# SOME SOLAR ENERGY OPTIONS FOR YOUR HOME

## Reference Material for a Talk Presented at the Unitarian Universalist Congregation of NW Tucson On December 2, 2007

## By


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**You can download the latest version of Adobe® Reader from http://www.adobe.com/products/acrobat/readstep2.html**

**For a wealth of information on solar energy usage and benefits, see http://www.azsolarcenter.com/ and http://www.ases.org/**

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# Arizona Solar Rights Laws

**ARS 33-439.** Restrictions on installation or use of solar energy devices invalid; exception

A. Any covenant, restriction or condition contained in any deed, contract, security agreement or other instrument affecting the transfer or sale of, or any interest in, real property which effectively prohibits the installation or use of a solar energy device as defined in section 44-1761 is void and unenforceable.

B. A deed, contract, security agreement or other instrument affecting the transfer or sale of, or any interest in, real property entered into before April 17, 1980 shall not be subject to the provisions of this section.

Some Home Owner Associations (particularly in the Phoenix area) decided that ARS 33-439 still gave them the right to dictate where solar energy systems can be placed, even if such placement hinders their proper operation. A bill was passed in the 2007 state legislative session that specifically addresses this issue:

**ARS 33-1816.** Solar energy devices; reasonable restrictions; fees and costs

A. Notwithstanding any provision in the community documents, an association shall not prohibit the installation or use of a solar energy device as defined in section 44-1761.

B. An association may adopt reasonable rules regarding the placement of a solar energy device if those rules do not prevent the installation, impair the functioning of the device or restrict its use or adversely affect the cost or efficiency of the device.

C. Notwithstanding any provision of the community documents, the court shall award reasonable attorney fees and costs to any party who substantially prevails in an action against the board of directors of the association for a violation of this section.

Of interest to all home owners who have installed (or are planning to install) solar energy devices is paragraph 2, section C of **ARS 42-11054** which deals with property tax valuations: **"Solar energy devices, as defined in section 44-1761, and any other device or system designed for the production of solar energy for on-site consumption are considered to add no value to the property."**

You can view the text of ARS 44-1761 which defines "solar energy devices" at http://www.azleg.gov/FormatDocument.asp?inDoc=/ars/44/01761.htm&Title=44&DocType=ARS .

# Federal Solar Energy Tax Credit

| | Incentive | Credit Window | Cap | Eligible Technologies |
|---|---|---|---|---|
| **Business Credit** | 30% | 1/1/09-12/31/16 | No cap | PV, CSP, hybrid lighting, solar domestic water heating (excluding pool heating). |
| **Residential Credit** | 30% | 1/1/09-12/31/16 | No cap after 1/1/09 | PV, Solar domestic water heating (excluding pool heating). |

## Frequently asked questions

1. ***What are the dates of the credit? Is it applicable to existing systems?***

The credits become available for systems that are "placed in service" or activated between 1/1/06 and 12/31/16. If the installation is on a new home, the "placed in service" date is the date of occupancy by the homeowner. **Residential systems installed after 1/1/06 but before 1/1/09 were limited to a $2000 tax credit.**

2. ***What about systems that have been purchased but not installed?***

Should you buy a system and even start work prior to January 1, 2006, but do not complete the install or place it "in service" until on or after January 1,2006, it will qualify for a credit.

3. ***Can this credit be applied to capacity additions? (i.e. I have a 1.5kW system and and I want to add 1.5kW more.) Similarly, can I apply this credit to used equipment going into a new installation?***

This is not entirely clear at the present time. However, the language would suggest that both scenarios are allowed - the credits apply to the amount of expenditure on the solar energy property in a given year.

4. ***How does the residential tax credit on expenditures operate?***

An individual can take the 30% credit for photovoltaics, while also taking a separate 30% credit for solar hot water heating. Any unused credit may be carried over to the next year.

5. ***How does the credit work with existing state credits or utility incentives?***

The credit applies to the basis remaining after any state or utility incentives available to the taxpayer have been taken.

6. ***What IRS form do I use to obtain the credit?***

Use IRS Form 5695 for residential energy credits; check with your tax professional to determine how to claim non-residential energy credits.

# Arizona's Solar Tax Credit

The State of Arizona offers a Solar Tax credit for 25% of the cost of an approved solar device or system. The maximum allowable credit is $1,000 to be carried forward up to five years; it is deducted directly from state taxes owed. (In other words, if your tax liability is less than the credit the first year, you can carry the credit forward for up to five years.)

