Unleashing Consumer Energy Savings: A Mass-Deployment Strategy for Solar Water Heating in Prince George's County

Report to the

Prince George's County Solar Water Heating Task Force

Maryland, the birthplace of commercial solar water heating

1892 Advertisement for solar water heating Source: A Golden Thread, Butti and Perlin

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Reducing Resident's Electricity Rates and Usage: A Mass Deployment Strategy for Solar Water Heating in Prince George's County

Executive Summary

Prince George's County Solar Water Heating Task Force was created in 2010 by the Maryland Legislature to develop a business model that will lead to rapid and significant deployment of solar water heating (SWH) throughout the county. A realistic county-wide deployment expectation would be 5,000 systems per year[1]. A program of this magnitude would represent the first successful mass deployment of SWH in the continental United States (US) and would serve as a national showcase. Achieving this goal for mass deployment of SWH would provide increased employment for installers, sales and customer service representatives as well as engineers.

In addition to job creation, the major benefits associated with mass deployed SWH are consumer savings, emission reductions and increased acceptance of alternative energy solutions. When replacing electric water heaters, a realistic average monthly savings is $40. Other consumer savings are related to lower and flatter electricity demand curves which can significantly lower the state's cost of electricity. Finally, SWH is significantly more cost effective at creating clean energy and reducing emissions than solar photovoltaic (PV) solutions. Emission reductions from the average residential SWH system are more than a ton of CO_2 annually.

Nationally, despite millions being spent to stimulate SWH adoption, in fiscal year 2011, only 15 SWH systems were installed in Prince George's County, 423 in Maryland and approximately 30,000 in the US. Fundamental reasons why SWH use has not taken hold are: 1) it doesn't make economic sense for most consumers due to their high installed costs, (in Maryland the average installed cost is $10,000), 2) a dependency on consumer obtained financing, and 3) an extremely limited targeted market of wealthy early-adopters. The development of a successful SWH business model must directly address the first two reasons in a manner that can significantly expand the potential target market.

Key Drivers for Success

The two fundamental attributes necessary to drive mass deployment of SWH are: 1) the customer must save money, and 2) SWH must be easy to buy. Consumer economics of SWH are dependent upon both installed costs and financing terms. Installed costs can be dramatically lowered by volume purchasing. Unfortunately, such volume will not occur until the prices drop, and prices will not drop until adoption increases. What is needed in the marketplace is a solution provider that has the financial capacity and marketplace credibility to convincingly create the expectation that mass deployment will occur. As shown by a small electric cooperative in Nevada, a single focused and credible entity can radically change the dynamics of the SWH supply chain in Maryland, potentially lowering installed costs to under $4,000.

[1] As will be discussed, a successful SWH program was able to achieve a 3.5% penetration in 18 months. A similar customer acceptance rate for Prince George's County's 130,000 non-gas households would be 4,600 systems.

The current dependency upon consumer financing for SWH virtually assures little to no real savings for US residential SWH. With an equipment life of 20 years and limited economic savings, low-cost, long-term financing is required – the type of financing available to utilities.

Given that economics can be improved and appropriate financing obtained, making SWH easy to buy requires a trusted and competent solution provider. A trusted name provides the validation necessary to position SWH away from the "green" niche market and into the mainstream. Validation significantly decreases customer acquisition costs since consumers trust the solution provider and are no longer required to understand SWH technology, its incentives and providers. Lower customer acquisition costs feed into the positive feedback loop of increased volume driving down costs.

Offering SWH as a service from a trusted utility provides an additional benefit – the expansion of poten

tial customers. The easiest way to increase adoption is to expand the number of people who benefit from the product's value proposition and are in the position to afford it. Newly empowered customers would include tenants (with their landlord's permission), low income households and homeowners that have limited collateral or other credit deficiencies.

The community's embrace of SWH as a community good – one that saves money, improves our environment and allows us each to make a meaningful difference, can be a signature initiative.

Recommendation

Solar Water Heating as a Washington Suburban Sanitary Commission (WSSC) Utility Service

Currently, the method of selling hot water is for one utility to sell the water and another to sell the energy used to heat water. There is nothing which precludes hot water as being the only product sold. While novel, in such an "energy as a service" business model, having the local water utility provide hot water via its owned solar infrastructure is both feasible and practical. With extremely low cost of capital and existing billing relationships with most county residents, WSSC can be the low cost provider of SWH services. Therefore, the Task Force recommends that Prince George's County residents and small businesses have access to solar heated water as a utility service from WSSC. Utility service is defined as utility owned equipment, installed on the user's structure, that provides hot water partially heated by solar energy and for which WSSC is entitled to reasonable compensation.

Value Proposition

With WSSC provided SWH, the customer, WSSC and the community individually and collectively are placed in a superior position, creating a true win-win-win opportunity.

Customer

- Immediate monthly savings for electric, propane and heating oil customers
- Simple, hassle free, utility service with no new financial obligation
- New top-quality water heater – elimination of repair/replacement costs
- Being part of the energy solution

WSSC

- Expanded service offering
- New sources of revenue
- National, state and local recognition
- Green halo

Community

- Creates jobs
- Enables access to SWH for low income households – where the savings are most critical
- Reduces emissions – health benefits
- Renewable distributed SWH's generation of energy reduces the cost, and improves the reliability of electricity
- Delays, or eliminates, the need for new electricity generation plants, transmission lines and distribution upgrades

Target Market

The primary initial target market will be 130,000 single family and attached residential units that heat their water with sources other than natural gas and perceive the value proposition as saving money. The secondary target market consists of the 175,000 households that use natural gas to heat water but are willing to pay a small premium for clean and renewable energy.

Revenue Projections

Using a very simplified model, with a customer charge of $25 per month, WSSC and partners could expect $1,800 gross margin per system. Assuming a 5,000 annual install rate over 5 years, around $45 million would be available for program, marketing and reserves (25,000 x $1,800). These numbers are further improved by the inclusion of program costs in the cost basis used for the federal investment tax credit (ITC) and accelerated depreciation calculation, or if realized solar renewable energy credit (SREC) value is higher than assumed. Further beneficial margin improvements are likely as costs for equipment and installation can reasonably be expected to fall in subsequent years.

