Solar Water Heating: Ready for Prime Time?

J. Andrew McAllister and Annie Henderson, California Center for Sustainable Energy
Nicolas Chaset, California Public Utilities Commission

ABSTRACT

Solar Water Heating (SWH) is an essential part of any strategy for achieving zero energy homes, whether new or retrofit, and is receiving renewed policy interest, not least for its potentially large contribution to reducing carbon emissions. In California the legislative foundation exists for a statewide program that would install 200,000 systems beginning in 2009. In recent years statewide annual installations have totaled around 1,000. The San Diego SWH Pilot Program offers incentives for installation of SWH systems in residences and businesses. The program commenced July 2, 2007 and is explicitly intended by the California Public Utilities Commission to provide lessons for SWH market transformation and for design of the statewide initiative.

The program received 92 applications in its first 10 months, principally for small residential and commercial systems. Program design and implementation has focused on ensuring quality installations through training and inspections; providing contractor assistance; maintaining a streamlined incentive claim process, developing both targeted outreach and broad media campaigns, and collection of measured performance data. The program has trained over 250 industry stakeholders and educated over 300 homeowners. Twenty-three contractors have qualified for participation.

A preliminary analysis of program impact reveals both good progress towards increased penetration of SWH and significant barriers to its near-term proliferation in San Diego, including: customer awareness of and confidence in these systems; industry sales capabilities and outreach presence; discontinuity across local jurisdictions in permitting requirements and inspector knowledge; and lack of installer awareness of and compliance with SRCC standards. Finally, traditional measures of cost-effectiveness of gas-displacing systems are problematic at current gas prices. The program has attacked these barriers within the local context, we recommend that any statewide program include systematic and comprehensive efforts to educate the marketplace at all levels while ensuring quality installations.

Introduction

Solar water heating technologies hold great potential to contribute substantially to reduction of greenhouse gas emissions, both globally and in the US. The recently released REN21 study indicates that over 50 million households worldwide had SWH systems in 2006, a 19 percent increase over 2004 (RENI21 2007). In the US, NREL estimates that between 50 and 75 million metric tonnes of CO2 could be avoided with SWH systems nationwide, or 2-3% of current total emissions from residential and commercial buildings (Denholm 2007). Several US states are taking the initiative to promote SWH technologies, including Hawaii, Wisconsin, Oregon and California (Sinclair 2007). In California, legislative and policy initiatives pretend to increase SWH penetration by several orders of magnitude, with the idea that such initiatives can transform the SWH market just as the California Solar Initiative intends for photovoltaics. Advocates claim that SWH could cost-effectively displace over one billion therms of natural gas

in California, or over 5% of the state's consumption, and that such a reduction would reduce NG prices by around 30% (Environment California 2007). In many parts of the world, notably China, Israel, Spain and Germany, SWH is an increasingly seamless part of everyday life. In contrast, in the US only Hawaii has a well-developed large-scale program, with roughly 6,000 systems being installed per year. Most SWH programs in the U.S. have been designed to displace electric water heating load, while in California 95% of water heaters utilize natural gas. California is therefore being watched as a harbinger of things to come for the U.S. SWH industry.

Policy Context

On January 12, 2006, the California Public Utilities Commission (CPUC) issued Decision D.06-01-024 creating the California Solar Initiative (CSI). As part of the CSI, the California Center for Sustainable Energy (CCSE), then called the San Diego Regional Energy Office (SDREO), was directed to develop a regional SWH Pilot Program. SDREO submitted the Pilot Proposal on May 14, 2006. Subsequent discussions with the CPUC resulted in approval of the program in a CPUC Ruling on February 15, 2007 (CPUC 2007). The program is open for incentive application between July 2, 2007 and December 31, 2008.