**Note: This is a one-time tax credit and restricts the homeowner for additional credits for solar purchases made for the same residence in subsequent years.**

The law establishing the tax credit imposed several requirements on the seller of solar devices in order to qualify the equipment and application. Title 44, chapter 11, article 11 of the Arizona Revised Statues (ARS 44-1761- Definitions: http://www.azleg.gov/FormatDocument.asp?inDoc=/ars/44/01761.htm&Title=44&DocType=ARS and ARS 44-1762 - Solar energy device warranties; installation standards; inspections: http://www.azleg.gov/FormatDocument.asp?inDoc=/ars/44/01762.htm&Title=44&DocType=ARS ) detail the requirements.

Items qualifying for the credit include **solar water heating, solar pool heating, photovoltaic systems, water pumping, and solar lighting systems**.

The tax credit is claimed on ARIZONA FROM 310 when you file your Arizona State Income Tax Return. Contact a tax professional if you have questions.

# Utility Rebates

## Solar Electric Rebates

In 2006, the Arizona Corporation Commission passed a Renewable Energy Standard that will require the state's regulated electric utilities to generate 15 percent of their power from renewable energy sources by 2035. At least 30 percent of the renewable energy must come from **distributed renewable energy.**

A distributed renewable energy resource is one that is **located on a customer's premises** and either replaces the need for the use of conventional power or produces renewable energy – for example, **solar panels on a customer's roof**. In order to meet this requirement, most Arizona electric utilities are offering financial assistance in the form of rebates or "buy downs" to customers who install solar electric panels on their homes or businesses that meet certain requirements.

Both Tucson Electric Power (TEP) and TRICO Electric Cooperative offer financial assistance for the installation of **solar grid-tie systems** (this will be explained later) in their respective service areas. Some financial assistance is also available for "off grid" systems under certain conditions.

### *TEP's SunShare Program*

TEP offers a buy-down rebate of up to $3,000 per manufacturer's rated DC kW capacity at Standard Test Conditions ("STC") of qualifying, proven installed solar generating capacity up to a maximum of 40% of the system cost. For program details, see http://www.tep.com/Green/Home/Solar/electric.asp .

### *TRICO's SunWatts Program*

Under this program, TRICO customers can receive a rebate of $4 per installed DC watt capacity on their homes or small businesses up to 50% of the total system cost. For an overview of the program, see http://www.trico.coop/sunwatts_information.html . For detailed information, see http://www.trico.coop/documents/sunwatts_handbook.pdf (requires Adobe® Reader to view).

## Solar Water Heating Rebates

TRICO Electric Cooperative offers financial assistance for the installation of solar hot water heaters to customers currently using electric water heaters. For details, see http://www.trico.coop/documents/sunwatts_handbook.pdf (requires Adobe® Reader).

TEP residential customers can receive an up-front incentive payment of $750 plus $0.25 per kWh up to a maximum of $1,750 on a qualifying solar hot water system. See http://www.tep.com/Green/Home/Solar/spaceheating.asp for program details.