Table 1 - Present Value of Lifetime Cash Flows

Present value (PV) of system benefits to WSSC	
PV of $25 @ 3% for 20 years	$ 4,508
SREC value	$ 1,500
Federal ITC	$ 1,800
PV of Benefits	**$ 7,808**
PV of system costs to WSSC	
Equipment	$ 2,000
Installation	$ 2,500
Warranty/Service/Insurance	$ 1,500
PV of Costs	**$ 6,000**
Net to pay program costs and reserves	**$ 1,808**

Assumptions:

1. System life is 20 years
2. Long term cost of capital is 3%
3. Customer charge is $25 per month and never increases over lifetime
4. No customer charge-offs
5. Lifetime Warranty/Service/Insurance is purchased upfront for $1,500
6. Federal ITC is calculated at 30% of PV of system costs and does not include program and marketing costs
7. SRECs are sold for an upfront payment of $600 each (a significant discount)
8. Each system is eligible for 2.5 SRECs (low estimate)
9. No credit for accelerated depreciation
10. No deduction for tax equity partner's increased required rate of return

Why This Model Will Work

- A similar model achieved a 3.5% penetration of SWH into its customer base in 18 months.
- The customer value proposition is appealing: save money while reducing emissions and being part of the energy and green solutions.
- The service is easy to buy and from a trusted name, WSSC. WSSC's involvement validates the technology and moves the technology into the mainstream market.
- Volume purchasing of equipment and installation will dramatically lower installed costs.
- Elimination of consumer financing dramatically expands the potential market, simplifies the buying process and further lowers costs creating a positive feedback loop.
- The customer's financial commitment is to a utility service, not a loan or lease.
- Community support and marketing will produce customers while significantly lowering customer acquisition costs.

Competitive Strategy

Because of WSSC's competitive advantages of low cost capital and existing customer billing relationships, the only major threat to this model is a similarly advantaged utility entering the market. Unlike the gas and electric utilities, WSSC's existing revenues are not impacted by the customer's decision to utilize SWH. With a customer base inclusive of both gas and electric users, WSSC can cost effectively capture more customers in the service area than any other utility. Even if another utility would subsequently enter this space, it would not benefit from the initial County and community out-reach programs that will be put into place for WSSC. Being the first mover, WSSC will benefit by establishing the competitive price and the envisioned community support. As alternative marketing channels (Sierra Club, Neighborhood Associations and roofers) develop, it will be increasingly difficult for another competitor to establish the volume to achieve the necessary economies of scale.

Background

Prince George's County Solar Water Heating Task Force was created by the Maryland Legislature to develop a business model that will lead to rapid and significant deployment of solar water heating (SWH) throughout the county. While the definition of "significant deployment" remains fuzzy, a realistic county-wide deployment expectation would be 5,000 systems per year. A program of this magnitude would represent the first successful mass deployment of SWH in the continental United States (US) and would serve as a national showcase. Achieving this goal for mass deployment of SWH would generate increased employment for installers, sales and customer service representatives as well as engineers.

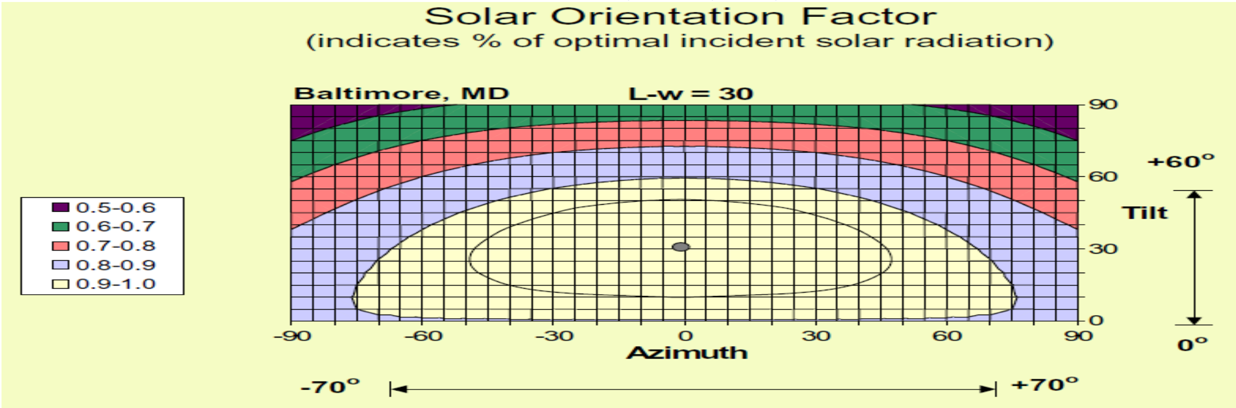
In addition to job creation, the major benefits associated with mass deployed SWH are consumer savings, emission reductions and increased acceptance of alternative energy solutions. Consumer savings are most directly influenced by conventional energy displaced (electricity or natural gas) and the household's use of hot water. When replacing electric water heaters, most studies have shown a direct average monthly savings between $30 and $50. If single occupant households are excluded from the data, the minimum average savings are closer to $40. Other consumer savings are related to lower and flatter electricity demand curves which can significantly lower the state's cost of electricity. Peak electricity demand is lowered by 0.5 to 0.7 kilowatts (kW) per system, the most of any water heating technology (1). When coupled with a control system, each system can reduce peak demand by more than 3 kW (2). Annual consumption reductions have been modeled in the Baltimore area by Solar Rating and Certification Corporation (SRCC) and average 2,500 kilowatt hours (kWh) per system.

Solar water heating is significantly more cost effective at generating clean energy and reducing emissions than solar photovoltaic (PV) solutions. The California Center for Sustainable Energy found that for the same capital costs and panel footprint, SWH produces 3 times more energy, with a corresponding reduction in emissions, than PV (3). For the average residential SWH system, CO_2 reductions range from 2,500 lbs per year from electricity derived from coal to 2,200 from natural gas (4).