The Solar Water Heating and Efficiency Act of 2007, (AB 1470) was signed into law on October 12, 2007. AB 1470 gives the California Public Utilities Commission (CPUC) the jurisdiction to create a statewide incentive program for gas-displacing solar thermal technologies, and sets aside up to $250,000,000 from California's gas ratepayers to fund incentives for up to 200,000 solar water heating systems by 2017. AB 1470 does not set a specific process for how or when the statewide program should be implemented, but does direct the CPUC as follows:

> *"The commission shall evaluate the data available from the Solar Water Heating Pilot Project conducted by the CCSE. If, after a public hearing, the commission determines that a solar water heating program is cost effective for ratepayers and in the public interest, the commission shall (1) Design and implement a program .. to achieve the goal of the Legislature to promote the installation of 200,000 solar water heating systems."* (Public Utilities Code, Ch. 9, Article 2, Sec 2863)

AB 1470 also sets a number of statutory requirements for equipment eligibility and Program design, including:

- Minimum 10 year warranty for collectors
- Residential collectors must meet SRCC OG-300 certification, and Commercial-Industrial applications must have collectors that meet SRCC OG-100
- Systems over 30 kWth must be metered, whereas metering requirements for smaller systems are at the discretion of the CPUC
- Appropriate EE improvements should be bundled with solar water heating incentives
- CPUC shall set rating standards for systems
- Set-aside of 10% of incentives for installations on low-income residential housing
- Incentives structure should decline over time and be paid-out on a performance-based incentive basis

The CPUC is working with CCSE to assess a variety of performance metrics relating to the SWH Pilot Program described here. Itron, the M&E contractor for the Pilot Program, will file an interim evaluation report in late 2008. Based upon the interim results, the CPUC may decide to initiate the proceeding that will eventually lead to a public hearing; it may also decide to wait until the final evaluation report is completed in 2009. The CPUC has indicated that the statewide SWH Program will be considered within the CSI rulemaking, R.08-03-008.

Program Development

The design of the Program incorporated wide and repeated stakeholder input. CCSE conducted a public workshop in March 2006 on SWH to solicit stakeholder input and comments. At focus groups held with existing and potential owners of SWH systems in April 2007 in San Diego, participants indicated the following:

- They are motivated to install solar hot water heating systems primarily because of environmental considerations.
- Those who have had current experience with solar technology have favorable impressions of it as an alternative source of energy.
- Most are aware that many solar hot water heating systems failed during the 1980s.
- Solar hot water heating contractors have a poor reputation and will need to improve it to become successful in the current market.
- They would like to rely on knowledgeable, neutral third parties for recommendations for equipment and reputable contractors.
- Homeowners are sensitive to aesthetics and wish to minimize unattractive tanks/collectors on their roof.

CCSE also conducted its own engineering, administration and marketing evaluations, and interacted extensively with industry, DOE, NREL and other interested parties to ensure the Pilot's approach and design were reasonable, necessary, effective and streamlined. At the same time, given past experience, clearly the program had to emphasize quality assurance.

Program Description

The Solar Water Heating Pilot Program provides incentives to residential and non-residential customers who install qualifying solar water heating systems that offset energy used by an existing water heater or boiler.[1] It is open to existing residential, commercial and industrial electricity customers of San Diego Gas and Electric Company (SDG&E). Solar water heaters displacing electricity, natural gas and propane are eligible for the Pilot. The Program provides training for contractors and education to help potential customers make informed decisions. The Program's explicit goals are to understand the various barriers to utilization of these technologies and the effectiveness of various strategies to overcome them, and to inform State policy makers and the CPUC of their relative importance.

To participate, a contractor must fill out a two-page form with their business and licensing information, provide proof of minimum insurance coverage, and submit a copy of the

[1] Full program details including the program handbook can be found at: www.swh.energycenter.org.

firm's standard warranty. Additionally, a contractor representative must attend a one-day seminar at CCSE describing the program itself, and providing a refresher on proper system installation.