# Solar Hot Water Heating

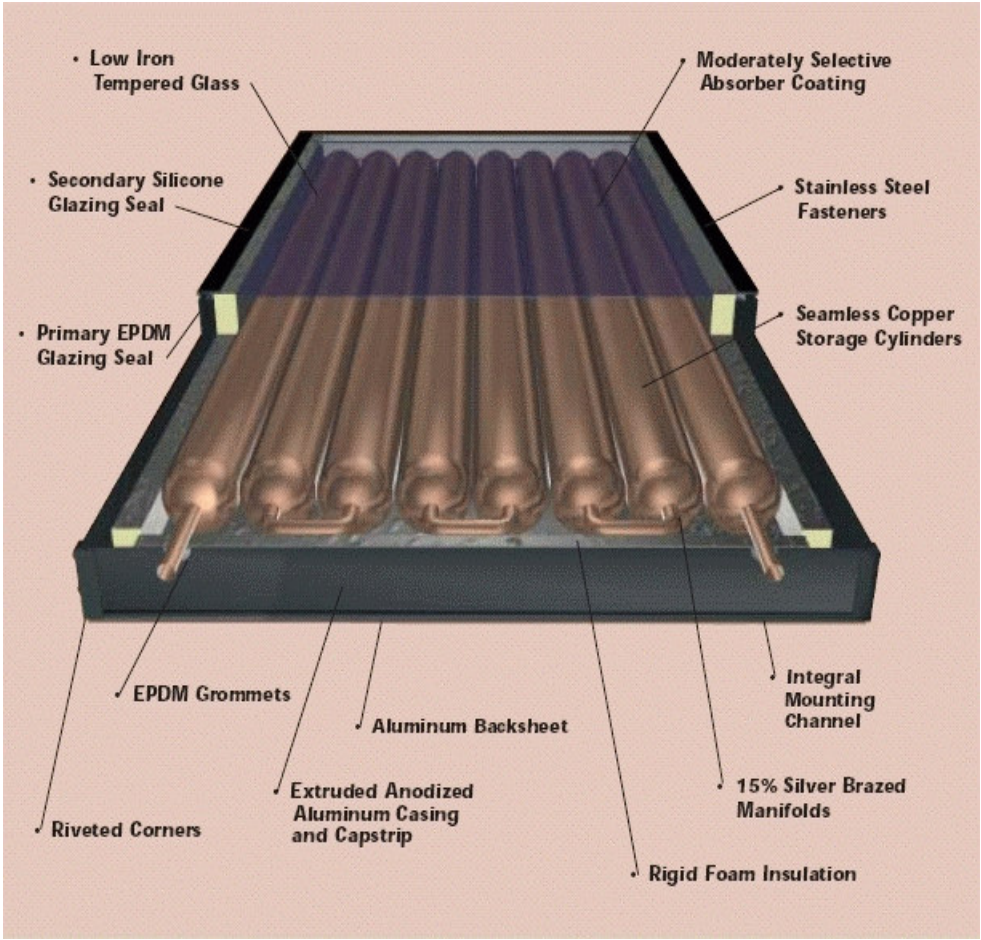
Humans have been using the sun to heat water since the dawn of time. Solar hot water heaters are heavily used in many parts of the world today. Remember those big tanks on tops of many houses on your visit to Mexico? Solar hot water heaters! Solar hot water heaters are required on all new homes in Israel. They were very popular in the United States in the early 1900's. So why are they not widely used in the U.S. today? Primarily because we are addicted to cheap fossil fuels! Well, those "cheap" fuels are becoming more expensive – hence there is renewed interest in "reinventing" solar hot water heaters.

In addition to saving on fuel costs, using the sun to heat water does not result in the generation of pollution or greenhouse gases – so it is good for the environment.

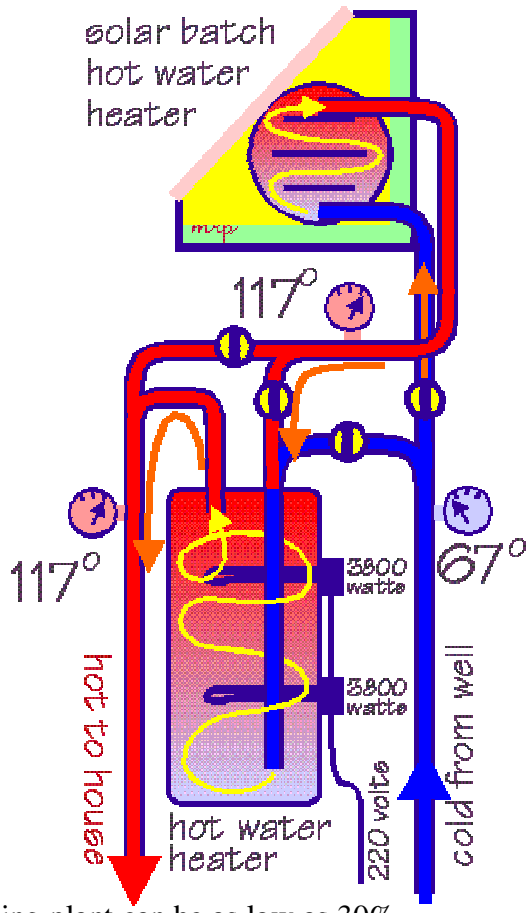
## Passive Solar Water Heaters

A passive solar water heater depends on water pressure and/or gravity for operation and contains no pumps. Storing water on the roof in a black tank exposed to the sun like one sees in Mexico is probably the simplest form of passive solar water heating. A more efficient method is to use some type of "collector" or "concentrator" to transfer the sun's heat to the water. An example of a commercially available collector is shown below.