Unlike PV, SWH has low sensitivity to the solar panel, or collector, orientation. As shown in figure 1, at Baltimore's latitude, over 90% of the potential energy from the sun (insolation) is available to collectors that face almost due east or west even while accommodating a tilt[2] from horizontal to almost 60^o (5). This flexibility suggests that a higher percentage of buildings will have an acceptable orientation to utilize SWH than would for PV, in keeping with the goal of mass deployment.

[2] Tilt refers to the angle of the collector measured from the horizontal. An tilt of 90^o means the collector is perpendicular to the ground. Azimuth refers to the collectors orientation measured from due south. A collector facing due south has an azimuth of 0^o and 90^o if facing due west.

Figure 1 - Percentage of insolation against collector tilt and azimuth
Source: Christenson, Burch, et al, 2002



According to the Department of Energy (DOE), water heating accounts for between 15 and 25 percent of residential energy use (6). In 2009, residential usage represented almost 30% of the natural gas and electricity energy consumed by the United States (7). Therefore, residential water heating accounts for 4.5% to 7.5% of the nations demand for both natural gas and electricity. Unfortunately, most consumers (and many policy makers) remain in the dark about the energy costs associated with heating water.

Despite clear advantages to using solar energy to heat water, last year there were only 15 solar water heating systems (SWHS) installed into Prince George's County (8). The primary reasons are:

1) high capital costs, the average cost in Maryland was $10,000;
2) limited consumer access to low-cost long-term financing;
3) mismatched terms of home ownership and equipment life;
4) poor consumer understanding of the costs to heat water, and
5) the lack of credible and trusted solution provider brands.

Today, the decision to install thousands of dollars of equipment to heat water is not taken lightly by consumers. When coupled with a requirement for customer obtained financing, the option does not even exist for many. Novel programs around the county are attempting to address high costs and financing by offering 20 year leases for SWH systems. Unfortunately, since homes have an average seven (7) year occupancy, concerns about the future sale of their home has kept consumer acceptance low. Alternatively, customers are familiar and comfortable with enabling services by utilities. During a home's sale, despite an infinitely long commitment for existing utility services, little anguish occurs. All parties just expect that the utility service will pass to the next occupant.

SWH systems' weak marketing brands (channels) impose a significant burden on potential consumers. Today, due to the lack of a credible solution provider, when electing to purchase a SWH system a consumer must become educated in SWH technology, installation contractors and incentives. Each aspect has a significant learning curve and potential for mistake. Not surprisingly, even motivated customers become frustrated or overwhelmed, and do not complete the transaction. Offering SWH systems through a trusted and competent party, such as a utility, allows the consumer to forgo the steep learning curve and rely upon the provider.

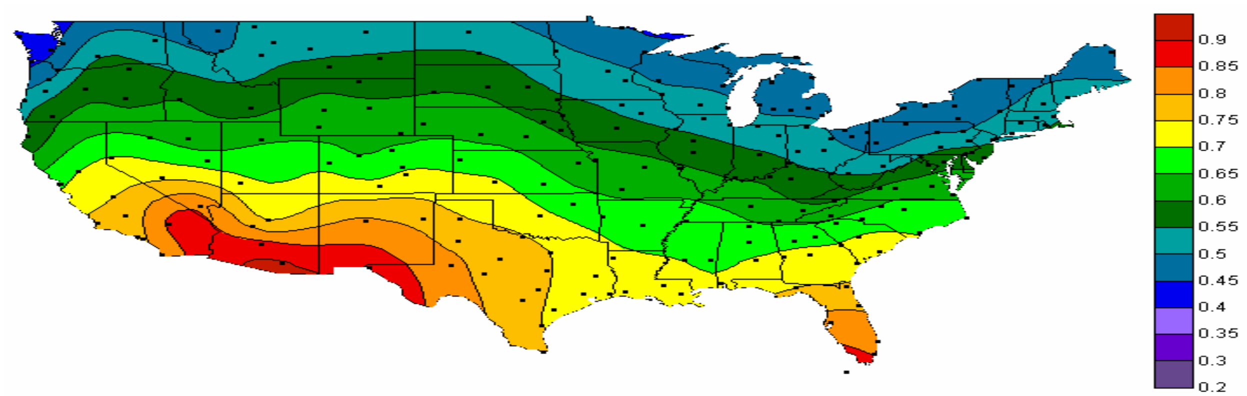
Around the country, most programs have focused primarily on providing incentives to lower the capital costs and have not addressed the lack of financing or weak brands. Not surprisingly, these types of programs have resulted in customer adoption rates of less than a single percent. Two alternative program structures have emerged; community bulk buying, best typified by Valley Electric Association (VEA), and leasing SWH systems from a utility, as pioneered by Lakeland Electric.

Selling SWH as a utility service effectively addresses the above impediments and plays on the strengths possessed by most utilities. Clearly, utilities have expertise in financing, volume purchasing and managing distributed capital infrastructure. The lack of a competing strong brand that offers an affordable and reliable SWH solution is a real and exciting opportunity for utilities.