Information collected in conjunction with program installations includes pre/post energy consumption information, demographic data, system characteristics and costs. System operation data is currently being collected from a selection of participating systems for performance and savings evaluation purposes. Itron is performing the market assessment, surveys and impact analysis, and will be responsible for the technical evaluation. These evaluation results will be central for the development of the statewide SWH incentive program contemplated by AB 1470; given the future program focus on gas-displacing water heaters, data collected from the Pilot emphasizes participating gas-displacing SWH units.

The SWHPP offers two levels of incentives: Prescriptive and Area. Both incentive structures utilize equipment performance certification information determined by the Solar Rating and Certification Corporation (SRCC). The Prescriptive approach is used for complete systems that are certified as OG300 by SRCC. These systems are small and are installed in residential and small commercial settings. Larger systems receive an incentive under the Area method, based on the installed collector area; the collectors themselves must be certified as OG100-compliant by SRCC.

The program seeks to encourage performance: the incentive calculation incorporates a simple Solar Orientation Factor (SOF), a derate based on the tilt and orientation of the collectors. Minimum shading criteria also apply: systems must be unshaded between 10AM and 3PM throughout the year to qualify for an incentive. Estimated system production applies to Prescriptive systems, as calculated by the OG-300 testing of SRCC.

Prescriptive systems may receive an incentive of up to $1,500. The level of the Prescriptive incentive was initially determined based on the estimated system installation cost of $6,000, with the incentive designed to cover 25% of the system cost. Area systems may qualify for up to $75,000. The Area method incentive calculation is based on a fixed dollar factor based on system type, SOF, and the SRCC OG-100 Certified Solar Collector rating, multiplied by the number of collectors in a system. The fixed dollar factor is $15 for an open loop system and $20 for a closed loop system.

Program Activity and Results to Date

Ten months after program roll-out, there are 23 qualified contractors, encompassing all generally known installers in the San Diego Region as well as several from other parts of the state. The program has trained over 250 contractors and other industry members and educated over 300 homeowners on the benefits of SWH. Among the most important activities for facilitating the marketplace is educating relevant code officials; CCSE has worked with 65 inspectors and plan checkers from the three largest local jurisdictions in the region: City of San Diego, County of San Diego and City of Chula Vista.

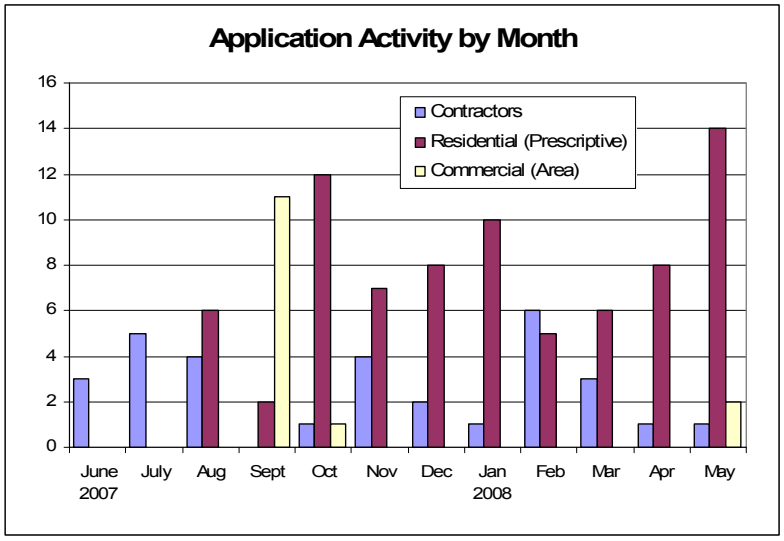
Program marketing has consisted of a wide variety of efforts to distribute the SWH message. While traditional program collateral provides tools for in-person and mailed outreach, the program has also utilized radio and TV media, both earned and paid. News outlets have presented SWH as a logical component of a green lifestyle, which has facilitated coverage of the program rollout and early installation milestones. Active media support from a respected local fire district has been used as a strategy for increasing the credibility of the SWH industry.