Basically, it consists of an insulated glass covered box containing copper pipes. Water enters at one end, is heated by the sun and exits the other end. Making a collector of this type is not rocket science! Anyone handy with tools and familiar with basic plumbing could build one. However, tax credits, utility rebates and permit requirements might make a do-it-yourself project more trouble that it is worth.



How to use a solar collector in conjunction with an existing domestic hot water system to form a passive solar water heater is shown at the right. Cold water is feed into the solar collector and then fed into an existing gas or electric hot water heater tank. The solar collector pre-heats the water and the hot water heater is used for storage and auxiliary heating when required. A series of valves can be used to choose between 100% solar heating, 100% "fuel" heating or a combination of the two.

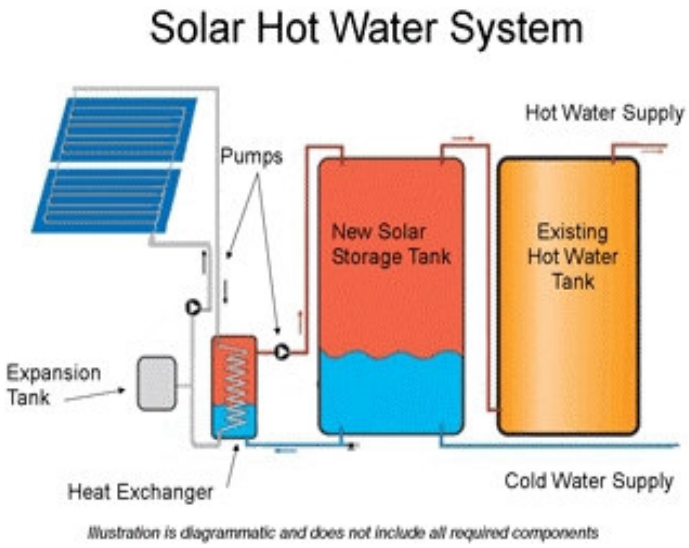



A "tankless" water heater can be used in place of a normal tank heater – water is heated "on demand" providing greater fuel savings. Such a system would be ideally suited to a small home with limited hot water requirements. An example of an electric "on demand" tankless water heater is shown below. These heaters are available from several manufacturers, both electric and gas models. Gas models typically have thermal conversion efficiencies of 80-85%. Electric models are claimed to have efficiencies of better than 95% – but keep in mind that the efficiency of a fossil-fueled generating plant can be as low as 30%. Tankless heaters range in price from $400 to $800 or more depending on capacity, plus installation.


One drawback of passive systems is the possibility of the water in the collector freezing on cold nights. This is not a great concern in mild climates like ours, so this type of system would definitely be worth considering. Additional valves could be added to allow manual draining of the collector on those rare occasions when freezing might be a problem.

## Active Solar Water Heaters

More complex systems containing pumps are called "active" systems. Many of these systems contain heat exchangers and/or auxiliary water storage tanks as shown in the illustration to the right. A heat exchanger is used to isolate the domestic water supply from the solar collector. An antifreeze solution in the heating loop and/or an automatic "drain-back" system prevents freezing. A tankless heater (see previous page) can be used for greater fuel savings in place of a tank-type heater for auxiliary heating.




Active solar water heating systems can be installed in this area for between $4500 and $6000 depending on complexity (whether or not an auxiliary storage tank is used, etc.) and capacity.

When asked to bid on a solar hot water system, most local (Tucson) contractors will recommend an active system citing that they are the most reliable. They are usually willing to also provide passive systems, so don't be afraid to ask about less expensive options (passive systems may no longer be less expensive – see note on previous page).

If you are interested in having a system installed, obtain bids from multiple installers and check references. Since there are so many different options available for solar water heating, it is sometimes difficult to compare competing bids. If you have questions, don't be afraid to ask; there are no dumb questions, just dumb answers!

The following web sites are worth viewing for additional information:

http://www1.eere.energy.gov/solar/sh_basics_water.html

http://www.solarexpert.com/Heatdhw.html

http://www.toolbase.org/Technology-Inventory/Plumbing/solar-water-heaters

http://www.solardirect.com/swh/swh.htm

http://en.wikipedia.org/wiki/Solar_hot_water

# Solar Pool Heating

If solar energy can be used to heat water, then it is logical to use it to heat swimming pools! Solar pool heating is very popular in our area; many people like to use their backyard pools in the cooler winter months and that morning dip can be pretty uncomfortable in 55-degree water!