Technology Description

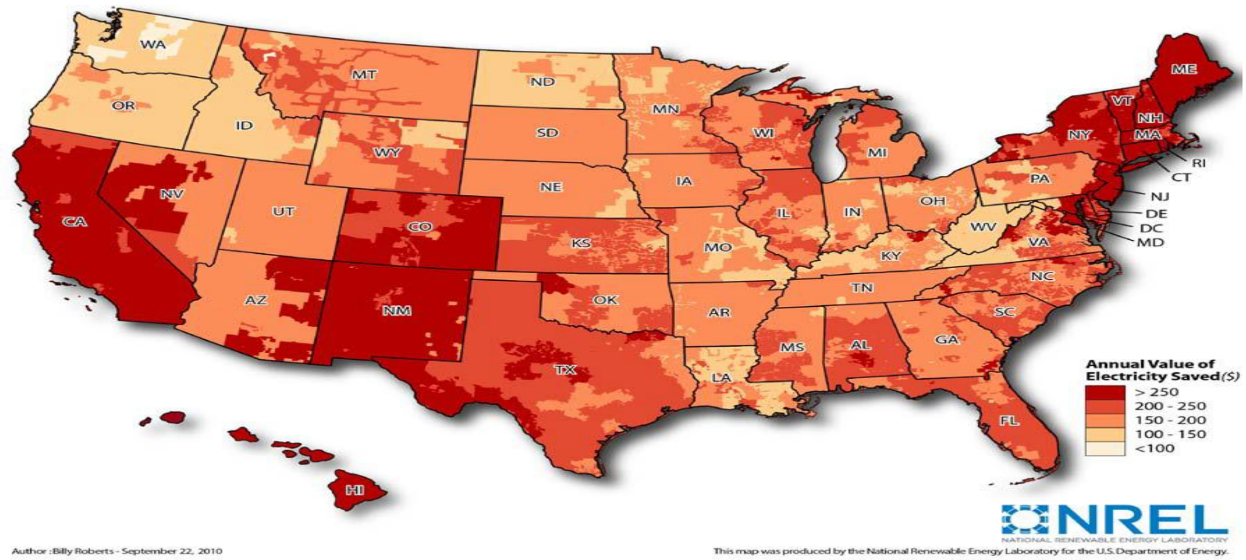
Solar water heaters use the sun to heat water either directly or indirectly via a working fluid and heat exchanger. The heated water is maintained in a storage tank, giving SWH systems the ability to store renewable energy. When hot water demands exceed the system's capabilities, conventional electric or gas heating devices provide augmentation. The ability of a SWH system to reduce its reliance from these conventional energy sources is measured by its solar fraction. A system with a 60% solar fraction means that, on average, 60% of the hot water and associated energy demand can be met by solar energy. Typical average solar fractions in Maryland are in the range of 55-65% with summer fractions approaching 100%. Cost effective and reversible energy storage is a key distinction between, and advantage of, SWH from other forms of solar driven energy generation.

Figure 2 Solar Fraction ***Source:*** *Denholm, 2007*



Counter-intuitively, a National Renewable Energy Lab (NREL) 2011 study found that when displacing electricity, SWH was more cost effective in Maryland than Florida, primarily due to higher electricity rates and cold ground water temperatures (9). Maryland's need to use a great deal of high cost electricity to heat water from a lower ambient ground temperature makes SWH a compelling renewable solution.

Figure 3 Value of electricity savings Source: Cassard, Denholm, & Ong, 2011



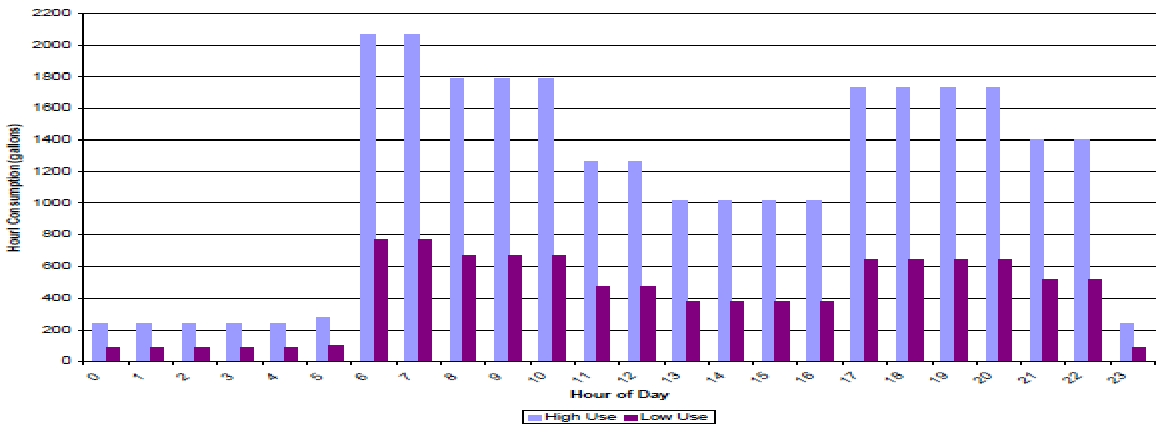
The typical SWH system's ability to deliver energy is directly limited by two factors: 1) the volume of the storage tank and 2) the timing and draw of hot water. If there is no usage of hot water, the system can quickly reach its design temperature and no further energy can be captured by the system[3]. Since solar energy technologies that directly generate electricity, such as PV, can shed their excess energy (electricity) into the grid, they are less dependent on the end-user's actual energy consumption. Due to interior space and cost constraints, the tank size for SWH systems will be limited. Thus the end-users hot water draw profile becomes the critical variable to determine the energy displaced by solar. Unfortunately, limited actual time-stamped data is available for modeling and therefore pilot results are most often used to calculate energy savings (10).

Energy Savings

The lack of published typical residential hourly hot water draw profiles limits the ability to model expected savings. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) standard 90.2-1993 represents average annual hourly hot water draws for both high and low residential usage (11).

[3] The SWH system will continue to produce a minor amount of energy associated with the thermal losses from the tank, although for all practical purposes the net energy generated approaches zero.

Figure 4 - ASHRAE Annual Residential Hot Water Load Profile Source: NAHB, 2002



Even the Solar Ratings Certification Corporation (SRCC) uses a primitive water draw test as part of its OG 300 rating. The OG-300 rating is the industry standard certification and is required by Maryland law for the SWH system to be eligible for state incentives. Table 2 reflects that the SRCC testing for overall system performance assumes 6 hourly draws of 3 gallons per minute for an aggregate daily draw of 64.3 gallons (12), significantly different than the ASHRAE profile and clearly not in keeping with the typical residential usage of hot water.