Literally dozens of well-placed news articles have highlighted the program. CCSE has provided participating contractors with program-branded support collateral for their sales process. Anecdotal evidence from participating vendors indicates that prospective client pool has increased significantly since the beginning of the program, due to both Program-related marketing and to an ongoing general increase in energy awareness and pro-environment sentiment. A collaboration between CCSE and GreenPlumbers has the potential to expand dramatically the qualified installer pool for SWH systems in California.

Application Flow

Figure 1 shows the application numbers by month, both for contractors applying to participate, and their applications. Contractors and other stakeholders have shown continued interest in the program, and attendance at the monthly contractors' workshops has remained strong. Many seem to be preparing to enter the market, utilizing the program training as a way to "test the waters," thus having little near-term effect on the application flow. Residential system applications have averaged about nine per month. One participating vendor is particularly focused on the commercial marketplace, and submitted a group of applications in August 2007.

Figure 1: SWH Program Applications by Month



Out of the 23 contractors qualified to participate in the program, relatively few account for most of the installed systems. Table 1 shows contractor participation in the program as of late May 2008.

Table 1: Residential Applications by Contractor

Contractor	Number of Applications	Percent Participation
1	37	47%
2	17	22%
3	9	12%
4	5	6%
5	3	4%
6	3	4%
7	2	3%
8	1	1%
9	1	1%
TOTAL	78	100%

Residential participants represent 78 of the 92 applications received as of late May 2008. Electric- and propane-displacing systems are overrepresented, accounting for 25 (32%) and 15 (19%), respectively, of the existing residential applications. Less than 10% of SDG&E electric customers are electric-only, so this overrepresentation likely reflects the favorable economics of using SWH to displace these relatively expensive heating fuels. Five applications are for replacement solar systems. Interestingly, these replacement systems were among the highest-cost systems, despite the potential savings due to the existing infrastructure. While the previous systems were generally older than 10 years, regrettably most had suffered freeze damage sufficiently grave to warrant system replacement. These repeat SWH customers upgraded their systems upon replacement, due either to ongoing freeze damage concerns, or because of the desire for a more upper-end system design.

The average incentive for the first 78 Prescriptive (residential) applications is $1,247. System costs show some consistency: the average cost of a Prescriptive system which offsets natural gas is $6,455; for electricity the cost is $6,234, and for propane, $6,899. Table 2 shows installation numbers, cost, and incentive information by system type for Prescriptive systems.

Table 2: Prescriptive Applications, Cost and Incentives by System Type

System Type	# Apps	Ave. Cost	Ave. Incentive
Glycol			
Passive	35	$6,554	$1,136
Active	19	$6,232	$1,267
Recirc	18	$5,915	$1,375
Drainback	5	$7,711	$1,444
ICS	1	$11,600	$1,500
TOTAL	78	$6,467	$1,247

The cost for a closed loop system is thus far $525 more than for an open loop system. All participating open loop systems utilize recirculation freeze protection. Also worth noting is that the lone integral collector-storage (ICS) application is actually for two identical systems installed on separate buildings at a single site. Three systems have been self-installed by the homeowners; these present the lowest reported costs for both open- and closed-loop systems.

There are only two contractors in the region focused on the commercial sector. Eleven of the commercial applications come from one vendor and represent similar projects, on a group of

adjacent multifamily buildings. These projects are expected to be completed in July 2008. The average cost of an Area method system is $19,020, with an average incentive of $2,887. Note that this reflects only 14 systems and is likely well below any long-term average for commercial systems, given that larger systems tend to take longer to develop and implement.