The required temperature rise for pool heating is considerably less than required for a solar hot water heater, thus the solar collectors tend to be much simpler. All that is really required is to circulate the pool water through a sufficient number of plastic pipes exposed to the sun. The collectors can be roof or ground mounted and their orientation relative to the sun is not especially critical.

**Nighttime heat loss from a pool can be drastically reduced by using a simple pool cover since much of the loss occurs through evaporation.** A pool cover in conjunction with a solar heater is often adequate to maintain a comfortable pool temperature during daylight hours without the need for auxiliary heating.

Two types of solar collectors designed specifically for pool heating are commercially available – spiral plastic coils and flat plastic panels. The spiral collectors are less prone to freeze damage and clogging and are preferred by most installers in this area. However, flat panel collectors are sometimes preferred for aesthetic reasons, particularly when mounted on roofs. Flat panels can be colored to match the color of tile roofs, but collection efficiency is reduced up to 30% (depending on color) compared to black panels.

It is highly recommended that a solar collection area of between 80% and 100% of the pool surface be used for best results.

A heating system for a 300 to 450 square foot pool using roof-mounted collectors can typically be installed for between $3500 and $4000. Note that an Arizona tax credit of up to $1000 is available for pool heaters, but no federal tax credit for pool heating is currently available.

# Solar Space Heating
## (And Cooling)

Solar energy can also be used for heating homes – either passively (by proper window orientation, etc.) or actively. Active solar space heating systems can take the form of window-mounted units, baseboard or in-floor circulating hot water systems, and air exchange systems.

Because of our mild climate, there is not much interest in solar home heating in the Tucson area. There are two main reasons for this:

1. Our heating season is rather short – typically only three or four months.
2. Most of our home heating is required at night, thus some type of heat storage system is required to make efficient use of solar heating (can be large and expensive).

There are some local contractors able to provide solar radiant floor heating systems. If you are interested in exploring solar space heating – perhaps for your "other" home up north – here are some web sites worth viewing:

http://www1.eere.energy.gov/solar/sh_basics_space.html

http://www.bobvila.com/HowTo_Library/Residential_Solar_Heating_Retrofits-Solar_Heating-A1935.html

http://www.aaasolar.com/design/HOMERadiant.html (Radiant floor heating.)

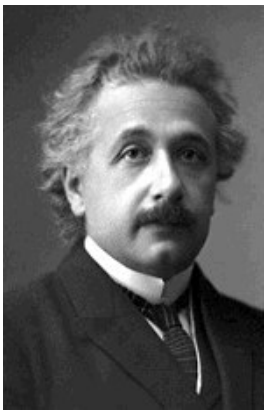
http://grosolar.com/solar_hot_air/ (Forced air heating.)

http://www.jc-solarhomes.com/ (Includes passive solar and water heating "how to" info.)

**Cooling and refrigeration** can be accomplished using thermally activated cooling systems (TACS) driven by solar energy. For more information, see http://www1.eere.energy.gov/solar/sh_basics_space.html and scroll down to "Space Cooling". This seems like an ideal technology for use in sunny climates like ours, but I have not seen any information on actual applications.

# Solar Electric Power Generation

## Photovoltaic (PV) Panels – What Are They?



A PV system makes use of the "photoelectric effect" by which light (from the sun or any other source) is converted directly into an electric current. The photoelectric effect was first recognized in 1839 but was not successfully explained until 1905 in a famous paper by Albert Einstein. Einstein was able to explain the effect by assuming that a light beam consists of discrete energy bundles that we now call ***photons***. This most remarkable assumption had a huge impact on Physics and resulted in Einstein being awarded the 1921 Nobel Prize in Physics. (His Nobel citation read "for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect").

Many materials exhibit the photoelectric effect, but to obtain reasonable conversion efficiency requires a material that not only absorbs light well but from which the freed electrons can be efficiently transferred to an external circuit. Many semiconductor materials (silicon, germanium, cadmium sulfide, others) have the desired characteristics.

Photovoltaic systems consist of one or more "cells" containing thin slices (or deposited films) of a semiconductor. Silicon is most widely used because high purity material is widely manufactured for use in semiconductors and it has good mechanical, thermal and electrical properties. Cadmium sulfide (CdS) is used for some applications (mostly in light sensors). Such cells are referred to as a "photo cells" (or "solar cells") and produce about one-half volt of electric potential when exposed to light. Cells can be electrically connected in series-parallel arrangements to provide the voltage and current required for a particular application. A PV "solar panel" consists of a group of interconnected cells arranged in a rectangular pattern and protected from environmental damage by a transparent coating or tempered glass.

