

2.0 OVERVIEW OF INSTALLED SYSTEMS

The following tables provide a detailed overview of the number, types, locations and costs of installed SWAP systems throughout Florida.

Table 2.0-1. SWAP Solar System Installations

Location	Agency	System Installed	Total Installed Systems	Average Cost (\$) Per Installation
North Florida	Tri-County	ICS	48	\$1,641
	Suwannee	ICS	90	\$1,631
	Suwannee	Active Pumped	1	\$1,690
	Central	ICS	45	\$1,641
All North Total Systems/Costs			184	\$1,650
Central Florida	Mid-Florida	ICS	162	\$1,497
	Mid-Florida	Active pumped	28	\$1,384
	Pinellas	Active pumped	5	\$1,535
	Pinellas	Thermosiphon	1	\$1,750
	Citrus	Active Pumped	4	\$1,388
	Citrus	CS	25	\$1,516
	Citrus	Thermosiphon	1	\$1,690
All Central Total Systems/Costs			226	\$1,537
South Florida	Dade	Active pumped	307	\$1,501
	Lee	Active pumped	31	\$1,414
	Lee	ICS	19	\$1,641
	Centro	Active pumped	30	\$1,423
	Centro	ICS	4	\$1,540
All South Total Systems/Costs			391	\$1,504
		TOTAL ALL SYSTEMS	801	
		TOTAL AVERAGE COST		\$1,555

The following table outlines the types and sizes of collectors installed by total program participants:

Table 2.0-2. SWAP Installed Systems - Collector Types and Sizes

Collector	Size (Square footage for Flat-Plate and Square footage/ Gallons Capacity for ICS)	Total Installed	Percentage of Total
Flat -Plate	20	4	5
	21	3	4
	24	1	1
	25 (commonly identified as 26)	208	26
	32	157	20
	40	4	5
Thermosiphon	25	2	2
Integral Collector Storage	32/30	263	33
	40/40	131	16
Unknown*	-	28	3

*Note: Centro-Campesino did not report the size of the flat-plate collectors that were installed on active systems at numerous SWAP sites. From past installation inspections by FSEC staff of this installer's work in Lee County, it was noted that the collectors installed were either 26 or 32 square feet in size. Thereby, it is assumed that these would be in that same range.



Figure 2.0-1. Twenty-square-foot collector installed on tile roof.

As stated previously, a variety of systems were installed as part of the SWAP program. Table 2.0-3 provides an overview of the types and number of systems installed.

Table 2.0-3. Overall Summary of System Types Installed

System type	Total Installed	Percentage of total
Active Pumped Differential Controller	313	39
Active Pumped Timer Controller	70	9
Active Pumped Photovoltaic Controller	23	3
Integral Collector Storage	393	49
Thermosiphon	2	0.2

2.1 GENERAL COMMENTS ON NORTH FLORIDA INSTALLATIONS

North Florida installations were restricted to the use of ICS systems. As stated previously, more complex systems could have been used, but due to cost restraints, future maintenance, and criteria for system simplicity, they were not. The ICS systems in North Florida proved quite reliable. Local SWAP participating agency personnel found the system simplicity provided them with confidence in understanding and explaining to clients how the system worked. In addition, the rural nature and distances between clients and installers (as well as local SWAP agencies) necessitated the use of a simple system that would require very little service during its lifetime.

Three agencies participated in the SWAP program in North Florida. These agencies and the areas they served are as follows:

Table 2.1-1. SWAP Participating Agencies - North Florida

Agency	City	Region	Percent of total installed systems
Suwannee River Economic Council, Inc. (SREC)	Live Oak	Rural	11
Tri-County Community Council, Inc.	Bonifay	Rural	6
Central Florida Community Action Agency, Inc.	Gainesville	Urban	6

Both Suwannee and Tri-County served clients that lived, in large part, in rural areas. Central Florida encompassed an urban area, Gainesville, but also served numerous clients in outlying rural communities.

