

PROGRAM SUMMARY

SOLAR WEATHERIZATION ASSISTANCE PROGRAM

The Solar Weatherization Assistance Program (SWAP) was a joint effort of the U.S. Department of Energy (DOE), the Florida Department of Community Affairs (DCA) and the Florida Solar Energy Center (FSEC) to provide solar water heating systems for low-income residents in Florida.

Raising families, incurring everyday bills and purchasing common necessities are all part of daily life that can rapidly drain a family's budget. This is especially burdensome for low-income and elderly residents on a fixed income. A major part of the budgetary concerns are the recurrent and unavoidable electric bills.

In northern colder climates, weatherization programs assist low-income clients in reducing their energy costs by conducting weatherization on existing homes.

Very often many northern weatherization measures such as caulking and weatherstripping are not cost-effective in warmer climates. Therefore, it only makes sense to take advantage of Florida's abundant and everlasting solar energy resource to help reduce energy costs in low-income residences.



Mrs. Roundtree and her three children are quite happy with the solar heated water they get from their SWAP solar system. They have more hot water than before the solar water heater was installed and reduced electric bills.

The SWAP program's major objectives included:

- ✓ **reducing energy consumption and power bills for low-income residents**
- ✓ **calculating the savings-to-investment ratio from the DOE NEAT audit procedures**
- ✓ **Evaluating the feasibility of solar systems as a WAP program measure**
- ✓ **provide a niche market for the solar industry**
- ✓ **reducing LIHEAP expenditures**

DCA provided grants to local Weatherization Assistance Program agencies and other non-profit agencies to operate the program, while SWAP-certified solar contractors provided installations.

The program was widely administered in rural and urban communities by non-profit organizations and governmental agencies in cooperation with local volunteer groups.

FSEC established an extensive database to compile and store information obtained by site inspections, surveys, utility bill analysis and computerized data acquisition at over 30 selected sites, where such variables as water temperature, water consumption, and power consumption are monitored.

FSEC developed all technical guidelines and provided on-going technical assistance, training, and program support to DCA and all participating local agencies and installers.

SWAP participating agencies throughout Florida



Solar system installed on country home in rural North Florida.



Solar collectors mounted on low-income residences in Miami.

SWAP INSTALLED SYSTEMS

Several types of solar systems were installed under the SWAP program. The primary ones were the Integral Collector Storage (ICS) and the direct pumped systems.

In the ICS unit pictured below, one can clearly see the large tubes in which water is heated and stored. ICS systems combine both the heat collection and storage in one unit. Water is heated in the ICS tubes and flows to the back-up water heater when the client uses hot water.

Of course, both ICS and pumped systems include a back-up electric water heater for use during inclement weather.



The flat-plate solar collector, above, is mounted on a residence in Miami. This collector uses a pump to help circulate water through the small tubes in the collector.



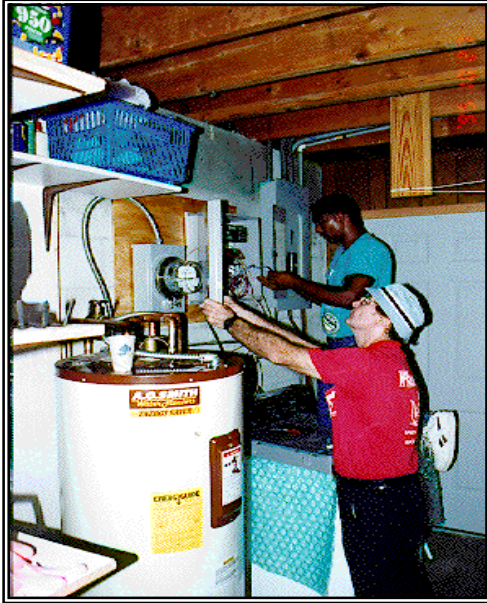
Direct pumped systems include a pump and some type of controller that determines when the pump should be on. The pump then forces water through the solar collector, where it is heated and returned to the water heater in the house.

Listing of SWAP Systems installed throughout Florida

Florida Location	Agency	System	Total installed Systems	Average System Cost
North	Central	ICS	45	\$1,641
	Suwannee	ICS	90	\$1,631
	Suwannee	Pumped	1	\$1,690
	Tri-County	ICS	48	\$1,641
Central	Citrus	ICS	25	\$1,516
	Citrus	Pumped	4	\$1,388
	Citrus	Thermo	1	\$1,690
	Mid-Florida	ICS	162	\$1,497
	Mid-Florida	Pumped	28	\$1,384
	Pinellas	Pumped	5	\$1,535
Pinellas	Thermo	1	\$1,750	
South	Metro-Dade	Pumped	307	\$1,501
	Centro	ICS	4	\$1,540
	Centro	Pumped	30	\$1,423
	Lee County	ICS	19	\$1,641
	Lee County	Pumped	31	\$1,414
		Total Installed Systems		801
		Average Cost		\$1,555

SWAP INSTRUMENTED MONITORING

In order to assess the viability of solar systems as well as low-income hot water use characteristics, FSEC conducted detailed instrumented monitoring at over 30 SWAP sites.