*Monocrystalline cell*

The silicon photocells used in commercially available PV panels come in three basic forms:

**Monocrystalline** – Manufactured from thin slices cut from a single crystal of silicon. They are the most expensive to produce because of material costs, but they have the highest conversion efficiency: typically 16 to 18%.

**Polycrystalline (or Multicrystalline)** – Manufactured using thin slices cut from a silicon ingot comprised of multiple crystals. Polycrystalline material is less expensive to use than monocrystalline but the resulting cell conversion efficiency is slightly lower: typically 12 to 14%.

*Polycrystalline cell*

**Amorphous** – Made from a thin film of silicon deposited on a substrate. The manufacturing process requires less silicon and less energy. It can be used to produce flexible cells in various shapes. Conversion efficiency is typically around 8%.

Most PV panels used in commercial applications – such as home solar electric systems – are made from polycrystalline cells because they are relatively inexpensive to produce in large quantities and provide reasonable efficiency. Applications requiring contoured shapes or flexibility use cells made from amorphous (thin film) silicon.

An interesting application for thin film solar cells has recently become commercially available: Semi-transparent photocells embedded between glass sheets for use in building skylights for the dual purpose of generating electricity and providing light. The photo at the right illustrates an example of this application. For more information, go to http://www.w1hue.us/private/Photovol_glass.pdf .

PV panels using mono- or polycrystalline cells are very rugged and most are guaranteed for 20 to 25 years – even against hail damage. Their useful life is in excess of 30 years.

Higher efficiency PV cells – with conversion efficiencies in the 25 to 30% range – can be produced using more exotic materials and manufacturing processes. However, the cost is high. Except when physical size is a critical issue (space probes come to mind), it does not make economic sense to gain a factor of two in efficiency at three to five times the cost (unless you have a Government contract…).

Research is underway on the use of organic compounds to make very inexpensive PV cells that can be applied to a surface like paint. So far efficiencies have been low (less than 5%) and reliability poor.

For more that you will probably ever want to know about the photoelectric effect and photocells, see http://en.wikipedia.org/wiki/Solar_cell .

For an overview of current PV research and development, see http://www.nrel.gov/pv/research_development.html.

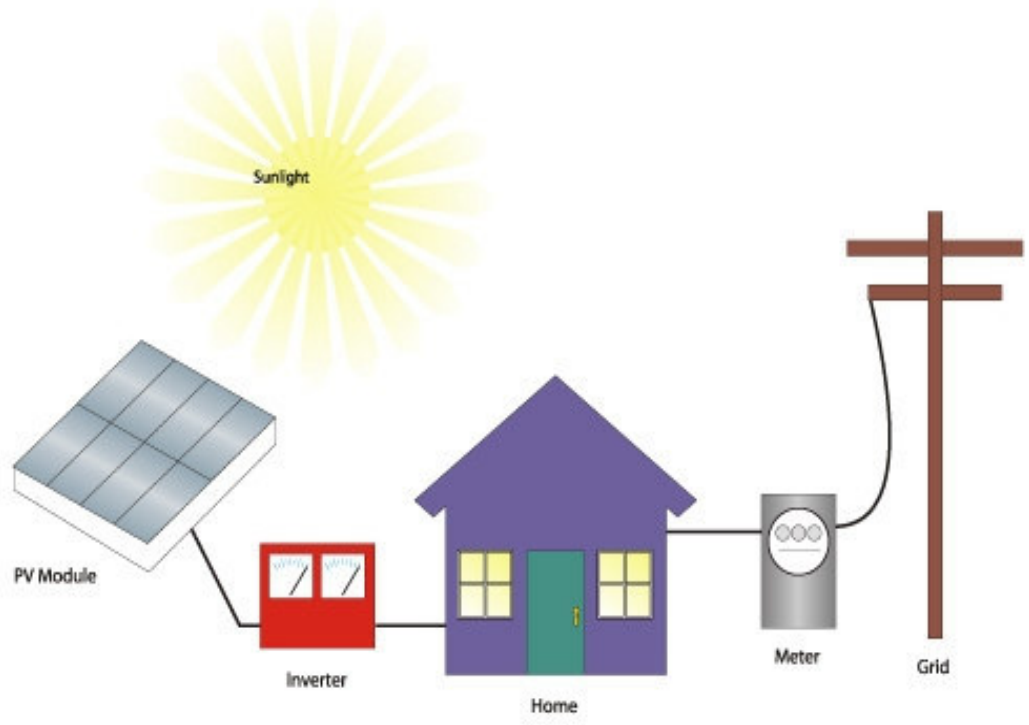
At this point, you are probably thinking, "Ok, this is all very interesting, but how can I make use of PV panels that are available today to generate electricity for my house?"

