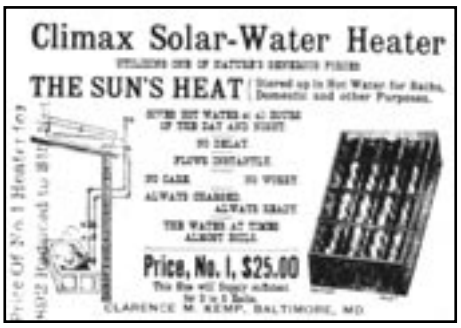
A Brief History of the American Solar Water Heating Industry

1890 to 1930's - the California Era



The first commercial solar water heater, named Climax, was introduced by Clarence Kemp in the 1890's . For a $25 investment, Californians could save about $9 a year in coal costs. It was a simple batch or ICS solar water heater that combined storage and collector in one box. The first thermosyphon systems with the tank on the roof and the collector below were invented, patented, and marketed in California in the 1920's by William Bailey as Day and Night solar systems. One of the largest commercial systems in California was installed by Death Valley Scotty for his resort in Death Valley. Natural gas was discovered in Southern California and cheap natural gas, aggressively marketed by utility companies, ended the solar water heating market. The Day and Night patents were sold to a Florida company, owned by HM Carruthers in 1923, in a trade for an Oldsmobile and the solar hot water industry began in the coastal cities of central Florida and southern Florida. There wasn't a significant solar industry outside of Florida and California in the USA, because thermosyphon systems could not survive hard freezes.

1930's to 1973 - the South Florida Era

Floridians purchased or shipped to the Caribbean more than 100,000 thermosyphon water heaters between 1930 and 1954 when the industry collapsed. During the second World War (1942 to 1945) copper was reserved for the military and the industry was not able to make solar collectors. After the war, the Florida industry boomed again for about six years. Half of Miami homes had solar water heaters with over 80% of new homes having them installed. In the early 1950's electricity became cheap in Florida and utility companies gave away electric water heaters in an effort to eliminate the solar water heating industry. By 1973, there were only two full-time solar water heating companies left in the United States both operating out of Miami, Florida. They were WW Robbins Roofing and Beuthel Solar Water Heating.

1973 to 1986 - Oil Embargos and Carter Tax Credit Era

The first Arab-Israel War in 1973 resulted in the first oil embargo and a rise in gasoline prices. A few companies started experimenting with solar water heaters and designing systems but there were really no national solar collector manufacturers with widespread distribution until the late seventies. Many people, including myself, started making homemade solar water collectors in 1974, using the designs and research from the early 1950's assessment of the best designs by the University of Florida. Little practical information was available at the time, except research by Farrington Daniels at the University of Arizona and Dr. Eric Farber at the University of Florida. The federal government sponsored a few HUD Grants for domestic solar water heaters in the period just before the start of the 40% Federal tax rebate in 1979 by Jimmy Carter, following the second Arab-Israel War and oil embargo. The tax credit era, 1979 to 1986, started a nationwide boon in solar hot water systems that resulted in hundreds of manufacturers and thousands of contractors and distributors starting new businesses. The solar hot water industry was essentially destroyed in early 1986 by two major events and one ongoing professional problem. The Reagan administration refused all industry appeals to taper the tax rebate from 40% to 10% over a five to ten year period. It ended January 1, 1986. In February 1986, oil prices plunged from $35 a barrel to $9 to $12 a barrel as OPEC collapsed. Gas prices dropped at the pump to less than $1.00 a gallon - the public's perception was that the energy crisis was over. A nagging professional problem was constant with stories of "suede-shoes barracudas" or "tin men" taking advantage of the tax credit and selling ridiculously bad designs at exorbitant prices to take advantage of tax credit schemes. A lot of the early systems suffered freeze damage, had components failures, or were poorly designed and installed - this was giving the whole industry a bad name. Active solar air collector space heating systems were sold during this time whose parasitic power for blowers, etc. used more energy than they saved. The air systems cost more to operate than they saved. Many solar contractors were poorly trained in roofing. Homes often had roof leaks because the installers had no concept of how to properly install a system on a roof. Good solar contractors, trying to build an industry and pioneering homeowners were guinea pigs during this time for a menagerie of "good, bad, and ugly" systems.

