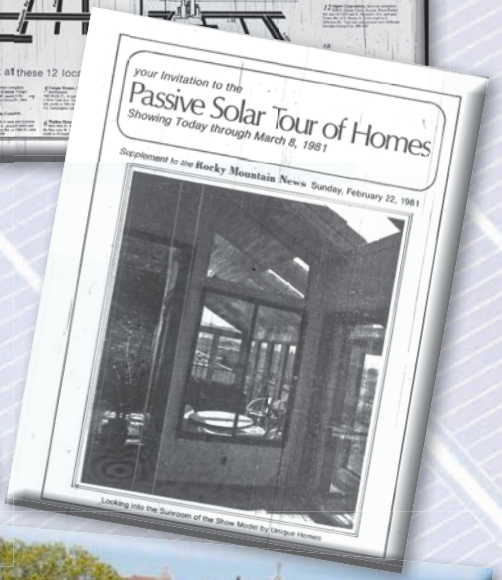
ASES NATIONAL SOLAR TOUR

THEN....





and now!

Solar homes have MORE VALUE!

Solar Increases Home Property Values

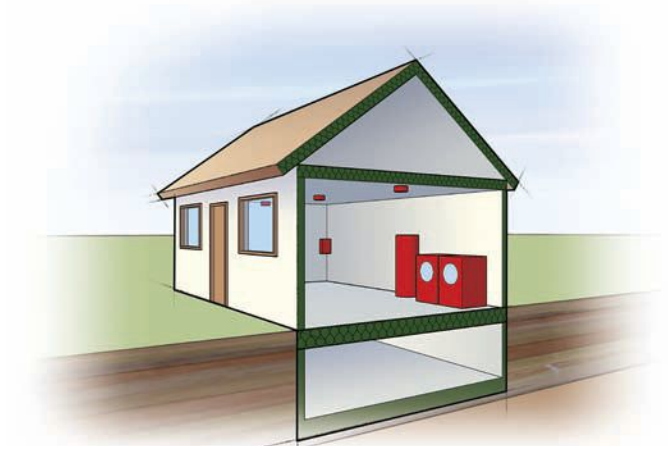
Research finds that homes with PV have sold for a premium, expressed in dollars per watt of installed photovoltaic (PV) panels. In California, on average, solar PV added about $5.50 per watt to the home's resale value. This corresponds to an average home sales price premium of approximately $17,000 for a relatively new 3,100 watt PV system.

Study by Berkeley National Laboratory, Ryan Wiser and Ben Hoen, "An Analysis of the Effects of Residential Photovoltaic Energy Systems on Home Sales Prices in California", 2011.

Opposite Page:

1. 1981 Denver Passive Solar Tour, courtesy of John Avenson
2. Crossville, Tennessee Tour, 2012
3. Northeast Iowa Tour, McGregor, Iowa
4. Illinois Solar Tour 2011, Camasto Residence
5. Illinois Solar Tour 2011, Britton Residence
6. Farm worker housing with solar, Woodland, California
7. Maine Solar Workshop
8. Louisville Solar Bike Tour, Kentucky 2015
9. SolarYpsi Tour, Ypsilanti, Michigan, 2016

Time is limited to receive the solar Investment Tax Credit (ITC):
2017-2019: 30%
2020: 26%
2021: 22%
2022 and beyond: 10% (non-residential and third-party-owned residential) or 0% (host residential)



Energy-Efficiency Basics

By **Seth Masia and Carly Rixham**

It's cheaper to save energy than to make energy. If you want to offset $100 a month in utility bills, the right place to start is not with a solar array on the roof, but with insulation under it.

First, Look at Your Heating and Cooling Bills

Whether you battle high heating or cooling expenses, a quality roof and windows, good insulation and proper sealings are important in maintaning a controlled climate. Most homeowners can save 20 to 25 percent by caulking air leaks around windows, doors, foundations and soffits. Check the attic insulation, too. It's cheap to add an extra layer of batting or blown-in cellulose. It's more expensive to swap out old single-pane or metal-frame windows for more efficient modern insulated triple-pane wood- or vinyl-frame windows. The cheapest fix of all is to renew weather-stripping around all doors and window sashes, and put insulating covers on pet doors.

Spending $2,000 on insulating upgrades may cut heating costs by 50 percent and pay for itself in about three years. The U.S. Department of Energy (DOE) website (energysavers.gov) includes interactive worksheets to help you figure out how much more insulation you may need (depending on your climate), how much it may cost and, depending on what you're paying for heat energy today, how long the payback period may be.