FSEC staff members Tom Tiedemann, right, and Patrick Robinson installing monitoring equipment at one of the SWAP sites.

The following were monitored at the instrumented sites:

- ✓ Cold and hot water temperatures
- ✓ Collector feed and return line temperatures
- ✓ Flow to and energy usage of water heater
- ✓ Horizontal solar radiation
- ✓ One-time measurement of pump and controller power usage
- ✓ Scanned data every 15 seconds - stored average - totals every 15 minutes.
- ✓ Ambient temperatures during pre-solar monitoring

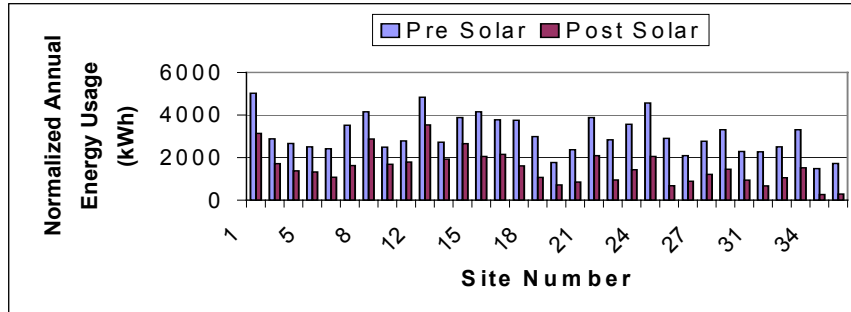
SWAP Monitoring Program Results

Parameter	Pre Solar	Post Solar
Average family size	4.7	4.4
Average water heating energy consumption (kWh per system, per year)	3,100	1,500
Water heating costs per year (\$.08 kWh)	\$250	\$120
NEAT Savings-to-Investment Ratio (at \$.08 per kWh)	N/A	1.0
Solar Fraction (Percentage of hot water heated by solar)	N/A	0.53
Average system Coefficient of Performance	0.73	1.4
Average SWAP solar system installed cost	N/A	\$1,550
Gallons used – Family per day	63.8	62.5
Gallons used – Per person per day	13.6	14.2
Average hot water temperature (° F)	119	119

SWAP INSTRUMENTED MONITORING RESULTS

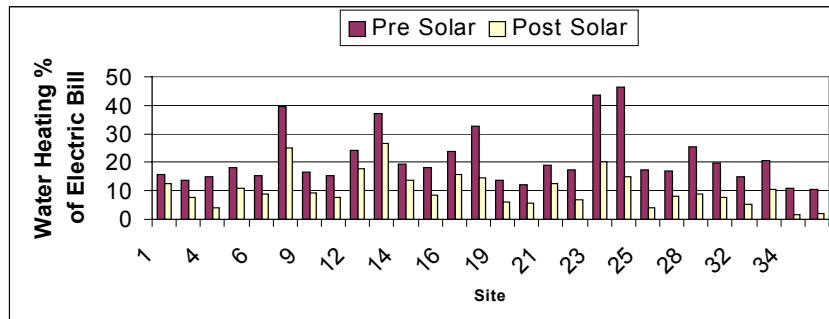
The following charts are based on instrumented monitoring data from 32 SWAP sites.

SWAP Hard Monitoring Annual Energy Usage



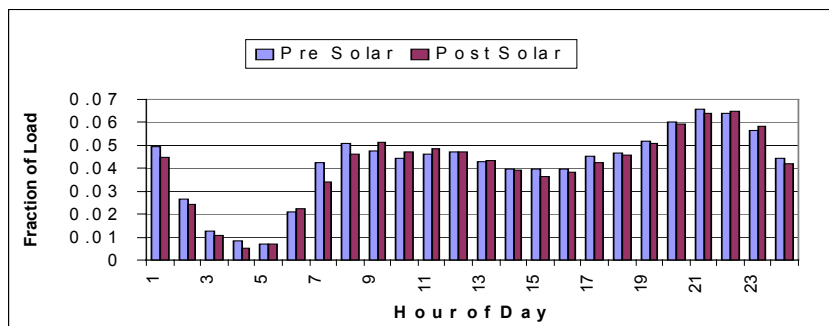
Pre solar energy usage and energy costs are greatly affected by factors such as water usage, and existing water heater and water heater thermostat settings. Post solar system usage and savings are affected by the above as well as timing of loads, solar radiation, and solar system performance.