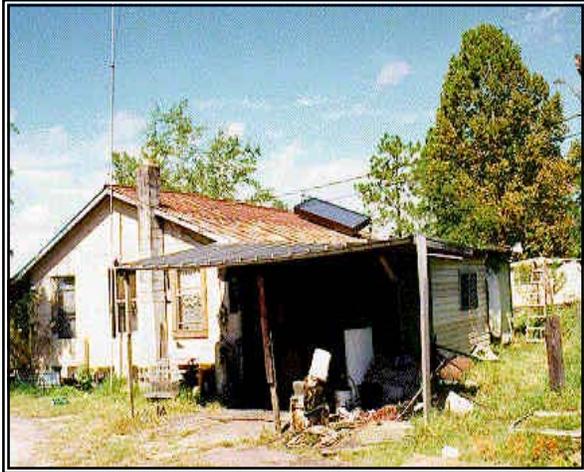


Figure 2.1-1. ICS system installed on a rural residence in North Florida.

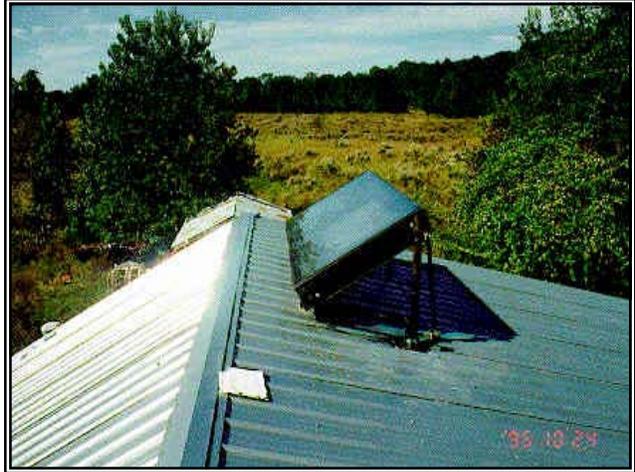


Figure 2.1-2. ICS collector installed on metal roof in rural area.

A major handicap in both Suwannee and Tri-County areas was that solar installers had to come from great distances (1 to 2 hour travel time) to install the SWAP solar systems. System installations were scheduled when more than one site was contracted for the installation of a solar system. Installers would often have to stay at area motels whenever numerous systems were to be installed. This of course affected the final installation cost of the systems, since logistics and costs involved with these distances had to be considered. Unfortunately, there were no installers closer than those selected for several of these agencies.

Suwannee did solve some of this problem by having FSEC train a local licensed plumber in the installation of the ICS unit. This provided the local agency with additional contractors from which to choose. Plumbers are, by Florida construction licensing regulations, allowed to install solar water heating systems. This will also serve to provide Suwannee with a local craftsman in the event of required service calls.



Figure 2.1-3. Local plumber installing ICS system.

Of special technical interest were specific instances where problems occurred in two North Florida areas (Suwannee and Tri County) where solar systems were installed. Interestingly, both problems were not the result of solar system discrepancies, but instead were caused by the quality of the local water.

Several systems installed in a specific neighborhood in Jasper, Florida, developed pinhole leaks in the absorber tubes. After detailed laboratory analysis, it was determined that the most probable cause of the leaking appeared to be localized pitting corrosion. This was the result of iron precipitation from the incoming city water supply. The severe iron content in the water supply was creating adverse galvanic corrosion in the copper tubing. This iron came from old iron pipes or/and pumps used in that specific neighborhood. A final report developed for FSEC on this problem is attached in Appendix 3.

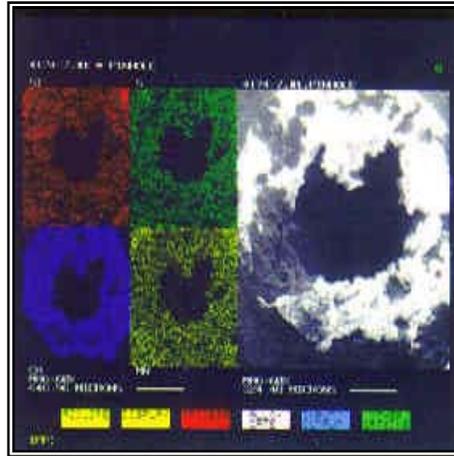


Figure 2.1-4. Analysis of pin holes with Energy Dispersive Spectroscopy analysis of pin holes.