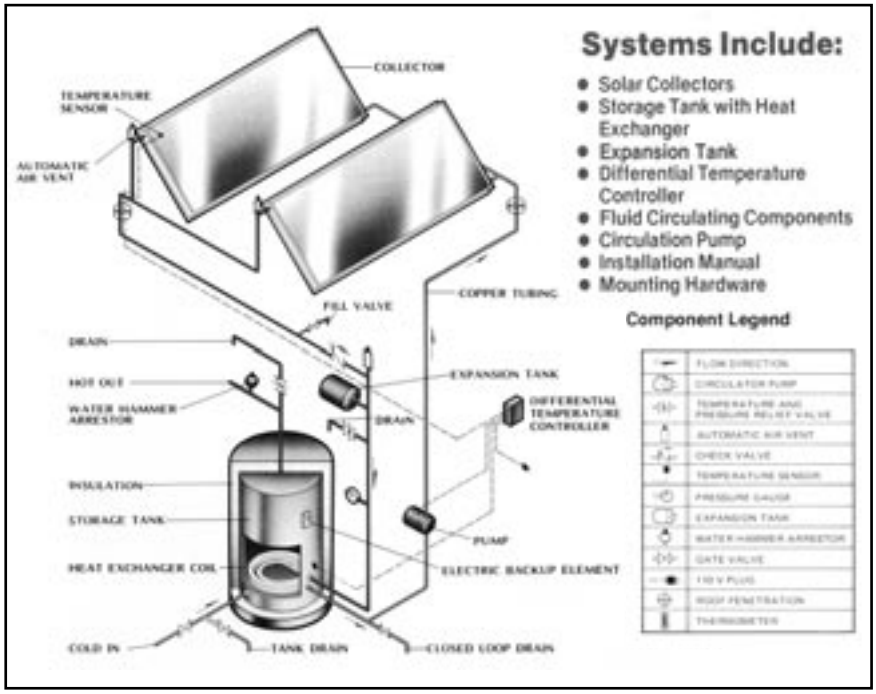
1977 to 1986 - Mass Marketing and Technological Development

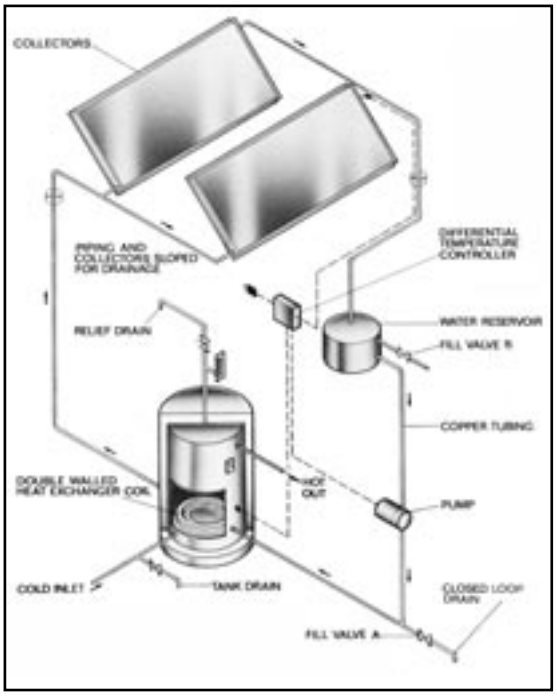
Mass marketing and technological development of solar hot water designs basically started in 1977 with two designs: Closed loop glycol systems using a differential controller and AC pumps and Open loop systems using AC controllers and pumps with freeze protection, providing manual draindown, and freeze sensor(s) that cause the pump to run during a freeze. This was a total failure for three reasons: 1) utility companies often back out sections of the grid for hours during a hard freeze 2) sensors and controllers failed to operate 3) homeowners would forget to manually drain the systems, or the collectors were incorrectly mounted for drainage. The closed loop designs were almost all glycol closed loop systems using AC pumps and differential controls. To eliminate the need to replace glycol fluids every seven to ten years, a couple of manufacturers tried to use silicone or hydrocarbon oils. These systems took too much power, performed poorly, and had serious installation problems. They were eliminated from the marketplace before the tax credits expired. The first successful drainback system with heat exchange tank was marketed by State Industries, a large manufacturer of water heaters. It was expensive and complicated. It required three pipes going to the roof to facilitate water draining back into the reservoir that was part of the tank, and was taken off the market in 1980.

In 1979, Webb Farber and I, at US Solar Corp, designed, tested, and marketed the first residential drainback system that was simple and used only two 3/4" pipes (one feed and one return). This design revolutionized the use of low cost drainback systems. Gulf Thermal, Morningstar, and State Industries followed with copies of this system. Along with glycol systems, these were the most successful systems when correctly installed. Unfortunately, a lot of manufacturers did not understand the fundamentals of drainback systems designed by US Solar Corp. Most drainback systems (other than the companies that used the US Solar Corp design and installation procedures) were a failure in the field. Western and Midwest manufacturers of drainback systems produced terrible designs that gave gravity a bad name. At the same time the first successful drainback system was introduced by US Solar, the first mass marketed draindown valve was introduced by Sunspool. The Sunspool is a draindown open loop system that tries to drain pressurized household water out of the collector that is a part of the household's water plumbing. The Sunspool had massive failure rates for many reasons having to do with water quality, system design, and collector designs that would not drain. Draindown systems gave the whole industry a tremendous set-back due to widespread failure. There was a growing cadre of excellent solar thermal professionals during this time - "learning by doing" because there were no schools or colleges to teach contractors the solar contracting trade.