Table 2 - SRCC OC-300 Certification test water draw Source: SRCC, 2011

RATING PARAMETER	(SI Units)	(I-P Units)
Environmental Temperature	19.7°C	67.5°F
Auxiliary Set Temperature2	57.2°C	135°F
Water Mains Temperature	14.4°C	58°F
Total Energy Draw (QDEL)	43,302kJ	41,045Btu
Approximate Volume Draw	243l	64.3gal
Draw Rate	0.189l/s	3.0gpm
Draw Type: Energy		
Number Of Draws: 6 - One at the beginning of each hour starting at 9:30 am		

Fortunately, there are several pilots that have published their energy saving results. In 2006, Valley Electric Association (VEA), a Nevada electric co-operative, conducted an 18 month pilot with 40 households, all of whom used electricity to heat water (2). The below table shows the results for the 10 units that were metered during the pilot. The VEA pilot results show the wide variation of energy savings associated with SWH. As discussed, these variations are primarily attributable to the overall usage of hot water which is mainly dependent on household size. The average savings during the pilot period was almost 9% of the end-user's electricity which translated into an approximately $30/month reduction in their bill. By focusing on larger households the actual average savings will be much higher. Removing the four households in the sample that saved ~1,000 kWh or less, the average monthly savings rises to over $40. In any event, the maximum monthly savings was almost $50 and 3 of 10 households had monthly savings of over $40. With electricity costs assumed to be $0.103/kWh, about 70% of the cost in Prince George's County, comparable savings in Prince George's County would be between $56 and $70.

Table 3 VEA's pilot study results Source: Cliburn and Associates, 2008

Customer Code	Estimated Annual SHW Production (kWh)	Total Annual Energy Consumption	Net Present Value of Hot Water System	Benefit-Cost Ratio	Average Annual Value of Energy	Simple Payback Period (years)	Lifecycle IRR	% of Electric Bill Savings
Home 1	3,345	19,805	$4,782	2.47	$576	6.0	27.70%	16.89%
Home 2	539	15,281	-$256	0.91	$168	18.3	1.84%	3.53%
Home 3	2,801	38,749	$3,806	2.19	$497	6.8	23.72%	7.23%
Home 4	1,053	16,643	$667	1.22	$243	13.0	8.59%	6.33%
Home 5	1,777	13,039	$1,967	1.63	$348	9.3	15.56%	13.63%
Home 6	2,836	30,794	$3,868	2.20	$502	6.8	23.98%	9.21%
Home 7	1,189	14,690	$912	1.30	$263	12.1	10.04%	8.09%
Home 8	1,011	14,148	$592	1.19	$237	13.3	8.12%	7.14%
Home 9	1,995	25,451	$2,359	1.75	$380	8.6	17.41%	7.84%
Home 10	968	9,136	$515	1.17	$231	13.6	7.64%	10.60%
PROGRAM TOTAL	17,512	197,736	$1,921	1.62	$344	9.4	15.34%	8.86%

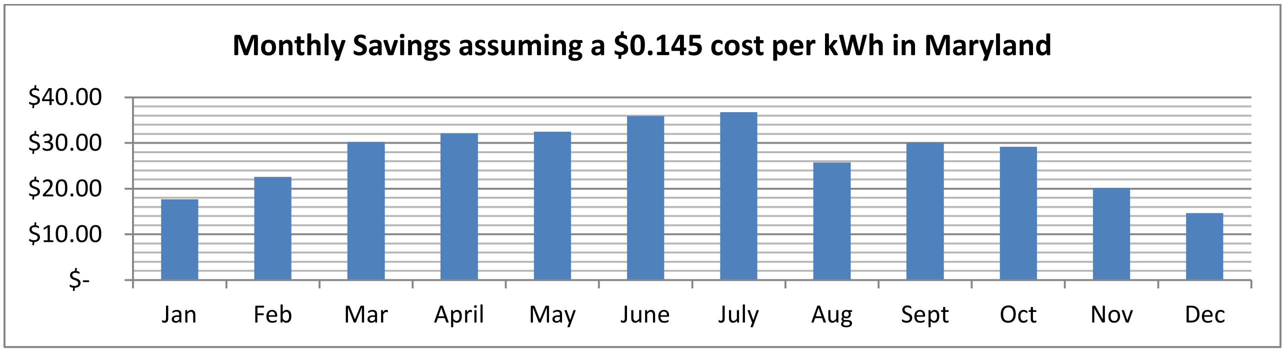
California ran a metered pilot in 342 residential, multifamily and commercial units from 2007 to 2010 in San Diego. The results are shown in Table 4. The 99% realization rate for electric water heating signifies that, on average, 99% of the expected savings was realized. Monthly SWH savings are based on a $0.177/kWh and $1.28/therm for electricity and gas rates, respectively (3). Similar to VEA, California found that the number of occupants in a household had the greatest impact on hot water usage and expected savings.

Table 4 California's SWH Pilot Program savings Source: Itron, Inc, 2011

Fuel	Realization Rate	Monthly SWH Savings		
		Mean	Min	Max
Electric	99%	$41.08	$11.67	$80.93
Gas	91%	$11.29	$3.70	$24.77

The National Renewable Energy Lab (NREL) has developed a solar energy modeling software package called System Advisor Model (SAM) that now includes the ability to model SWH. Unfortunately, there are system issues and weak assumptions that have been discovered and reported to NREL by the author. Again, the lack of accurate hot water draw data is the central weakness. Regardless, the software does provide accurate insolation projections, and if appropriate precautions are taken can provide a better understanding of SWH potential performance in Maryland. Fig. 5 reflects the monthly energy savings from an Alternative Energy Technologies AE-24 system with two collectors (total area ~48 square feet) and an average daily water draw of 70 gallons. The noticeable drop in August's energy savings is due to the NREL hot water draw assuming a one week absence of water draws in that month, as well as in May and December[4].