Cost-Effectiveness

Tables 3 and 4 present preliminary cost-effectiveness information for the existing pool of Prescriptive (residential) applications to the program, from the customer perspective. Simple payback is shown, along with Net Present Value and Internal Rate of Return for four fuel cost escalation rates. This information includes both paid incentives and those still in the queue for installation. The difference between electric and natural gas displacing units is notable, with electric-displacing units presenting a considerably more favorable picture than NG. The assumed cost of electricity is Tier 3 (131-200% of baseline) of the standard SDG&E residential rate; the gas rate used is the May 2008 non-baseline rate applicable to single family households.[2,3]

Table 3: Customer Cost-Effectiveness for Electric-Displacing SWH Systems

Electric Backup - 25 Systems			System Life (yrs)	20
Average System Cost (Net)	$3,476		Discount Rate	6%
Average Savings (kWh/yr)	2688		Year 1 Electricity Cost ($/kWh)	$0.22
Simple Payback (yrs)	5.9		5-year maintenance cost	$100
Electric Escalation rate	2%	4%	6%	8%
Net Present Value	$4,447	$5,872	$7,653	$9,885
Internal Rate of Return	21.7%	24.1%	26.5%	29.0%

Table 4: Customer Cost-Effectiveness for Natural Gas-Displacing SWH Systems

Natural Gas Backup - 38 Systems			System Life (yrs)	20
Average System Cost (Net)	$3,662		Discount Rate	6%
Average Savings (therm/yr)	128		Year 1 NG Cost ($/therm)	$1.84
Simple Payback (yrs)	16		5-year maintenance cost	$100
Fuel Escalation rate	2%	4%	6%	8%
Net Present Value	($457)	$114	$827	$1,721
Internal Rate of Return	4.2%	6.4%	8.5%	10.6%

The economics of electric-displacing SWH thus far appear relatively close to a sustainable market path, with simple payback of under six years at current electric rates. Since a statewide SWH program would cover only gas ratepayers, we are particularly concerned with the gas-displacing units. At current gas prices, cost-effectiveness is tenuous; a higher incentive for gas-displacing systems would seem reasonable to offset a greater part of the initial cost to the customer. Note that the costs shown are based on a still relatively modest number of applications, and may change somewhat over time through the remainder of the Program.[4] Finally, the program evaluation may reveal the extent to which SWH customers place value on protection against gas price volatility.

[2] http://www2.sdge.com/tariff/com-elec/DR.pdf.
[3] http://www2.sdge.com/tariff/com-gas/GR.pdf.
[4] Installed costs can be expected to decline with increasing scale. However, the federal tax credit is scheduled to end in December 2008; were this to occur, net residential system costs would increase by $1500-$2000.

Carbon Impacts

Given the context of AB32 implementation, the carbon emissions impacts of SWH systems are important to quantify. Table 5 shows the impacts and costs of electric- and gas-displacing systems participating in the program, based on current costs for participating systems and considering only the incentive—i.e. not taking into account Program administration costs.

Table 5: SWH Carbon Reductions and Costs

	Electric	Gas
Average System Cost	$ 6,234	$ 6,455
Average Incentive	$ 1,269	$ 1,224
Avg. Savings (kWh, Therms)	2688	128
Emissions factors*	0.55	116
Lifetime CO2 Reduction (lbs)	36,960	37,120
Economic Cost/ton	$ 337	$ 348
Public Cost/ton	$ 69	$ 66

*SDG&E electricity Carbon content from Table 2.2, p. II-6 of SDG&E Climate Action Initiative, Application 07-08-031, filed August 31, 2007. This is a low-end estimate.

Technical and Quality Assurance Issues

The Pilot was designed to provide quality assurance measures that would eliminate the potential for improper system installation. These measures include both technical and programmatic requirements to promote high quality SWH installations. We discuss the most important of these issues below.

