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Energy Efficiency & Environmental News: Practical Uses of Solar Energy[1]

Florida Energy Extension Service and Mike West[2]

PRACTICAL USES OF SOLAR ENERGY

You can put solar energy to work for you and save energy and money. Switching to solar helps protect Florida's beautiful and delicate environment, and reduce our dependence on fossil fuels. Today, there are three practical uses of solar energy for the homeowner: pool heating, hot water, and electricity for remote locations.

Less use of electric power generated from fossil fuels means less greenhouse gas and acid rain emissions. Every kWh saved eliminates 1.5 pounds of carbon dioxide, 0.2 pounds of sulfur dioxide, 0.25 pounds of carbon monoxide, and 0.01 pounds of nitrogen oxide emissions.

To purchase solar systems, consult a local contractor. Many communities are served by an energy conservation or solar contractor. Check the yellow pages under "Solar Energy Systems." ***Follow up on each potential contractor's list of references.***

Solar Pool Heating

The most practical and popular use of solar energy for the homeowner is solar pool heating. A solar pool heater extends the swimming season from May through October to February through November (in Central Florida, water temperature at least 75 degrees). This amount of heating is equivalent to $1500 worth of electricity (heat pump) or natural gas for a 24' by 20' pool.

A solar system for a 24' by 20' pool costs $3200 to $4200. The installed cost of a solar system is about the same as a heat pump, or about twice the cost of a natural gas heater ($1500 to $7000, depending on the desired pool temperature and the size of the pool). Solar heater maintenance costs are much less than either type of conventional heater. An additional advantage of solar is quiet -- solar pool heaters are almost silent.

The best type of pool heater collectors are the rubber mat type, according to FEES specialist Gary Cook. The mats are virtually indestructible, and if damaged, are easily repaired. Gary has had this type of collector on his roof for over 12 years. The mats heat his 700 gallon hot tub from 75°F to over 100°F in less than one hour (two hours in winter). His swimming season is extended three months (Gary lives in Gainesville).

Solar Water Heating

Today, there are thousands of solar water heating systems installed in Florida. They put the sun to work heating water for showers, hot tubs, and dish washing. Reliable solar water heating systems are economical where natural gas is unavailable. Modern systems can supply at least 70% and up to 90% of a

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family's hot water needs. This can cut the typical Florida home electric bill by 10% to 13%. In this sense, a solar hot water heater is a good economic investment. The return on investment is the cash saved on utility bills. This corresponds to an annual rate of return of 7-9%, very respectable for such a safe investment. Quality systems last as long as the home they are installed in. The Florida Solar Energy Center can provide their ratings of solar collectors and systems (see References).

Solar water heating systems range in price from $1600 for a small system serving two people, up to $5000 for a system that serves a family of eight. A quality system sized for a family of 4 costs $3000 to $3500. A solar water heater could save the average Florida family around $300 per year, and help protect the environment by reducing the pollution caused by generating electricity from fossil fuels.

Be aware of a few important details when selecting a solar water heating system. A system sized for a typical Florida family uses two 4' by 8' collectors. Look for a system that uses a *solar powered* pump. According to Tom Lane* of Energy Conservation Services, most Floridians should select closed-loop systems that use antifreeze to protect the system from freezing. Drain-back systems are another option. (Open-loop systems are suitable in South Florida and the Keys). The storage tank should hold at least 20 gallons of water per family member. Extra storage capacity is recommended, and is inexpensive.

* Licensed solar contractor, Gainesville FL. (904)373-3220. FEES does not endorse brands or contractors.

Solar Electric Power Generation

Today, solar photovoltaic (PV) systems are at work converting the suns radiation directly to electricity. PV generated power has three main advantages over all other types of remote power generation:

- Free Inexhaustible Power
- Simplicity
- Low Maintenance

PVs provide electricity to rural homeowners, ranchers, and farmers for TV, VCR, stereo, landscape and security lighting, pumps, electric fences, and livestock feeders, *without connection to the power company*. Some farmers use PV powered pumps for watering of livestock on remote grazing areas. PV systems power street, billboard, bus stop, and highway sign lights, navigational buoys, and emergency telephones throughout Florida. Small PV systems provide portable power for camping equipment, computers, fans, pumps, and test equipment. PV cells are used in calculators and watches. Photovoltaic power is practical where access to utility company lines is costly, and for low power/portable needs.

Industry improvements have reduced the cost of PV systems to 25-50¢ per kWh. This is still considerably more than the 7-10¢ per kWh of utility power. The U.S. Department of Energy (DOE) goal is PV power at 12¢ to 20¢ per kWh before 2000.

To take advantage of the economies of large scale production, the DOE announced a new strategy to accelerate the use of PV power. The DOE *Solar 2000* plan calls for an increase in PV use by a factor of ten by the year 2000. Use of PV power is increasing by over 25% each year, and has been for the past few years.

PV power systems range in price from $75 to $40,000 depending on how much electricity the user needs. The box below shows how system cost varies. PV systems are a poor economic investment if power is readily available: the annual rate of return is around 1%. However, in outlying or isolated locations, connecting to faraway power lines can cost **more** than a complete PV power station!