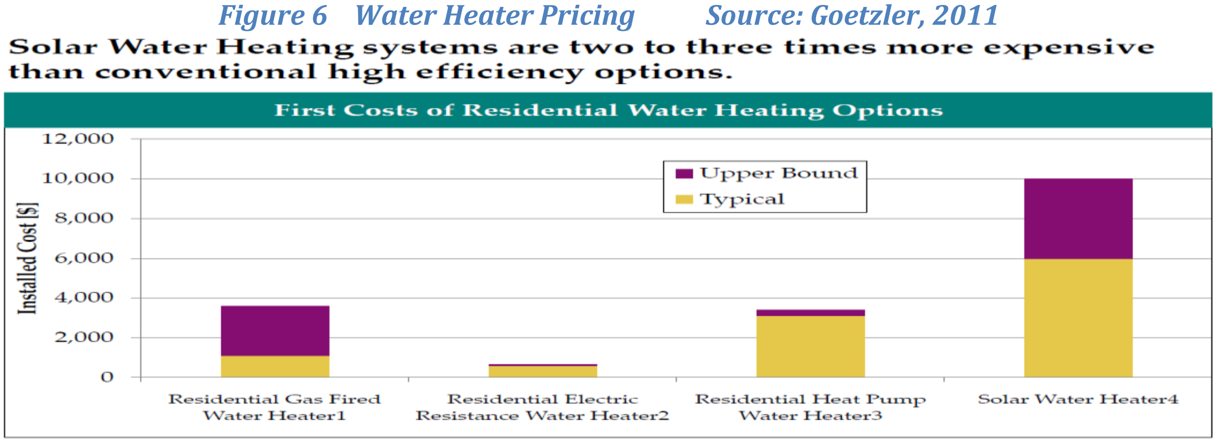
Figure 5 - SAM Model of Maryland Cost Savings



System Cost

The US cost of SWH systems varies dramatically and is often quoted in a $5,000 to $10,000 range. As shown in Fig. 6, a Navigant study found typical installed costs are approximately $6,000 which compares poorly to high efficiency heat-pump water heating systems (13). To effectively compete with heat pump and other efficient water heating technology, Navigant claims that SWH systems must have an installed cost nearer to $3,000 after incentives (13).

Figure 6 Water Heater Pricing Source: Goetzler, 2011

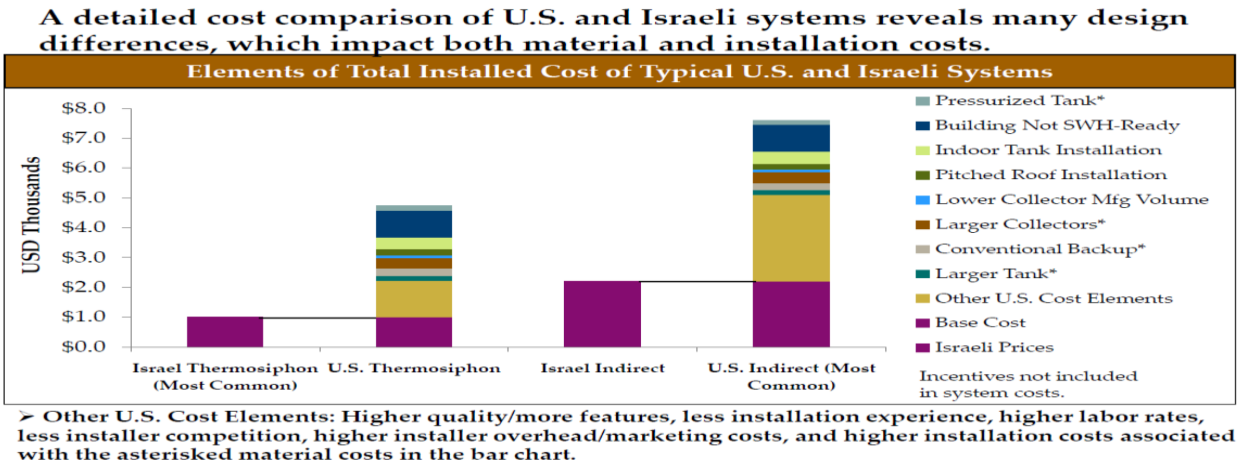


US SWH prices are significantly above global prices. Israeli has successfully achieved mass deployment via low cost SWH. Fig. 7 shows some of the explainable components for this differential with Israeli. Half the difference is associated with less installer competition, high contractor overhead and marketing costs. Differences in US codes, labor costs and construction styles will work against US pricing approaching the ~$2,000 Israeli level, although there is clearly room for US pricing to drop and approach the costs of other efficient water heating solutions. Through a volume buying program, at least one US

[4] NREL has also struggled with the lack of hot water draw data. Their data is from a system being studied and the lack of water draws is due to vacations.

program has already lowered installed costs to around $4,000, significantly below typical US installations.

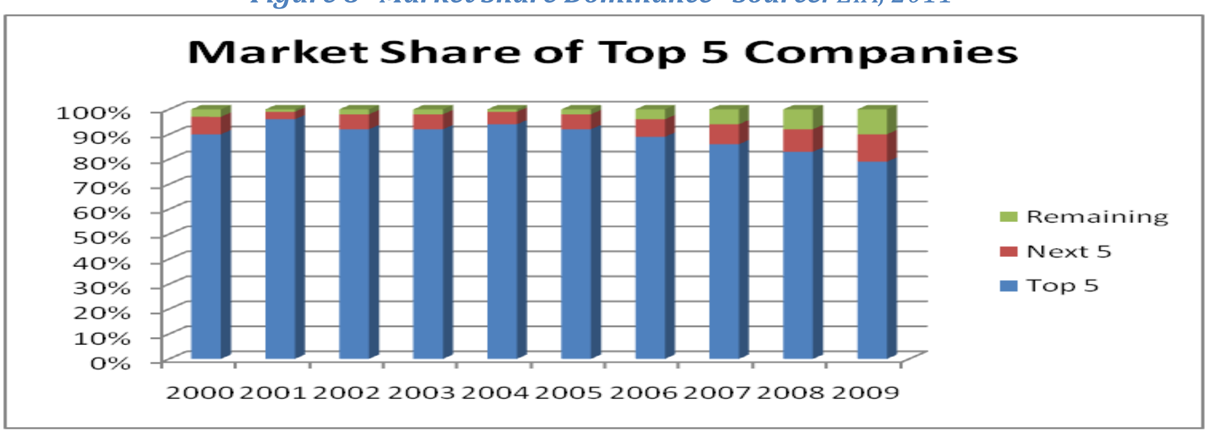
Figure 7 Components of US v. Israeli SWH prices Source: Goetzler, 2011



Manufacturing production volume is extremely low in the US market. Alternative Energy Technology, Inc., one of the largest volume US manufacturers of solar collectors, has an annual production line capacity of 17,000 units (14). Despite this capacity, the company only sold 5,000 systems in 2010.