Freeze protection. Freeze protection is a major concern to the longevity and lifespan of a SWH system. Four main types of freeze protection are currently represented within the Program: recirculation (direct force circulation in an open loop system), propylene glycol (antifreeze solution in a closed loop system), drain-back (water or antifreeze solution in a closed-loop system which allows for the draining of fluid from the collectors), and integrated collector and storage (thermal mass of roughly 40 gallons of water).

Freeze damage is not covered by any collector's manufacturer warranty. Additionally, SRCC OG-300 certification only allows recirculation freeze protection in areas with low mineral content, which is not the case in San Diego. For these reasons, many experienced members of the SWH community have discouraged allowance of recirculation freeze protection within the Program. At the same time, however, local contractors have been installing these systems along the coast and inland; many claim that the systems are not vulnerable to freeze in these areas. The lower cost and simplicity of a recirculation system make them a favorite of contractors.

The Pilot Program allows installation of systems with recirculation freeze protection only in Climate Zone 7, the coastal area of San Diego. This area has the lowest potential for freezing, though temperatures do reach 40°F which can cause freeze damage to collectors. For recirculation systems, freeze protection redundancy is required in the form of a freeze drain valve. The Program will closely monitor these systems to provide actual data of the freeze risk.

Scald protection. Scald protection is an issue for all water heaters, but especially for solar water heating systems given that some models have the potential to raise water temperature to over 180°F. Single-tank systems are of particular concern: it is common practice for the solar high temperature limit to be set at 160°F to account for relatively high losses for single-tanks systems, causing the upper regions of the tank often to be significantly hotter (Fralick 2008).

The Program initially required an anti-scald valve, but this requirement was reduced to a strong recommendation after two issues emerged. First, some customers noted reduced water temperature and pressure at appliances furthest away from the water heater. Second, the failure position of an anti-scald valve has been difficult to determine, which introduced some long-term uncertainty. Scalding remains a concern, but to remain consistent with current SRCC OG-300 standards the Program now only requires a mixing valve to be incorporated into all residential systems. Anti-scald valves are only required where required by local code.

The Program has focused its scald-prevention efforts on educating contractors about proper installation of certified valves and encouraging the installation of systems which have a mechanism to avoid stagnation. It is up to the market to provide a higher quality of service; indeed, inclusion of anti-scald valves could be used as a sales advantage by the contractor.

Equipment standards. Compliance with SRCC OG-300 certification is important for Program success, for both quality assurance and to gauge the market's response to true standards. SRCC grew out of previous problems relating to improper system design, and enforcement of SRCC standards will improve average system quality. A number of SWH programs have used some variation of SRCC certification in defining eligible equipment. Indeed, federal tax code requires equipment certification by the SRCC in order to claim the solar investment tax credit.

In practice, even SWH programs incorporating SRCC ratings have not field-verified OG-300 compliance; in practice enforcement is a challenge. While each certified system is listed on the SRCC web site with the specific SRCC OG-100 certified collector, size of tank, and a single-line diagram of the system configuration, detailed information on the other components (tank, pump, controller, heat exchanger and other components) is not available there. Due mainly to proprietary concerns of the manufacturers, specific parts are included only in the manufacturer's installation manual. Therefore, verifying that a system has been installed exactly as tested for OG-300 certification is difficult, and the process has resulted in some confusion for contractors who were previously buying locally sourced parts without knowing whether they were in fact part of the OG-300 certified system. SRCC is addressing this concern by requiring all systems to provide a single-page parts list with potential substitutions.

Barriers to Market Transformation

The solar water heating industry is currently experiencing a rebirth after decades of low installation rates, latent consumer mistrust, lack of new market entrants, and absence of state-sponsored incentives. Solar installers, consumers, permitting agency staff, inspectors and other market actors all require renewed engagement and education on SWH technology, performance, costs and benefits. The main mandate of the SWH Pilot Program, in fact, is to gather information on the current state of the market and the principle barriers to its sustained growth and success. Here we detail a number of important lessons that are emerging from the program.

