Used with Permission from American Solar Energy Society (ASES)
Published in the proceedings of the ASES 2003 Annual Meeting

UTILITY SUCCESS STORIES IN SOLAR WATER HEATING

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ABSTRACT

This paper describes four utility solar water heating (SWH) success stories from Hawaii, Oregon and Florida and offers lessons learned to help others replicate their success.

SWH, though under-utilized, is a cost-effective, pollution-free renewable technology. As utility interest in green energy expands, solar thermal systems deserve strong consideration as a way to meet renewable portfolio standards (RPS), supply energy for green pricing programs, and add customer value. Among renewable technologies, SWH offers several advantages. SWH is cost-effective, comparable in cost to biomass and wind. Today's solar thermal industry produces durable equipment that requires little maintenance. Independent standards are in place to ensure quality hardware. Installer training and inspections ensure reliable performance. Aesthetics continue to improve, and siting of systems is not a major concern.

From an energy provider's perspective, SWH offers additional benefits. SWH can reduce peak demand. Systems can be metered and the measured energy can be offered as a for-profit green energy product. Customer service and environmental image can also benefit.

1. UTILITY INITIATIVES IN RENEWABLE ENERGY

Utility involvement in renewable energy is on the rise again and is expected to make an increasing contribution to the nation's energy mix for the foreseeable future. In early 2003, there were over 300 utilities in 32 states that offer green pricing, an option allowing customers to purchase a portion of their energy supply from renewable resources. Fourteen states have implemented mandatory renewable portfolio standards (RPS), which require energy providers to include renewable sources as a percentage of their supply mix. Similar federal legislation is being considered.

A range of renewable technologies supplies the green energy for these programs but almost universally focus on the production and delivery of electricity to the grid. Solar thermal technology, by contrast, produces heat energy and delivers it directly to customers on site. This technology has been labeled "demand-side" and, so far, excluded from most green programs.

Despite being under-utilized, solar thermal technology offers many benefits from the energy provider's perspective and deserves consideration. First, solar thermal is a cost-effective solar technology. Table 1 shows that SWH compares favorably with other renewable "generation" technologies and especially well with other solar technologies.

TABLE 1: COST OF RENEWABLE ELECTRICITY

Plant Type	Levelized Production Cost, cents/kilowatt hour
Solar Water Heating[1]	4.0 – 8.0
Municipal Solid Waste[2]	3.5 – 15.3
Biomass (direct combustion)[2]	6.3 – 11.0
Landfill Gas[2]	2.4 – 6.3
Solar Photovoltaic[2]	19.4 – 47
Natural Gas Combined Cycle[2]	3.9 – 4.4
Wind[3]	3.9 – 5.0

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[1] Analyses from HECO, EWEB and WPSC.
[2] Florida Public Service Commission and the Department of Environmental Protection, An Assessment of Renewable Electric Generating Technologies for Florida, January 2003.
[3] National Renewable Energy Laboratory, Quick Facts about Wind Energy, 2003.

Second, SWH can reduce peak electrical demand. Third, through the use of available meters, SWH's energy output can be quantified and expressed in kilowatt-hours, making it feasible to incorporate SWH into green pricing and RPS programs. Fourth, SWH can meet the needs of customers who want to install cost-effective renewable equipment at their own facilities. For all these reasons, solar thermal technology offers strong potential for utilities implementing green energy programs across the United States.

2. SOLAR THERMAL BACKGROUND

SWH is a well-established, effective, pollution-free technology that is applicable throughout the United States. An estimated one million residential and 200,000 commercial SWH systems have been installed. SWH systems can provide up to 90% of the hot water needs of a residence depending on location. Equipment is durable, trained installers are available, and support from related organizations is growing.

2.1 U.S. Solar Water Heating Industry

In the 21st century, SWH equipment is better than ever. Systems are durable and require little maintenance. Solar collectors themselves are constructed of long-lived materials: aluminum, copper and glass, or, for pool heaters, UV-resistant plastics. Other components like pumps, heat exchangers and controllers, are long-lasting and can be easily repaired or replaced. In some designs, groups of components are pre-assembled, reducing installation time and error. Efficient design of solar thermal systems translates to high thermal conversion efficiency, averaging about 50% annually.