SWAP Hard Monitored Systems Water Heating Ratio



This chart indicates the percentage of electrical energy devoted to heating water. The amount varies by site and is typically a very substantial portion of the utility bill. Solar systems reduce this percentage dramatically.

SWAP Hard Monitored Systems Water Usage Profile



This water usage pattern is very favorable for solar water heating since usage peak is in the evening.

SYSTEM OWNER SURVEYS

Surveys were sent to over 800 clients that had received a solar system. Over 35% responded to the survey. Overall, the survey indicated that:

- ✓ most participants were satisfied with their systems
- ✓ participants were aware of the weather-sensitive nature of the solar systems
- ✓ participants need more information and education regarding system operation, maintenance, etc.

SYSTEM INSPECTIONS

FSEC staff inspected over 200 of the installed systems, looking at the quality of the installations as well as system/component problems. In general, the inspections revealed:

- ✓ Few component failures
- ✓ Most installation discrepancies are easily fixed
- ✓ Most discrepancies are related to workmanship versus equipment problems
- ✓ Post-installation inspections are critical.

LOCAL AGENCY PARTICIPATION

Brenda Mobley, SWAP Program Manager for the Mid Florida Community Services Agency, believes that “. . . a solar water system doesn't just help with the energy bill, it also relieves other financial stress.”

Brenda goes on to state, “For a program that reduces your energy bill and doesn't cost you a penny, the solar heater is the way to go. This program has proven itself to many low-income clients in Hernando and Sumter Counties. Several clients have made a point of telling me personally that the solar water heaters have cut their electric bill in half and have advised anyone to take advantage of this worthwhile program. The SWAP program has been very worthwhile in meeting Mid Florida's primary mission of reducing the energy costs of low-income clients.”



Brenda Mobley, SWAP Program Manager for the Mid Florida Community Services Agency discusses a local installation with FSEC SWAP Program Manager John Harrison (right), and FSEC's Patrick Robinson (left).

THE CLIENTS' STORIES

The Sims Family – Brooksville, Florida

Although it's easy to get lost in the technicalities of this program, the end product is that these solar systems are affecting people's lives in a positive manner. They are helping low-income people better support themselves. At this point, let's allow a few clients to speak for themselves on the impact of their solar water heating systems.

Take the example of Mrs. Sims and her family. As a single mother with three children, Mrs. Sims provides a stable family environment, maintains two jobs and is currently attending medical radiologist school.

According to Mrs. Sims, the ICS solar system that was installed on her residence has become one of her favorite appliances. It works quite well; she doesn't have to do anything with it. It's just there, silently creating hot water from a free energy source.

The monthly savings accrued from the solar system provide her with additional income that can be used for her family's unavoidable expenses.

And, Mrs. Sims states: "I also feel like I'm doing my part in preserving natural resources as well as helping save energy and the environment. But most of all, I really appreciate the savings and extra hot water that I have enjoyed since the solar system has been installed."



Mrs. Sims is shown conferring with FSEC SWAP program staff members. Her ICS solar system is conveniently mounted facing south. Note the solar collector's unobstructive look, similar to that of a standard skylight.

Sims System monitoring results

Category	Pre Solar	Post Solar
Installed system	N/A	ICS
Installed system cost	N/A	\$1,500
Water heating energy usage (kWh per year)	2367	846
Water heating costs per year (\$.08 kWh)	\$189	\$68
Water usage (Gals per day)	59	44
Solar Fraction	N/A	.64
NEAT Saving-to-Investment Ratio	N/A	1.03

The Ahmadi Family – Miami, Florida



Behind Mrs. Ahmadi and her two children is the water heater. Above the tank is the solar system pump and piping going up to the solar collector.

“Since my solar system has an on/off switch that turns the electricity to the water heater off, during sunny days, we always keep the switch off. This way, all the hot water that I use is made by the sun. This really cuts my utility bill. I’m getting free hot water.”

Mrs. Ahmadi received her solar system through the Metro-Dade Community Action Agency in 1996 and has been quite satisfied with it since. “What took you so long in providing me a solar system?” she wonders. “I’ve had neighbors ask about the collector on the roof and after I’ve told them of how great the system was, they also want one.”

The system consists of a flat-plate pumped solar collector retrofitted to a 50-gallon water heater. Sensors at the collector and pump tell an electronic controller when there is sufficient solar energy available to heat the water. At that time, the pump comes on and circulates the water from the tank through the solar collector where it is heated.

Ahmadi system monitoring results

Category	Pre Solar	Post Solar
Installed system	N/A	Active Pumped
Installed system cost	N/A	\$1,550
Water heating energy usage (kWh per year)	2902	679
Water heating costs per year (\$.08 kWh)	\$232	\$54
Water usage (Gals per day)	78	79
Solar Fraction	N/A	.77
NEAT Saving-to-Investment Ratio	N/A	1.4