As shown in Fig. 8, the top 5 manufacturers have represented ~80% or more of total annual shipments, although this dominance is decreasing (15). Having the vast majority of the market controlled by just five manufacturers limits the ability to negotiate equipment price; however, Rheem's significant concessions to VEA and the author's discussions with AET support the conclusion that volume commitments will result in the desired price reductions.

Figure 8 Market Share Dominance Source: *EIA, 2011*



Reliability

If properly installed, SWH can have extremely low system and component failure rates. As shown in Table 5, Hawaii Electric Company's (HECO's) SWH program, with 40,000 systems, had 158 equipment and component failures during the 1996 to 2004 time period. The Table's top sets of numbers reflect the rate of equipment failure expected by Hawaii. The bottom set shows the actual failure rate experienced.

Table 5 Hawaii Electric SWH System Reliability Based on >20,000 Systems

Source: (Cliburn and Associates, LLC, 2008)

Preliminary Research Findings (1995)

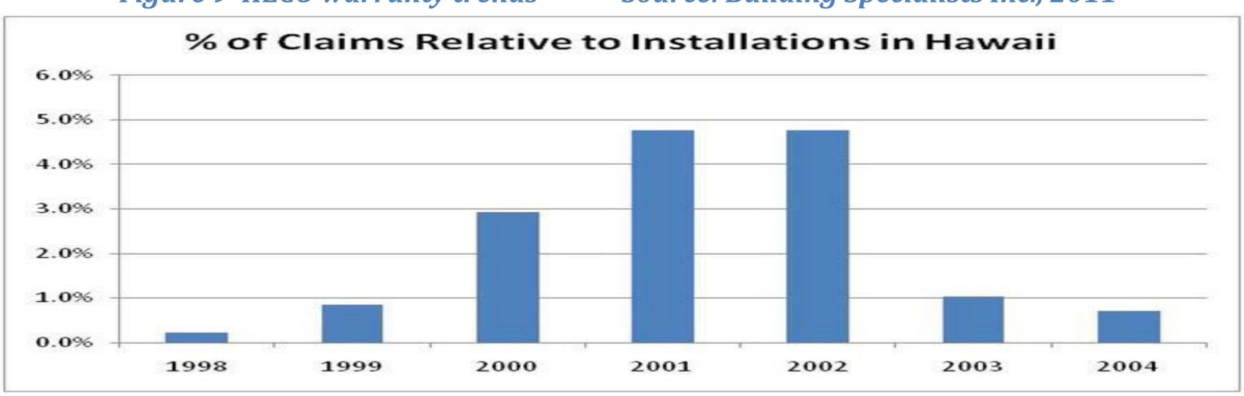
Component	**Est. Life**	**Warranty**	**Claims**
Collectors	>20	5 & 10	<0.1%
Tanks	>15	5	<1.5%
Pumps			
AC	>10	1 & 15	<1.0%
DC	>5	1	<3.0%
Controllers	>10	10	<1.0%

Hawaiian Electric Company Warranty Claims (1996-2004)[12]

Equipment	**Claims**	
Collectors ~40,000	63	0.16%
Tanks ~27,000	21	0.08%
Pumps ~27,000	38	0.14%
Controllers ~25,000	36	0.14%

A more recent Sandia National Lab analysis of Hawaii's experience reported in much more depth and postulated there were two fundamental reasons why Hawaii's experience was so trouble-free. First, the systems used were simple direct systems. Second, a structured problem identification and resolutions process supported its trained city inspectors (16). This second component was put into place as warranty issues began to escalate in the early 2000's. As shown in Fig. 9, warranty issues can clearly be influenced by a managed installation process with high quality control standards.

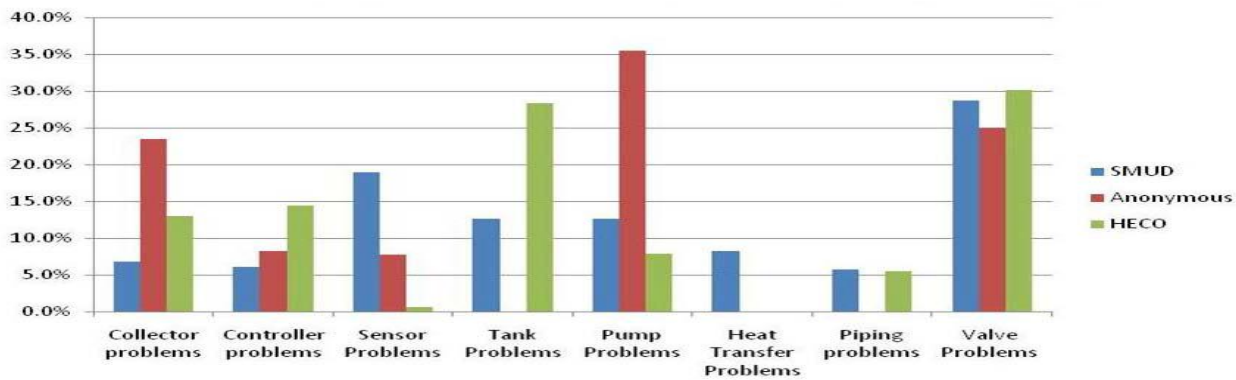
Figure 9 HECO warranty trends Source: Building Specialists Inc., 2011



The Sandia reliability study used three databases of major SWH projects, they were: 1) Sacramento Municipal Utility (SMUD), 2) an anonymous major installer and 3) HECO. The study found that HECO's repair experience was exceptionally low, although noting the SMUD data was from the 1990's and the anonymous installer's performance showed significant improvement between the two years examined (16).