One major advancement in solar hot water systems during the time period from 1983 to the end of the tax credits in 1986 was made by Pulstar Corporation. Pulstar Corporation made one major and one minor advancement of the industry. First was the testing and matching of specifically designed solar electric modules for use with the Pulstarter as both a power and a control source for use with DC pumps. Wide spread sales by Pulstar led to solar electric manufactures making P.V. modules for specific D.C. pumps.Pulstar Corp sold these controllers worldwide for open loop systems and closed loop glycol systems. These components replaced AC pumps and controls for open loop and pressurized closed loop glycol systems. Greg Peebles, Broward Hunter, John Ault and myself developed "Real World Testing" at Pulstar that actually measured the performance of all types of systems using DC pumps and PV modules. Pulstar did the only testing for thermal drip valves (like the Dole valve) under real world freezing conditions that established how these valves actually worked to protect solar systems. Two technology success stories developed in the early 1980's in active open loop and glycol systems using low power DC pumps and PV modules. Open loop systems for areas that experienced no freezes (Hawaii) or less than one freeze a year changed from AC pump and controls to DC pumps and P.V. modules. Closed loop glycol and drainback systems also reached the apogee of their development during this era. The original technology that started the industry (passive thermosyphon and batch (ICS) solar preheaters) had a mixed history during the 1977 to 1986 era. Thermosyphon systems had massive failures due to freezes when dealers tried to install them in areas that had more than two or three freezes a year. ICS or batch heaters that were properly designed proved successful in areas that had 20 to 60 freezes a year. However, the major market penetrations were with low quality, single glazed, over-priced, low performing ICS units. The only significant research was by C. Cromer at FSEC on system performance and thermal stratification in solar hot water systems.

Successful Tax Credit Era Technology



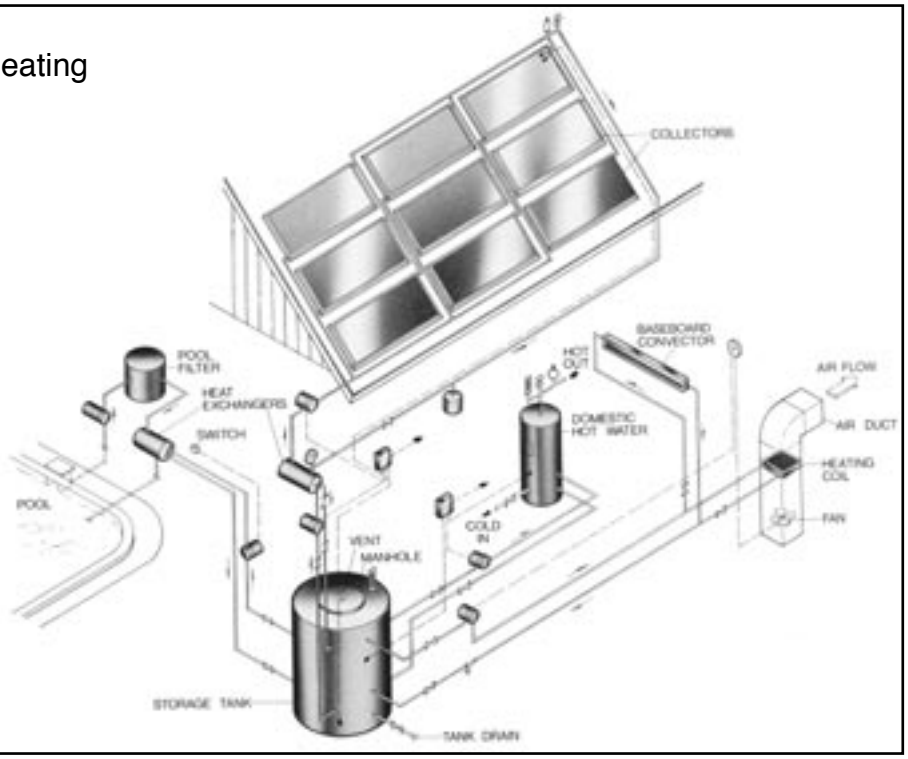


In general, the two diagrams above of closed loop, glycol antifreeze on the left and the unpressurized drain-back systems were the only simple successful active closed loop designs of the 1977 to 1986 time period (see page 18). They use various heat exchanger tanks. By 1985 DC pumps and PV modules were used instead of differential controls and AC pumps on half of the glycol antifreeze systems marketed.