The ICS units were repaired and whole-house water filters were installed. Since that time, there have been no further problems at the sites. The clients later remarked that their water was now much better with the filter. (Filters were purchased at a local hardware store that always stocks the filter replacement cartridges. Cost is \$5 for 2 cartridges. An FSEC follow-up indicated that cartridges should be replaced every 4 to 6 months.)



Figure 2.1-5. Whole house filter being installed.

At two rural sites in the Tri-County area of North Florida, two clients started noticing that their tubs, shower curtains, and, at times, laundry had a blue color to it. FSEC investigation determined that these systems were installed on wells where the pH of the water was below 5.0. This very acidic water was leaching the copper, which in turn, caused the “blue water” syndrome. It was also noted that neither house had copper piping before the solar installation. The original piping was either short runs of metal pipe and/or PVC piping. Local plumbers must have known about this problem and therefore did not use copper in the potable water system.



Figure 2.1-6. Blue residue from copper leaching due to very acidic well water.

The problem was solved at one residence when the client decided to switch to the city water system. The other resident was not as fortunate. The system had to be removed and installed at another residence. The drilling of a new well may have provided better quality water, but this was cost prohibitive. In the end, FSEC sent the agency in that area a simple pH meter and instructed the agency to test the water prior to qualifying a site for a SWAP system. Sites with water pH levels less than 7.0 were excluded from the program.

Another water quality problem occurred in the active automatic draindown photovoltaic-powered system installed in North Florida. During instrumented monitoring of this system, it was noted that the draindown mechanism was not sealing completely during the draindown mode. Investigation revealed shell-like material stuck within the draindown valve mechanism. Flushing of the water heater also revealed large amounts of crushed shell material. FSEC staff conducted several trips to this site to clean the valve and completely flush out the system.

The above examples point out the problems that can occur due to water quality. This is a very important and troublesome issue for both solar systems and water heater manufacturers. Conversations with water heater industry representatives indicate that manufacturers at times have to modify warranties for water heaters in specific geographic areas due to the destructive quality of the water. (Sutherland, 1994)

2.2 GENERAL NOTES ON CENTRAL FLORIDA INSTALLATIONS

The agencies listed in Table 2.2-1 were initially selected for participation in the SWAP program in Central Florida. Pinellas dropped out of the program after only six system installations. The remaining agencies, Citrus and Mid-Florida, and their clients participated in all phases of the SWAP program: system installations, instrumented monitoring, and utility bill analysis.

Table 2.2-1. SWAP Participating Agencies - Central Florida

Agency	City	Region	Percent of total installed systems
Mid Florida Community Services, Inc.	Brooksville	Urban/Rural	24
Citrus County Housing Division	Lecanto	Urban/Rural	4
Pinellas County Urban League	Gainesville	Urban	1

The outstanding feature of the installations in Central Florida was the efficiency with which the sites were identified and the systems installed by the Mid-Florida Community Services agency and their selected local installer. The SWAP coordinator in Mid-Florida (Brenda Mobley) was very instrumental in the success of the program by using every available means to procure clients for the SWAP program. This included working with the Mid-Florida database of low-income clients as well as through church groups, Habitat for Humanity, etc. The installer used in that area was also exceptional. Their professional attitude and craftsmanship greatly advanced the goals of the SWAP program in that area. The SWAP program greatly benefited from this special combination of SWAP program coordinator and particular solar installation firm.



Figure 2.2-1. Brenda Mobley of the Mid Florida Community Services discusses a ICS installation with FSEC's John Harrison and Patrick Robinson.

Pinellas County presented an initial administrative challenge to the SWAP program in that solar systems could not be installed on residences in St Petersburg without a separate professional engineer's certification for each proposed installation. This requirement would have greatly increased the installation cost of each system. FSEC staff and Henry Healey of Healey and Associates, a professional engineer familiar with structural requirements, met with St. Petersburg Building Department officials to resolve this problem. FSEC and Henry Healey presented the department staff with documentation, illustrating the various methods of attaching solar collectors to roof trusses. The building department officials were satisfied with one specific mounting method (spanner mounting) and agreed to allow a generic drawing of that mounting method to be submitted with each building permit, indicating that this type of mounting would be used for collector mounting. This precluded the requirement that a professional engineer had to develop a structural mounting analysis for each separate residence. Unfortunately, soon after this resolution was achieved, the Pinellas County Urban League dropped out of the SWAP program.