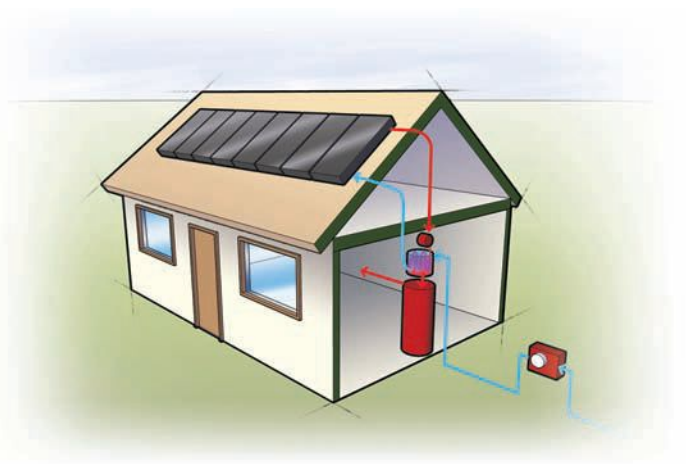
Heating and cooling systems can usually be improved. Be sure to change the furnace air filter quarterly. Get ductwork cleaned and air leaks sealed, and make sure that ducts are insulated at least to local codes. Your ductwork should be set up to heat (or cool) recirculated air from inside the house, but the furnace should draw combustion air from outside — you don't want to burn fuel using air you've already paid to heat.

If you heat with oil or electricity, consider installing a modern high-efficiency gas furnace or ground-source heat pump. A $6,000 investment in insulating and HVAC improvements might pay for itself in five or six years.

Not sure where to start? The most direct way to find cost-effective fixes, especially in an older house, is with a professional energy audit. Check with your utility company to see if they offer free or reduced-cost audits. Standard price for this service is $200 to $400. It may include a blower-door test to locate air leaks.

Look Into Energy-Efficient Appliances

The typical refrigerator built in 1980 costs about $154 in electricity to run for a year, at today's average rate of 11 cents per kilowatt-hour. A modern high-efficiency refrigerator runs for about $55 a year. The average homeowner would save $99 a year — enough to pay for the refrigerator in a few years. A new water-heating system may be cheaper still.



Solar Water-Heating Basics

Edited by **Barry Butler, Liz Merry** and **Diana Young**

In most parts of North America, the best bang for your solar energy buck is with domestic solar water heating (DSWH). It's a no-brainer in the desert Southwest and in semitropical Florida and Hawaii.

A complete DSWH system can be installed for $4,000 to $7,000, depending on its size, complexity and the climate. These systems are now eligible for the 30 percent federal tax credit. At today's energy prices, over the life of the system, the cost to operate is about 20 percent lower than a conventional gas water heater and 40 percent lower than an electric one. As gas and electricity prices rise, DSWH will look like a better and better deal. The benefits are much greater since solar energy avoids 2,400 pounds of CO_2 per year and provides a secure domestic source of hot water.

Solar water-heating systems come in two flavors: passive and active. In warm climates, a simple passive system can provide plenty of hot water.

Passive Solar Water-Heating Systems

Passive systems are installed in areas where freeze protection is not an issue. The most common types are integral collector storage (ICS) and thermosiphon systems.

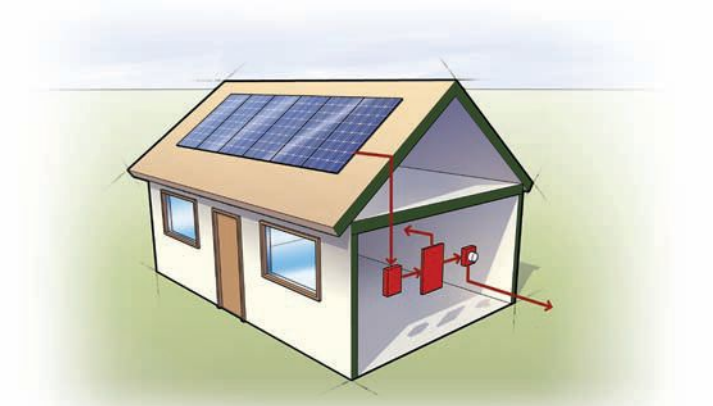
In an ICS (or breadbox) system, cold city water flows into a rooftop collector. The collector holds 30 to 50 gallons of water in a serpentine pipe with a heat-capturing coating. Hot water from the collector flows directly to a conventional water heater; in effect the sun does most of the work usually performed by the water heater's burner. As hot water is withdrawn from the water heater, cold water is drawn into the collector, driven by pressure in the city water pipes.

A thermosiphon takes advantage of the fact that water rises as it's heated. Solar-heated water in a flat-plate collector rises through tubes and flows into the top of an insulated storage tank. Colder water at the bottom of this tank is drawn into the lower entry of the solar collector. Water thus flows in a continuous loop, continually reheating during daylight hours. When a hot water tap is opened in the house, hot water flows from the top of the storage tank, and is replaced with cold city water flowing into the bottom of the storage tank.