The U.S. solar industry, though small, is stable and poised for growth. There are currently six U.S. manufacturers of solar thermal equipment, and they offer commercialized, off-the-shelf SWH and solar pool heating (SPH) systems. Approximately 7,000 SWH and 35,000 SPH systems are installed annually in the United States. In active markets there is a network of qualified installers and service personnel, and in less mature markets, plumbers often have experience with installation and service.

Though support for the solar thermal industry from other groups is growing, SWH technology is still not broadly accepted in the United States. Consumers remain wary of initial costs, and the energy and building industries have not embraced the technology to the point of advocacy. Bringing solar thermal into the mainstream involves many players. Their roles are described below.

2.2 Support Organizations

Several private and government organizations support the solar thermal industry. U.S. Department of Energy (DOE, www.energy.gov) sponsors work across the entire energy sector, and DOE's renewable energy goal is to identify and develop clean, affordable sources of energy for the future that enhance domestic energy security. One of DOE's most significant solar programs is the Zero Energy Buildings (ZEB) initiative. ZEB's goal is to bring high-performance buildings into the mainstream using a whole building approach that takes advantage of the best technologies from energy efficiency and solar energy.

Other organizations supporting the solar thermal industry include the Solar Rating and Certification Corporation (SRCC, www.solar-rating.org), which develops certification programs and national rating standards for solar thermal equipment; and the Solar Energy Industries Association (SEIA, www.seia.org), the national trade association of the solar industry. The Florida Solar Energy Center (FSEC), a research and training organization, also supports the industry.

DOE's solar thermal research is carried out primarily at two national laboratories: National Renewable Energy Laboratory (NREL, www.nrel.gov) and Sandia National Laboratory (SNL, www.sandia.gov). The labs perform research on advanced solar thermal concepts and work with stakeholders to implement DOE's priorities for renewable energy. The Utility Solar Water Heating Initiative (USH_2O) provides a forum for utilities that are pursuing solar thermal programs to exchange ideas.

2.3 Licensing, Training, Inspection, Maintenance

Quality installation is just as important as the durability of the equipment itself. Eleven states, including Florida, Hawaii, Oregon, Arizona, Nevada, and California, require licenses for solar contractors. Several organizations, including FSEC and the North Carolina Solar Center, offer training. Utilities typically require training and/or certification for participating contractors. They also conduct thorough post-installation inspections to ensure that systems will function properly.

Thanks to quality components, efficient design and well-trained installers, today's SWH systems require little maintenance. Nearly 20,000 systems have been installed

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under Hawaiian Electric Companies' program, and average annual maintenance is $40. SPH systems require even less maintenance.

3. UTILITY SUCCESS STORIES

Utility involvement in SWH began in the 1970's during the era of tax credits. Significant programs were implemented in the 1980's and 1990's by Sacramento Municipal Utility District, Florida Power and Light, Wisconsin Public Service, Public Service of Colorado, Salt River Project and others. According to USH$_2$O, over forty utilities nationwide have considered SWH in the last ten years.

The four utilities described in this paper represent a sample of the utilities implementing solar thermal programs as part of their green energy portfolio. The four companies vary significantly, and Tables 2 and 3 provide profiles and summarize their SWH programs.

TABLE 2: UTILITY PROFILES

	HECO	EWEB	LE	JEA
Type of Utility	Investor-owned	Municipal	Municipal	Municipal
Number of Customers	394,000	81,000	106,000	360,000
Saturation of Electric Water Heaters, Percent	62	80	95	95
System Peak, Megawatts	1,250	560	663	2,636
Residential Electric Rate, cents per kilowatt-hour	14 – 20	7.2	7.5	6.9
Average Solar Radiation[1], kWh/m^2 day	5.7	4.1	5.3	5.0
Sunshine Clearness Index, Percent[2]	57	49	54	52

[1]Average annual value for a surface tilted at the local latitude and facing south
[2]Average annual ratio of global horizontal solar radiation/extraterrestrial horizontal solar radiation