Read on…

## Grid-Tie PV Systems

This is the simplest type of PV system for individual home or small business use and is the type most commonly installed in metropolitan areas (like Tucson). Other types of systems – stand-alone, grid-tie with battery backup, etc. – are available but will not be discussed here. See http://www1.eere.energy.gov/solar/pv_use.html for information on other types of systems.

A typical grid-tie PV system has a series of PV panels connected together to form an array. The array can be installed on a roof or on ground or pole-top mounts. The DC output of the PV array is fed to a device called an inverter that converts the DC to AC (alternating current) power that exactly matches the voltage and frequency of the electricity flowing in the utility line. Such a system is illustrated schematically below.




The electricity generated by these systems flows into the home's electric service panel and merges with the utility power. If the PV system is producing more energy than the home is using, the excess flows out into the utility grid, turning the utility meter backwards and (here in Arizona, at least) generating a credit. If the home is consuming more energy than the PV system is producing, the meter turns in the forward direction. This is known as **net metering.** (For a good overview of how net meting works, see http://www.greenwatts.com/Docs/TEPNetMetering.pdf .)

There are no storage batteries in this type of system. It is designed to shut down during a power outage and cannot function as a backup power system. In the event of a power outage, safety circuits in the inverter automatically disconnect the PV system from the power grid. This safety disconnect protects utility repair personnel from being shocked by electricity flowing from the PV array into what they would to be a "dead" utility line.

**Be sure to request "net metering" from TEP – otherwise they may block your meter from running backwards and you won't receive credit for the power delivered to the grid!** TEP will then install a digital meter that automatically records the amount of electricity consumed from the power grid, the amount feed back into the grid and the difference, or net amount. You will receive credit if more is feed back into the grid than is used against future bills.

TEP will install an additional meter between the inverter and service panel so that they can more easily monitor – and get credit for – the solar electricity generated.

The orientation of PV panels relative to the sun is more critical than for heat collecting panels used for water heating. The ideal orientation is perpendicular to a line drawn to the sun. Since the sun's apparent position changes during the day and from season to season, maintaining the ideal orientation would require s system to automatically track the sun. This is not usually practical for a home system. A good compromise is to mount the panels at an angle respect to the ground equal to local latitude (32° in our area) and pointing as close to true south (not magnetic south) as possible. The panel angle could be optimized for each season if desired (see http://www.macslab.com/optsolar.html.)

An example of roof-mounted panels (on my house) is shown at right. The PV array contains twenty 150 W panels electrically connected in two banks and feeding an inverter mounted on the side of the house next to the utility panel. Each bank of panels produces approximately 320 VDC; the inverter converts this to 240 VAC that is feed to the utility panel through a "solar meter" (described above). The system has been in operation since May 2006 and typically generates between 16 and 20 kWh (kilowatt hours) on reasonably clear days. The only maintenance required is occasional washing (from the top of a ladder with a hose) to remove accumulated dust.

Solar panels are rated in terms of peak DC Watts under standard test conditions (STC): cell temperature of 25°C, incident solar-spectrum radiation at an intensity of 1000 Watts per square meter. The value of 1000 W/m$^2$ was chosen because that is the approximate solar intensity at the equator at equinox at noon on a clear day. The actual "real world" output will be 80 to 95% of the STC value depending on latitude and season. Inverters used to change the DC current from the panels to AC current are 90 to 95% efficient. Therefore under the very best conditions, the usable peak output of a "real world" solar panel will be no more than 90% of the array's peak DC rating. My system is rated at 3000 W peak DC power and the AC power out of the inverter typically peaks between 2400 W and 2600 W on a clear sunny day.