Table 1. Cost Comparison. High Capacity Solar PV Systems Cost Considerably More Than Low Capacity Systems.

Appliances Powered By Solar PV	System Cost
Outdoor/Path lighting	$75
DC power for computer or TV only	$800
TV, VCR, stereo, lights, computer	$7000
-- above plus refrigerator	$12,000
-- above plus well pump (home)	$15,000
-- above plus ventilation fans	$17,000
-- above plus central A/C	$31,000

As Table 1 shows, even modest increases in electrical capacity increases the price considerably. When using PV power, it is especially cost effective to replace inefficient appliances with modern energy efficient ones -- allowing selection of a less costly PV system. Since PV cells produce DC voltage, the use of DC (instead of conventional AC) pumps, fans, refrigerators, lights, etc. makes sense. Use of DC appliances reduces the cost of the PV system since they are typically more efficient and require no invertor capacity. (*The invertor is the part of the PV system that changes the PV cells DC voltage to AC.*) In most cases, it is not yet economical to power cooling and heating equipment with PV power since these are seasonal loads. Heating and cooling accounts for over half the residential energy use of a typical Florida family.

PV power systems are modular, so they easily grow with the users budget and electricity needs. PV system size is measured in watt-hours per day (WH/D). Typical system cost is around $3 per WH/D of system capacity. The smallest systems (around 200 WH/D) can cost up to $5 per WH/D, while very large systems (10,000 WH/D) cost less than $3 per WH/D. Storage batteries are required for power at night and on overcast days. The required size and cost of a PV system can be estimated using the Sizing Worksheet given in Table 2.

Utility bills can be used to determine the WH/D of electricity currently consumed. Most bills give "average kWh used per day," simply multiply this number by 1000 to obtain WH/D. Or, (1) take the total kWh on the bill, (2) divide by the number of days in the billing period, and (3) multiply by 1000 to obtain WH/D. Using this method, one can see that a conventional small home, with a $65 monthly electric bill, would require 25,000 WH/D of PV capacity to go completely solar using the same appliances and lighting. The great cost of such a system emphasizes the importance of using efficient lighting and appliances, natural gas for cooking and heating, and fans for cooling.

References

Solar Photovoltaics: Out of the Lab and onto the Production Line. Mechanical Engineering, January 1992 by Steven Ashley.

Solar Equipment Standards: some Questions and Answers. Florida Solar Energy Center #GP-9. **E**nergy **R**escource **D**irectory #421. Contact the Center at 407-783-0300.

Simplified Sizing Procedure for Solar Domestic Hot Water Systems. Florida Solar Energy Center #GP-10. ERD #417.

Thermal Performance Ratings of Solar Collectors. Florida Solar Energy Center #'s GP-14 and GP-16.

FSEC Approved Solar Energy Systems: Domestic Hot Water and Pool Heating. Florida Solar Energy Center #GP-15.

Measurement of Solar Radiation. IFAS publication #CIR-827, ERD# 214.

Solar Water Heating: A Question and Answer Primer. Florida Solar Energy Center #EN-5. ERD #426.

Solar Heating of Swimming Pools: A Question and Answer Primer. Florida Solar Energy Center #EN-6. ERD #422.

Solar Swimming Pool Heating in Florida: Collector Sizing and Economics. Florida Solar Energy Center #GP-13. ERD #423.

Solar Water Heating Options in Florida. FSEC #EN-9. ERD #425.

Sources of Solar Consumer Protection. Florida Solar Energy Center #FS-29. ERD #428.

Global Climatic Change Primer. Florida Energy Extension Service # EES 72.

The Greenhouse Effect. FSEC #EN-16. ERD #431.

The worksheet in Table 2 will aid in estimating the required size of a solar photovoltaic electric power system. In the first block, list all the appliances which are to be powered by the PV system. Check the appliance label or nameplate for its rated wattage. Next, estimate the number of hours per day each appliance is "on". Then, follow the calculation instructions in lines **A** through **G** to arrive at the estimated cost of a complete PV power system.

Table 2. PV Sizing Worksheet. Check Appliance Labels For Wattage. For Ratings in AMPS, Multiply AMPS x VOLTS (120 or 240) to Obtain WATTS. HOURS/DAY is Hours Used Per Day.

List All Appliances to be PV Powered	**WATTS**	**HOURS/DAY**	**WH/D**
A. Load: Sum of all WH/D above		LOAD WH/D =	
B. Battery and Invertor Losses: 25% of line A.		LOSSES WH/D =	
C. Net energy needed per day: Add lines A and B.		NET WH/D =	
D. Desired number of days of storage capacity.		STORAGE DAYS =	
E. Total required system size: Multiply line C by line D.		TOTAL WH/D =	
F. System unit cost. (typically $3 to $5)		$ per WH/D =	
G. Total system cost. Multiply line E by line F.		TOTAL COST =	$

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SIMPLY SAVING

Energy Efficient

Economical

Environmentally Sound

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family's hot water needs. This can cut the typical Floridians home electric bill by 10% to 13%.

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