TABLE 3: SOLAR PROGRAM INFORMATION

	HECO	EWEB	LE	JEA
Program Goals	Energy efficiency; Demand reduction	Customer service; Demand-side management; Environmental image	Profitable service; Distributed generation; Customer retention	Clean power goals
Start Date	1996	1984	1997	2002
Number of SWH systems	20,000	925	57	12 (approximate)
Most common system type	Open loop, direct	Closed-loop, antifreeze	Open loop, direct	Solar pool heating
Certification Required	SRCC OG 100; HECO approval	SRCC OG-300	FSEC or SRCC	FSEC or SRCC optional
Current Utility Incentive	$750-$1,000	Cash discount ($700 max.); 0% loan ($4,000 max.)	N/A; LE owns systems	$1-4/ft^2; varies by system
State Incentive	Tax credit 35%	Tax credit ($1,500 max.); property tax exemption	Sales tax exemption	Sales tax exemption

3.1 Hawaiian Electric Company (HECO)

HECO has the largest SWH program in the United States, with nearly 20,000 systems installed between 1996 and 2002. These systems have reduced the utility's demand by a total of 12.7 MW.

3.1.1 HECO Background

HECO is an investor-owned, regulated electric utility that serves the islands of Oahu, Hawaii, Maui, Lanai and Molokai. The system peak occurs between 5:00 p.m. to 9:00 p.m., driven by residential electric resistance water heaters.

3.1.2 HECO Program Description

HECO's *Energy$olutions^{SM} for the Home* program, introduced in mid-1996, has facilitated the installation of nearly 20,000 SWH systems through 2002. Residential customers with electric resistance water heaters, and homebuilders or developers, are eligible to participate in the program. High participation levels have been

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achieved through multi-channel marketing, financial incentives of $750-1,000, and strong quality assurance.

Systems must be installed by authorized contractors in accordance with HECO's standards using only pre-approved products, and each system must pass a rigorous inspection. All solar collectors must have a SRCC OG-100 rating.

Any state-licensed solar or plumbing contractor is eligible for the program, and currently about 60 authorized contractors participate. Competition has resulted in an average cost of $4,500 for a system designed to provide 90% of the annual hot water load. In addition to the $750 HECO rebate, the State of Hawaii provides a 35% income tax credit.

3.1.3 HECO Impacts

The impacts of HECO's program are significant. From mid-1996 through 2002, 19,525 SWH systems have been installed, reducing demand by 12.7 MW and saving 53.8 million kWh. In terms of the environment, 89,730 barrels of oil have been saved, and 47,048 tons of CO_2 have been avoided.

Program participants save about $7.1 million annually, or an average of about $366 year per participant. Annual maintenance costs are estimated at about $40 per year. Program costs for 2002, excluding lost margins, were about $4.8 million. The Public Utility Commission has authorized recovery of program costs, lost margins and provided for shareholder incentives based on program performance.

The program has produced a positive impact on the local solar industry. On an annual average basis, the number of installed systems has increased 75% over the estimated 1995 level. The program has resulted in the creation of about 12 new businesses and 150 new jobs.

3.1.4 HECO Success Factors

HECO's policies and procedures, as originally planned, have proven effective and program goals have been met. This is noteworthy because of the variability in the residential sector.

HECO has formed strategic partnerships with state, county, and federal governments, homebuilders, and the solar industry. HECO is a U.S. DOE Million Solar Roofs partner and an Environmental Protection Agency (EPA) Energy Star Homes partner and certifier. In addition, its partnership with the Department of Defense (DOD) has resulted in the payment of rebates for over 2,100 systems installed on military housing units.

HECO's partnership with homebuilders and developers has focused on market transformation. Solar is either standard or an available option for most residential new construction projects. HECO relies on the solar industry to sell, install and service program systems, and this partnership has been pivotal to the program's success.

Lessons learned include recognizing that prudent flexibility is required for successful implementation and that objectivity must be maintained in dealing with contractors. The administrative tool that has served well in attaining this objective is the "reasonableness test." Within the utility, strong management support allowed initial challenges to be overcome. Outside the utility, the continuation of tax credits for solar water heating system creates uncertainty, and restrictive covenants of homeowner associations are a continuing barrier.

3.1.5 HECO Future Plans

Over the next five years, HECO forecasts about 2,800 SWH systems per year. No major program design changes are foreseen at this time.

3.2 Eugene Water & Electric Board (EWEB)

Eugene Water & Electric Board (EWEB) is a municipal utility serving Eugene, Oregon with 81,000 electric customers (73,000 residential) and an average electric system peak of 560 megawatts. About 80% of EWEB's residential customers use electric water heating.