## How Can I Get One and What Will It Cost?

First, lets consider the cost. The table below gives typical costs in the Tucson area of four common sizes of grid-tie PV systems. These system costs are *only approximate* and will vary depending on the market price of solar panels (which has been relatively stable for the past few years) and installation complexity. Prices will also vary somewhat between installers – sometimes substantially. **When comparing quoted costs from different installers, be sure that the quotes are for systems with similar performance capabilities.** One installer might quote a system containing twenty 150 W panels and another a system with eighteen 175 W panels that potentially provides 5% more output.

| Peak System Capacity, DC Watts | Expected Output, kWh per Year (1) | System Cost Before Credits | TEP Rebates (2) | Arizona Tax Credit | Federal Tax Credit | Net System Cost |
|---|---|---|---|---|---|---|
| **2000** | 3600 | $17,500 | $6,000 | $1,000 | $3,450 | $7,050 |
| **3000** | 5400 | $21,000 | $9,000 | $1,000 | $3,600 | $7,400 |
| **4500** | 8100 | $30,000 | $13,500 | $1,000 | $4,950 | $10,550 |
| **6000** | 10800 | $40,000 | $18,000 | $1,000 | $6,600 | $14,400 |

(1) Expected yearly average for the Tucson area.

(2) TRICO rebates are $1 per DCW higher than TCP rebates.

Even with utility rebates and tax credits, PV systems are not cheap! The estimated payback period is 10 to 14 years, depending on assumptions made about future costs of electricity and whether financing charges are involved.

Tax credits are helpful, but it would be nice if the state or federal government would help with up-front costs via low-cost loans or out-right grants. Some states do have grant programs for solar energy system (I believe Massachusetts is one), but not Arizona. The usual suggestion is to use a home-equity line of credit for financing – assuming you actually have some home equity! Some help may be on the horizon as described on the next page.

As the above table shows, the "best bang for the buck" is achieved with 3000 WDC or larger systems. Most local installers are prone to bid a 2000 WDC system unless requested to bid on a larger (or smaller) system.

Ideally, you would like a system that supplies between 70% and 80% of your yearly electricity usage. You can determine your annual kilowatt-hour usage from old utility bills. (As a point of reference, the current national household average annual usage is 11,000 kWh.) For help with sizing a PV system, see http://www.findsolar.com/ and click on "Solar Tools and Calculators."

Once you decide to install a PV system, the next step is to contact several installers for bids and references. And most important: check the references! If you contract your utility first, they will simply refer you to their web site for information. You will need to sign an interconnection agreement with your utility company and apply for a permit from your city or county. Installers will normally take care of obtaining the permit and some will help with the utility paperwork. If the installer that you choose does not handle the utility agreement for you, they should at least tell you who to contact and perhaps supply the necessary forms. Be sure to ask up-front about this.

## PV With No Up-Front Cost – A Near-Future Possibility?

Two companies – one national and one local – have recently been advertising their intention to supply solar PV systems at a very low up-front cost to the customer. The idea is for the company to own the system (and receive the tax credits and utility rebates) and sell the electricity generated to the customer at a price per kilowatt-hour fixed over specified time period. The only up-front cost would be a deposit on the order of $500 - $1000 that would be refundable at the end of the contract period.

The two companies are:

**GreenSun Energy Solutions LLC** *(No phone or email - no longer in business?)*
Phone: ???
Email: ???
URL: http://www.greensunenergy.com/ (*Website was still up as of 9/09.)*

**r think solar**
Local contact information (*possibly out-of-date)*:
Phone: (520) 245-1970 or (602) 739-5747 (Phoenix)
URL: http://www.solargies.com/

It is not clear if either of these companies has actually installed a system, so check them out thoroughly before committing any money. If they do succeed in their plans, that would be a tremendous step in getting more people to install solar electric systems!

## Electricity From Wind Power

Why do I include Wind Power under Solar Energy? Because non-uniform heating of the earth's atmosphere by that sun is what gives rise to wind!

Wind Power is a very viable option for many parts of the country, but not necessarily for the Tucson region. Yes, we have wind – at times too much – but it is not consistent. We may have days on end with very little or no wind. But it is worth considering for that summer cabin up in the mountains or summer home in the Midwest.

Several companies now produce small-scale (1-10kW) electric wind generators specifically designed for home use. An example is shown at the right; it has an output of 1.8kW and a built-in inverter for grid-tie use. See http://www.skystreamenergy.com/ for more information.

Cost wise, wind generators are competitive with PV systems, and usually less expensive for systems over 5kW. TRICO will gives rebates for wind generators, but TEP does not at this time.

For additional information on wind power, see http://www.nrel.gov/wind/ and http://www1.eere.energy.gov/windandhydro/ .