Solar System Design
Hot Water, Space Heating, Pool Heating

Component Legend

	FLOW DIRECTION
	CIRCULATOR PUMP
	TEMPERATURE AND PRESSURE RELIEF VALVE
	AUTOMATIC AIR VENT
	CHECK VALVE
	TEMPERATURE SENSOR
	PRESSURE GAUGE
	EXPANSION TANK
	WATER HAMMER ARRESTOR
	GATE VALVE
	110 V PLUG
	ROOF PENETRATION
	THERMOMETER



This diagram shows a solar system that will provide domestic hot water, space heating and swimming pool heating. The collectors are connected in parallel and are freeze protected by the double pumped heat exchanger antifreeze in the system. Domestic hot water is provided by circulation to a heat exchanger in a second tank. Space heating is provided by either baseboard convectors or a water coil in the air duct. Space heat is controlled by a standard thermostat. The pool is heated by another heat exchanger near the filter.

1986 to 2003 - Survival Era at Ground Zero

Few manufacturers of solar collectors survived the end of the tax credit era. Most national manufacturers of water tanks discontinued special solar tanks in the late 80's, especially tanks with integrated heat exchangers. Over 95% of all solar dealers nationwide went out of business. Many states were left with only one of two contractors in the whole state. Over 90% of all collector manufacturers and distributors outside of Florida, Hawaii, California, and Arizona went out of business. Over 80% of the contractors and manufacturers in these states went out of business. Only one flat plate collector manufacturer in Florida and three in California were left by 1987, along with two ICS manufactures - one in Florida and one in California. While solar pool heating continues to grow and thrive in these areas, the hot water industry fell by over 90%. Most contractors in these states continue to service and repair solar hot water systems installed during the tax credit era. Solar pool heating became the major business for most of these contractors. A few also branched out into solar electric systems. Since 1986 new sales of solar water heaters has not kept up with systems being removed and discarded from the tax credit era. The hardcore professionals who survived the 1986 crash barely kept the industry alive. Environmentalists talked the talk, but failed to open their wallets to buy systems. One major technical advancement during this era was the El Sid DC pump by Ivan Labs. Evacuated Tube changed from direct transfer in the tubes to indirect transfer with heat pipes.

The Future

The public seems to be unaware of the impending end of the fossil fuel age and the need for a sustainable future. As of 2003 both politicians and the mass media are failing to educate the public of the hard choices ahead. Renewables are our only natural choice for the future. The economic price of having our military secure cheap oil from the Mideast is going up each year. Natural gas prices will dramatically increase between 2004 and 2009 because supply from the USA and Canada will not be able to meet the demand for the product. Between 2008 and 2015, the public will be hit with crushing gas and diesel prices as the oil energy will not be able to meet demand. All fuel prices will dramatically rise. **Bright Lights**: Home Power magazine is now featuring regular articles on solar water heating. Changing sunlight into electricity captures everyone's imagination and the publicity causes them to contact solar contractors. Once they focus on KWH's saved, it becomes clear that for every $20 to $30 spent on a PV system you can save the same amount for $1 spent on a solar hot water system. Solar contractors have learned how to present saving in KWH instead of BTU's. The pragmatic homeowner will then also buy a solar water heating system when he learns about its benefits. This is the solar industries' best opportunity to sell a meaningful product.

The solar electric industry is currently viable, yet we have a long way to go to increase the cost effectiveness of all the components. Solar thermal systems both hot water and pool heating, however, have reached the apogee of design. They are at the theoretical maximum of cost effective efficiency. The greatest need is to disseminate information on simple proven designs that were perfected during and after the tax credit era. Hopefully, national tank manufacturers will start producing solar heat exchanger tanks again.

The entire contracting industry of old time professionals are entirely against the return of tax credits of any type that are non-performance based. The industry needs low interest loans available to the public and the elimination of property taxes and sales tax on renewable energy equipment. We do not need non-performance-based larger credits or grants that bring "tin men" into the industry. We do need federal and state governments to show more enthusiasm for the technology - lending a friendly voice and face to the cause costs federal and state government and legislators almost nothing. All parties win - the consumer saves money and increase their property value, pollution discharge is reduced, massive number of new jobs are created and it improves the energy efficiency and independence of the county. A little visible and vocal support from the government and homebuilders for a viable thermal industry, that's been ignored, would help a lot. Especially when solar water heating is the cheapest and most easily affordable clean energy available to residential homeowners - AND has the greatest potential to reduce energy bills. We need real estate agents and homebuilders to educate themselves about the benefits of solar energy and make responsible decisions about energy and homebuilding.