System Cost

The initial assumed cost of $6,000 for a residential system has proven to be accurate to within 10%. However, evidence in the program suggests that systems have been undersold due to unease with the potential costs to the contractors of participation in the program. Discussions with participating and non-participating contractors have highlighted three main unforeseen costs resulting from their participation in the program: 1) freeze protection requirements which limit the applicability of lower-cost systems and thus increase the cost of equipment to some customers; 2) direct and indirect costs associated with permitting and inspection, and 3) administrative costs to process the incentive paperwork. Further, there may be some costs associated with adjusting practices to fully comply with SRCC system parts lists.

In response to dialogue with participating installers after six months of program operation, CCSE modified the incentive basis upward. The first 35 Program Applications showed an average OG-300 performance, based on SRCC ratings, of 130 therms and 2700 kWh. To compensate for some of the expressed costs and enable the contractors to maintain margins while still passing on reasonable savings to the customer, an adjustment was made to the benchmark factor in the calculation to calibrate the incentive level to what was actually being sold. The benchmark was lowered from 160 therms to 150 therms and from 3200 kWh to 3000 kWh. This change results in a 7% increase in incentive amounts. The new benchmarks reflect an ongoing goal of meeting a 75% solar fraction for the average hot water load, estimated to be 200 therms and 4000 kWh in Climate Zone 7, the dominant climate zone in the San Diego region (SRCC 2007). Adjustments were also made to the Solar Orientation Factor; reducing the incentive derate for a wider range of western facing systems.

Contractor Barriers

The SWH industry has been stagnant for over 20 years. Few companies have been installing more than a handful of domestic hot water solar systems each year; many have been focusing primarily on solar pool heating. Some photovoltaic contractors have expressed interest in expanding into solar water heating; however, SWH requires a different set of skills than PV, and the PV market is robust enough that many contractors lack the additional resources to implement this in practice. There is thus a lack of qualified contractors in the SWH sector to support a large-scale program in the region.

All actively participating contractors in the SWHPP are companies with less than 20 employees; most lack a dedicated sales force. Most leads are generated by word of mouth. Customers report that salespeople sometimes do not understand the systems they are selling, or cannot explain system sizing, provide savings numbers or address other issues basic to the decision making process. CCSE holds a monthly training for contractors, and has sponsored additional sessions covering sales management and practical installation instruction for SWH contractors, in partnership with the California Solar Energy Industries Association (CalSEIA) and other organizations. Several additional barriers to contractor participation in the program are reported:

- Changes in standard practices. Quality assurance requirements (e.g. freeze protection measures) can affect the type of system offered and installed, requiring adjustments by the contractor.

- Installation standards. True compliance with SRCC OG-300 certification has required changes in practices by some contractors.
- Increased costs. Systems with more reliable freeze protection are more expensive than recirculation systems, and improper bidding of these projects could result in lower profit margins. Incentive paperwork also adds some cost, though the actual impact is unclear.
- Permitting. Proper permitting also has a cost. This is not in fact a Program cost, but may increase price to the customer, since historically many installations were not permitted.
- Perceived financial risk associated with carrying the incentive. Any perceived exposure could be addressed by opting to have the incentive can go directly to the customer; however, this approach might have a negative impact on the sales process.
- Distrust of incentive programs. Past experiences may make contractors distrustful of a program that alters their business practices and brings new actors into the marketplace

Local Permitting Bureaus

Local plan checkers and building inspectors require education on SWH designs and current SRCC standards. Inspectors are often unfamiliar with these systems, and their concern for safety steers them to take a skeptical approach. As has been the case with the PV industry, the SWH industry must work with building departments to ensure code requirements are met while the specific expectations for SWH systems remain reasonable.

There is considerable unevenness in the process and costs of permitting across local jurisdictions; permitting and inspection can be an onerous process and cost hundreds of dollars in one city while being expedited with fees waived in the city next door. While for some contractors permitting has been viewed as an additional cost, it is unreasonable to expect that a state-funded incentive program provide incentives for unpermitted systems. With proactive education of local permitting staff, and as SWH systems become more prevalent, these transaction costs should drop.