Although the system is simple, thermosiphons put an 800-lb storage tank high on the roof, which should be reinforced to support it. Other solar water-heating systems put the storage tank at ground level or in the basement, where it's not a structural challenge.

Active Solar Water-Heating Systems

Active systems use an electric pump to circulate water through the collector. In warm climates, a direct (or open-loop) system is practical: City water goes into an insulated storage tank. A pump draws water out of the storage tank to pass through the solar collector and go back into the tank.



Solar Electric System Basics

Edited by **Joseph McCabe, PE.**

A basic home photovoltaic (PV) system consists of weather-protected panels, also called modules, fastened side-by-side on a racking system to form an array. The PV modules produce direct current (DC), which flows to an inverter. The inverter changes DC voltage to alternating current (AC) for the household electric circuit.

Excess power from the inverter may flow out of the house through the utility company's electric meter, into the city-wide grid. The utility will credit the outflowing electricity against electricity purchased from the grid at night. This process is called net-metering.

In an off-grid system, common in remote locations, DC power flows from the modules through a charge controller (also called a regulator), an electronic device that produces a smooth flow of current at the desired voltage. From the charge controller, the power can go to a set of storage batteries and then on to the inverter, as needed.

Most home systems today use crystalline silicon PV modules because they produce the most power in the limited space available on a house roof (cheaper thin-film modules are common in large industrial arrays).

Crystalline PV cells use silicon, a little bit of boron and phosphorus along with anti-reflection materials and a screen printing of electrically conductive grid lines on the top and a coating of aluminum on the bottom to collect the electrons.

Thin-film modules are made from very thin layers deposited on an electrical conducting surface. These materials may originate as silane gas for amorphous silicon, cadmium and tellurium for CdTe, or copper, indium, gallium and selenium for CIGS. The deposition techniques may include sputtering, co-evaporation in a vacuum, electro-deposition, sintering or other techniques. Many variations of thin-film materials are being investigated for low-cost manufacturing and higher solar-to-electrical efficiencies.

Installation Location

Location is critical to PV performance. The array should face the sun. This usually means due south, though if you have a heavy air-conditioning load in the late afternoon you may want to point the array southwest. The array should not be shaded during any part of its productive day. The array should be tilted upward at the correct angle to optimize seasonal exposure — typically at the angle of your latitude so it gets sunlight at a right angle at the spring and fall equinoxes. Some arrays can be made adjustable for varying the angle at different seasons.

Microinverters

Many new grid-tied systems feature microinverters, typically attached to the rack underneath the PV modules. These systems harness power at the module level, rather than the system level.

ILLUSTRATIONS BY KURT STRUVE

Wind System Basics

By **Mick Sagrillo**

It seems that everyone is interested in wind turbines, an intriguing technology that converts the kinetic energy in the moving wind to useful electricity. Let's look at the steps required to see if a small wind system (defined as up to 100 kilowatts in nameplate capacity) is in your future.

Step 1: Examine why you want a wind system. Energy independence? Lock in future energy costs? Return on investment? Do your part to mitigate global climate change? Support the renewables industry? Power an electric vehicle? Set an example for your family and community? Put your money where your values are?

These are valid reasons for installing a wind turbine. Your goals will affect the system you choose, the amount of money you are willing to spend, and the time you are willing to commit to being your own utility.

Step 2: Quantify the amount of electricity you use now. Most people put up only one wind turbine and they usually want it to generate the amount of electricity they consume over the course of a year. Cost-effectiveness changes with increasing size — the bigger the turbine, the more you spend on the installation, but the cheaper the cost of electricity will be over the life of the system. Matching the size of the system to your annual load maximizes the value of your investment if you can't sell the excess.

Step 3: Reevaluate how you use electricity and why. It's always cheaper to save energy than it is to generate it, so streamline your consumption. The most cost-effective way is to alter your electricity-use habits — turn off lights in unoccupied rooms, mind the thermostat, put "vampire" electronics on a switchable power strip. But habits are hard to change. Investing in high-efficiency appliances makes excellent sense. The rule of thumb is that every $1 spent on efficiency saves $3 in wind system costs.

Step 4: Determine how much fuel (wind) you have at your site. The best way is to hire a small-wind site assessor to evaluate your site and wind resource. This service may be available for a fee from a local wind installer, but be sure to shop around. You want an assessment of your wind resource, not a sales pitch for a particular turbine or manufacturer. Consider this akin to hiring a building inspector to evaluate a house you are interested in buying. The inspector's job is to evaluate the condition of the house and report back to you so you can make an informed decision as to whether or not the house is a wise investment. During this process, the inspector represents your interests only, as should a wind site assessor, and present you with unbiased information to evaluate.

Find more solar basics, on topics including ground source heating and cooling, passive solar building and working with a solar contractor, at ases.org.

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