Figure 2.2-2. Spanner mounting of solar collector.

Although the above problem was encountered during the administration of the SWAP program, it is a very good example of the local barriers that are often faced statewide by solar installers.

As outlined previously, specific systems (and system sizes) were required in each area. The specifics of this criterion were revised periodically as lessons were learned. Initially, systems using flat-plate collectors were permitted for installations in Central Florida. This was revised after the first freeze in the area, in which one resident, whose system incorporated a flat-plate collector, decided to drain the system instead of allowing the automatic freeze protection mechanism to operate. The client properly shut the isolation valves in the collector feed and return lines, but did not continue the manual draining process by opening the drain valves and allowing the water to drain from the collectors. Therefore, water was still in the collector. The water froze, expanded and burst the copper tubing in the collector. After this incident, FSEC staff decided to end the use of flat-plate collector type systems in Central Florida, where periodic freezes are a common winter occurrence. Installations were restricted to the use of ICS systems, which have an inherent freeze protection method due to the collector tubes' thermal mass - and require no homeowner interaction.

Note that this applied strictly to specific areas in Central Florida (Citrus and Mid-Florida) since these areas tend to encounter colder weather during freeze conditions. (USDA, 1475) Pinellas County was not

affected by this since it is located next to the Gulf Coast and does not register the extreme conditions noted in the other two areas.

Citrus County personnel brought up a specific situation that should be addressed for future low-income solar programs. Mobile homes are excluded from the Florida WAP program since the NEAT audit procedure does not apply to mobile homes. Unfortunately, a large number of low-income clients live in mobile homes in Citrus County. SWAP systems were not installed on these homes.



Figure 2.2-3. ICS system inadvertently installed on mobile home.

One must keep in mind that solar water heaters do one thing - heat water. they are not true weatherization measures. They are instead, water heating appliances. It does not matter whether the solar system is installed on tract houses, duplexes, mobile homes, etc. The system will work the same on any of these residences.

2.3 GENERAL COMMENTS ON SOUTH FLORIDA INSTALLATIONS

The majority of systems installed in South Florida were in urban areas. This includes a wide range of Dade County, from North Miami to Florida City. A tremendous amount of low-income housing stock was available. The majority of houses were quite suitable to the installation of solar systems. In the south part of Dade County, shading did not present a problem, since most of the trees and taller shrubbery had been destroyed by Hurricane Andrew. In addition, most of the houses in south Dade County had also received extensive renovation due to the hurricane, therefore providing housing stock with structurally sound roofing.

As stated previously, the ICS unit was not used in Dade County due to the cost the manufacturer would have to incur to obtain Metro Dade Product Approval on his collector. Fortunately, several flat-plate manufacturers did obtain approval and therefore all systems installed in Dade County incorporated the flat-plate collector.

In general, the installations in Dade County went in without a great deal of administrative problems. Nevertheless, since there are numerous cities within the greater Miami area, the installers very often had to deal with a variety of local code and building department requirements.

One problem that was encountered by local installers centered around the use of pitch pans that are used to seal roof penetrations. System inspections in the Dade County area indicated that the primary installer there was forced by local building code officials to use pitch pans instead of the standard copper flashing and cap method for sloped shingled roofing. Although the pitch pan method is often used, especially for flat roofs, this method requires maintenance and inspection over the life of the system to ensure that the pitch seal remains stable. FSEC contacted and provided documentation to the Metro Dade Product Approval Official specifying that the solar industry and FSEC recommended copper flashing was best for solar installations on sloped roofs. Unfortunately, Metro-Dade officials responded by stating that the copper flashing would not be approved and that pitch pans had to be used. After consultation with DCA, it was decided that system installations would continue in Dade County with the use of pitch pans.

Therefore, the majority of systems installed in the Metro-Dade area incorporated the pitch pan methods for roof sealing of penetrations. The installers did a very adequate installation of these pitch pans. Holes were drilled in the roof, the copper piping was wrapped with sealant tape and passed through the pitch pan, which was affixed to the roof. In turn, the pitch pans were filled with bitumen sealing material. A well-sealed pitch pan should not result in any problems, although pitch pans do require maintenance and inspections over the life of the system. Over time, the pitch material could dry and crack. If severe enough, these cracks could, in some instances, provide avenues for minute amounts of water to filter through.