Consumer Barriers

Many consumers are not aware of SWH as a current technology. Existing opinion may be negative due to improperly installed or poorly maintained systems which have failed over the years. Providing education on the technology and policy advancements in SWH has been an effective way to overcome information and awareness barriers with the general public.

Financial barriers also exist for customers. A conventional water heater costs a few hundred dollars, and a tankless heater under $2,000. A net investment of approximately $3,500 for a SWH system does not pass the initial cost test for some homeowners. For customers focusing on the economics, payback periods of over 15 years may prevent serious consideration. Even homeowners motivated principally by other factors may have a payback threshold that serves as a gatekeeper for home energy investments.

Conclusion

Solar Water Heating has great potential to reduce natural gas consumption and its consequent greenhouse gas emissions from homes and businesses in California and beyond. As global demand for SWH services grows, we can expect California to mirror and even drive this

trend; indeed policy initiatives in the state are aiming towards vastly expanded application of SWH technologies.

The question of whether or not SWH is ready for prime time will depend on three major achievements: 1. The creation by California regulators of progressive education and outreach programs, widely applicable standards and incentive mechanisms which ensure equipment and installation quality without excessively burdening the marketplace; 2. The ability of the contractor community to ramp-up their businesses, provide informed sales assistance, and deliver consistent, quality installations; and 3. Acceptance of SWH by consumers as viable, cost-effective and locally beneficial. The ramp-up of the solar-electric industry in recent years is instructive: a concerted effort by a coordinated industry, coupled with well-financed new entrants implementing scalable business models.

California represents a potentially large, sophisticated market, and indeed energy policy initiatives in the state tend to be tailored, performance-oriented and aggressive. At the same time, SWH presents challenges to rapid scale-up, both on the demand and supply sides of the equation, as well as within and among local jurisdictions. The prospect of a statewide SWH incentive program is stimulating great interest in the clean energy marketplace. Lessons from the San Diego SWH Pilot Program indicate that a statewide program will need to encourage innovation and new entrants into the SWH arena. At the same time, a sustained program presence will ensure a predictable, stable environment in which SWH innovators can develop and thrive. A statewide incentive program must look to the lessons from past and current programs to achieve the huge potential benefits of wide SWH penetration: reductions of CO_2 emissions, cost savings for the consumer (and ultimately all ratepayers), and increased utilization of local resources.

References

CPUC 2007. "Assigned Commissioner's and Administrative Law Judge's Ruling Approving Solar Water Heating Pilot Program." California Public Utilities Commission, Rulemaking 06-03-004, filed 2-15-07.

Denholm, P. 2007. "The Technical Potential of Solar Water Heating to Reduce Fossil Fuel Use and Greenhouse Gas Emissions in the United States." NREL/TP-640-41157. February.

Environment California 2007. "Solar Water Heating: How California Can Reduce Its Dependence on Natural Gas." Environment California Research & Policy Center, April 2007.

Fralick, S. 2008 "Protecting Solar Water Heating Systems from Freezing, Stagnation and Scalding: Interim Experience from San Diego's Solar Water Heating Pilot Program." Proceedings of Solar 2008, American Solar Energy Society, San Diego, May 2008.

Renewable Energy Policy Network for the 21st Century. 2007. "Renewables 2007 Status Report (REN21)." http://www.ren21.net/pdf/RE2007_Global_Status_Report.pdf.

Sinclair, M. 2007. "CESA State Program Guide: State Strategies to Foster Solar Hot Water Development." Clean Energy States Alliance. December.

SRCC 2007, "Annual Performance of OG-300 Systems in San Diego: Climate Zone 7." www.solar-rating.org/ratings/annuals/CAZONE720070911.PDF.