3.2.1 EWEB Background

EWEB has operated SWH programs since 1984. The utility's three main goals are to provide customer service, reduce customers' electric energy use, and enhance the utility's environmental image in the community.

3.2.2 EWEB Program Description

EWEB's SWH program is called *The Bright Way to Heat Water*™. It is designed to give residential customers quality assurance in the SWH systems they purchase. The program is backed by detailed technical specifications and utility financial incentives. Customers contract for the sale and installation of a system directly through a participating solar contractor. The SWH systems must be certified by SRCC and pass a technical review and inspection by EWEB.

EWEB currently offers two financial incentives, a "cash discount," proportional to the estimated performance of the system, and zero-percent financing up to $4,000. SWH systems typically cost $4,000-4,500 before incentives, and cash discounts range from $400-700. The customer receives the cash discount from the contractor as a reduction in the purchase price, and EWEB pays the

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discount amount to the contractor after the installation passes the utility's inspection. The State of Oregon also offers a tax credit up to $1,500.

Multiple marketing strategies are used, including newspaper and radio ads, bill flyers, and messages directly on utility bills. Contractors must meet state registration, insurance, and bonding requirements, and enter into a legal agreement with the utility to participate. Currently five contractors participate.

3.2.3 EWEB Impacts

Over 900 solar water heaters have been installed resulting in a demand-side energy resource of approximately 1.8 million kWh annually. Utility staff required for program operation has averaged about 0.5 FTE. The 20-year estimated resource cost for the utility is about 5.5 cents per kWh. Annual savings at current electric rates are typically $100-200 per year.

3.2.4 EWEB Success Factors

In EWEB's service area, solar water heating suffered a poor image in the 1970's and early 1980's due to unreliable products and poor installations. Even recent contractor promotion of "innovative" system types has resulted in additional "solar-black-eye" experiences. EWEB's technical review and specifications, plus its contractor requirements and inspections, are changing that image. The learning curve for solar contractors was initially difficult as they adapted to EWEB's standards, and the committed contractors remaining are now sticking with the more tried and proven technologies (active antifreeze, thermosiphon antifreeze, and drainback).

Many customers think solar doesn't work in Eugene's cloudy and rainy winter climate. Education about the annual performance of a SWH has been required to counter this notion. Low electric rates are a barrier for customers who look at strictly the economics of SWH, although recent rate hikes have stimulated additional interest. Printing a message directly on every customer's bill has been the lowest cost and most effective marketing strategy for the EWEB program. Offering both utility cash incentives and zero-interest financing has been the most effective combination for driving customer interest and adoption of SWH technology.

3.2.5 EWEB Future Plans

EWEB customers are largely environmentally conscious. The utility's solar water heater program offers them the opportunity to directly apply a comparatively cost-effective renewable energy technology on their home. For this reason the program has been popular, and EWEB plans to continue offering *The Bright Way to Heat Water*™ to its customers.

Furthermore, *The Bright Way to Heat Water*™, as developed by EWEB, is available as a complete, "off-the-shelf" utility demand-side management and customer service program. Additional utilities in the Pacific Northwest are licensing and implementing the program through the Bonneville Power Administration.

3.3 Lakeland Electric (LE)

Lakeland Electric (LE) is a municipal electric utility in central Florida serving 104,000 retail customers. In the absence of a competitive natural gas provider, all-electric housing stock is prevalent. As a result, LE is a winter-peaking utility.

3.3.1 LE Background

In 1997, with grant funding from the Florida Energy Office and technical support from the FSEC, LE launched the country's first metered SWH program. The purpose of the program is to determine if solar energy can be metered accurately and sold profitably.

3.3.2 LE Program Description

In June 1997, LE installed its first metered solar water heater, and as of March 2003, there are 57 residential SWH systems. Each system consists of a 4 ft. x 10 ft. (1.2 m x 3.0 m) flat-plate collector and an 80-gallon (303 Liter) solar storage tank that has a 4,500-watt heating element. Water is circulated using a direct current pump that is powered by a five-watt photovoltaic module. A "Btu" meter is utilized to quantify solar energy. This meter is reconfigured by the manufacturer to display kilowatt-hours. Solar energy is then sold at the utility's average residential rate of $0.075/kwh. This charge appears as a separate line item on the monthly utility bill. The installed cost is $1,898 per system including the meter. A single solar contracting company is performing all the work.