FSEC recommended the use of copper flashing and coolie caps, but since this was not allowed in Metro-Dade, the use of pitch pans was a second, although not highly recommended, option. Periodic inspection of the pitch material is recommended.

FSEC closely monitored many of these systems. As suspected, several problems did occur with the use of pitch pans. These were quickly brought to the attention of the installers and corrected. During periodic inspections, FSEC staff inspect the pitch pans and added bitumen as required.

Having stated the above, it must be noted that pitch pans have been in use for many years without an appreciable number of problems, and in the case of flat roofs, are the recommended method.



Figure 2.3-1. Pitch pan filled with bitumen.



Figure 2.3-2. FSEC's Tom Tiedemann adding bitumen to pitch pan during routine FSEC inspection.



Figure 2.3-3. Standard solar industry flashing.



Figure 2.3-4. Ideal roof flashing using copper flashing shown in Figure 2.3-3.

Lee County did not enter the SWAP program until quite late. An agreement between DCA and a local distributor/installer provided very reasonable installation costs for the active systems installed in that area. Unfortunately, the majority of the systems revealed many discrepancies during inspection by FSEC. These discrepancies were pointed out to local WAP staff, who in turn contacted the installer for corrections. Most of the discrepancies were due to poor installation workmanship rather than solar equipment failure, as is usually the case.

A second installer in Lee County installed ICS units in that area. Unfortunately, since Lee County entered the program at a late date, it was too late to monitor some of these ICS units. The second installer did outstanding work.

Of special note is the hope that some form of low-income solar program will be initiated in many of the agencies that participated in the SWAP program. Many local staff members are now very qualified and knowledgeable in the installation and inspection of solar systems. It would be a shame to let this experience go to waste. For example, Shawn Angell of the Metro-Dade Community Action Agency has become very adept at solar system issues. Not only has he done a commendable job in procuring and supervising the installations in Dade County, but in turn, has also reached a high level of competency in maintaining and troubleshooting any and all types of active solar systems installed in his jurisdiction.

Table 2.3-1. SWAP Participating Agencies - South Florida

Agency	City	Region	Percent of total installed systems
Metro-Dade Community Action Agency	Miami	Urban	38
Lee County Community Improvement Division	Lecanto	Urban	6
Centro Campesino / Farmworkers Center, Inc.	Immokalee	Rural	4

Due to its urban location and vast number of residences ideal for solar systems, the largest numbers of installations were in Dade County (Miami area). All installed systems in Dade County used flat-plate collectors and various control strategies. The most common control strategy was the differential controller, followed by the timer and photovoltaic controller methods.



Figure 2.3-5. Low-income residential area in Dade County using SWAP solar systems.

The photovoltaic control method proved ideal at those residences where there were no electrical receptacles in close proximity to the water heater. Unfortunately, the cost of the photovoltaic system was several hundred dollars more than the standard differential or timer controlled system, thus precluding its use at more sites. Yet, this was often cheaper than contracting with an electrician to provide power for AC pumps and controllers. One advantage of the photovoltaic-powered, pumped systems is that they can operate during periods of power failure.

The differential control system was the most common system used due to the system's lower cost and common use in South Florida solar system installations.

The majority of the systems were retrofitted to 50-gallon water heaters that, in most cases, replaced the old conventional electric water heaters. LIHEAP funds were used to replace the majority of these water heaters.

Initially, both 20 ft² and 32 ft² flat-plate collectors were installed on the active systems in Central and South Florida. The 20 ft² collector was incorporated in a low-cost timer-operated system that had previously been granted a low-cost system development award by the Florida Governor's Energy Office. This system was installed on residences with three occupants.

Until the collector manufacturers were able to provide mid-size collectors, the 32 ft² collectors were initially used on large occupancy residences. These were replaced, in time, by 25 ft² units. This is an ideal sized collector for retrofitting to 40- and 50-gallon water heaters in residences where there are four or more occupants. This intermediate size has several advantages. The cost is somewhat less than the larger 32 ft² unit and not much more than the 20 ft² collector. In addition, the use of this intermediate size collector tends to reduce the possibility of overheating with oversized collectors.



Figure 2.3-6. Twenty-five-square-foot collector installed on Miami site.