Customers gain several advantages with this approach. First, the utility assumes all the risk. LE owns the systems and performs all maintenance. Customers do not have any up-front costs or responsibility for ongoing maintenance, both major barriers to SWH adoption. Second, should a customer decide to purchase the system, he receives credit for the energy purchased. Third, with a larger tank, the customer has more hot water available.

3.3.3 LE Impacts

The program also benefits the utility. First, each SWH system reduces LE's winter and summer peaks by 0.7 kW and 0.4 kW, respectively. Second, each SWH system

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includes a timer that interrupts the electric heating element from 7:00 a.m. until 7:00 p.m. This maximizes the solar performance and revenues as well as helps to manage the utility's peaks. Third, by installing SWH systems on customers' roofs, LE is developing a secondary business relationship that, in effect, erects barriers to competition and sets a precedent for other programs that might occupy roof space. Fourth, LE has found that solar customers, and even many non-participants, express pride in their utility for demonstrating an environmental conviction. The program also strengthens LE's relationship with regulators, government agencies and the solar industry.

3.3.4 LE Success Factors

One key to the LE's success is targeting households with four or more people. These customers' hot water consumption is sufficient to justify the cost of the SWH system. One initial challenge was integrating the solar meter readings with the existing billing system. This process was done manually until a new billing system was implemented in June 2001.

3.3.5 LE Future Plans

LE's original plans called for installing several hundred solar heaters each year until the market was saturated. Since the program is just finishing its pilot stage, an aggressive effort will not occur until next fiscal year.

3.4 Jacksonville Electric Authority (JEA)

3.4.1 JEA Background

In 2000, JEA, the American Lung Society and the Sierra Club entered into an agreement to develop a clean power program. This program's goal is to derive 4% of JEA's capacity (approximately 120 MW) from clean power by 2004 and 7.5% by 2015 (approximately 350 MW). The goals are capacity-based and not energy-based. The solar incentive program was developed in 2001 and launched on Earth Day 2002.

3.4.2 JEA Program Description

JEA offers incentives for a range of renewable technologies. The incentive program is available to all customers, and a larger incentive is available to nonprofit groups. The incentives were established with the goal of paying for one-third of the cost compared to the full expense of deploying utility-owned systems. JEA also retains the rights to the "green attributes" of the solar power that is generated. For local vendors, JEA's solar incentives range from $\$20/ft^2$ for medium temperature solar thermal systems, to $\$4/ft^2$ for low-temperature, unglazed SWH systems, to $\$2/ft^2$ for SPH systems. The incentives for non-local vendors are half these values. SPH systems are the predominant type installed in JEA's program.

All contractors in JEA's program complete an application that includes licensure, insurance, and information about finances and experience in solar. They must also complete a course on, and demonstrate competency in, interconnection of photovoltaic systems.

Under JEA's program, the customer selects a contractor from a list of pre-qualified providers and negotiates a contract. The customer and contractor fill out a solar "certificate" that specifies the system, and the contractor installs the equipment. JEA inspects the system, and then the contractor receives payment of the incentive.

3.4.3 JEA Impacts

In the first year of the incentive program, solar thermal installations increased significantly. SPH business grew approximately 15%, for an additional 1,500 m^2 of SPH collectors. The SWH business grew from a negligible level to approximately 75 m^2. Two new jobs and one additional company have resulted. JEA has not extensively promoted the program, and the installers have not dedicated any substantial marketing resources either. However, the program has exceeded expectations to date and is well received by the majority of the stakeholders.

3.4.4 JEA Success Factors

Two early successes in JEA's program are noteworthy. First, JEA worked with SRCC and USH_2O to compute SWH's demand reduction, thereby quantifying its impact toward the overall clean power goal. This method is discussed on SRCC's web site. Second, JEA successfully bundles the SWH "green attributes" with other "electric-based energy" and sells them to Sterling Planet, a company trading in green supply and green pricing programs. Thus JEA passed a milestone in green supply by successfully selling non-electric based solar energy.

JEA's program is still in the early stages and is facing some challenges. Staff is working on enhancements and receiving input from the stakeholders to leverage the resources available.

3.4.5 JEA Future Plans

Small changes to the incentive structure are being tested to determine the best performance and customer satisfaction with the desire to increase the total number of SWH installations.