Other than issues with valves, there was no consistency between these databases of repair issues. Fig. 10 shows the relative percentage of problem types between component and the installation database. It reflects the relative percentage of problems experienced by each component in relation to total problems for that data set (color).

Figure 10 Comparison of component failure Source: Building Specialists Inc., 2011



While SWH certainly is not trouble free, HECO's experience shows the exposure can be managed by proactive management of the installation process. Additionally, WePower, a SWH leasing company, has purchased a third party insurance contract for its Rheem SWH systems to cover all required repairs. The ability to offload all warranty and service risk has significant appeal during the program's initial ramp up.

Incentives

Incentives are used to lower prices in order to stimulate higher purchasing volume which will hopefully lead to higher economies of scale. The incentives available for Maryland SWH purchasers are:

- Federal 30% investment tax credit (ITC)
- State MEA SWH grant
- County property tax credits
- Carbon credits
- SRECs

The Federal ITC for SWH has been extended until the end of 2016. While its future is uncertain, political winds suggest the credit may not see another extension. The ITC is a non-refundable tax credit, meaning that it can only be used to reduce a Federal tax liability. If the taxpayer has no Federal tax liability there is no value to this ITC. If the SWH asset is sold or transferred within 5 years of claiming the ITC, the ITC's value is recaptured from the taxpayer.

MEA is currently offering a grant for residential SWH of 20% of the installed costs up to a $500 maximum. The funding for this grant is from Regional Greenhouse Gas Initiative (RGGI) proceeds and SREC alternative compliance payment (ACP) fees. Both funding sources are diminishing and the grant is not expected to survive into next year (17).

Prince George's County offers a property tax credit for SWH and PV installations. The annual funding is limited to $250,000 and has been fully subscribed for the last two year.

The Regional Greenhouse Gas Initiative (RGGI) was expected to create a marketplace for selling carbon offsets. With the recent collapse of RGGI's market price on carbon, there is little short-term expectation for any significant financial incentive value from monetizing emission reductions.

A solar renewable energy credit (SREC) represents a megawatt hour (MWh) of electricity. For SWH, a simple conversion of displaced thermal energy into electricity is used to determine the number of credits awarded. For residential systems, both displaced thermal energy and its conversion to electricity is modeled by the SRCC. The average Maryland SWH system will earn 2.5 SRECs annually.

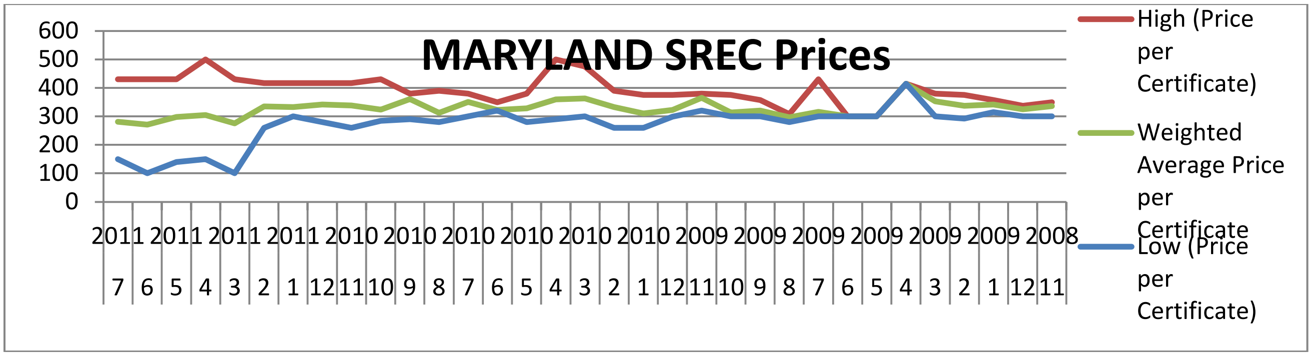
Because their funding is limited, the assumption of mass deployment means both the MEA and the county property tax credit incentives will not be available. Therefore, incentive value in Maryland for mass deployed SWH is primarily dependent upon the ITC and the value obtained from the solar renewable energy credits (SRECs). The avoided ACP represents the maximum value of an SREC. Beginning with the 2012 ACP, the aggregate ACP over the RPS's lifetime is $3,050. Assuming the SREC is worth 50% of the ACP's value and then discounting at 10%, this lifetime SREC payment stream has a value of $970. The ultimate value of the SREC is dependent upon the needs of the Load Serving Entities (LSEs). The SREC's historically high price has led to significant amount of solar PV development from both LSE affiliated and outside interests. Unfortunately, or fortunately, depending on your perspective, over 30 MW of new large scale solar PV is expected to come on line in 2012, which may result in another surplus year. For example, on July 27, 2011 Maryland's Board of Public Works approved the contract with the prison near Hagerstown for an additional 20 MW project that will begin construction this year.

Solar Renewable Energy Credits

[For an explanation of the solar renewable energy credit (SREC) and Maryland's electricity landscape please read Appendix 1]

With the 2011 passage of HB 993, Maryland has made solar water heating eligible for SRECs. The actual incentive available is dependent upon the market value of the SREC and the SREC owner's ability to receive that value over time. Beginning in 2011 the SREC's market price variation has been increasing. Fig. 11 shows the highest price, the lowest price and the weighted average prices paid for SRECs (17). The significant drop in 3/11 is associated with the announcement that the obligated parties expected to have enough SRECs to be in compliance this year.

Figure 11 Historical Maryland SREC market prices



As shown in Table 6, despite significant increases in required SRECs, existing or already announced large scale solar projects are forecasted to meet much of the demand in years 2012 and 2013 (18). Thereafter each year's required new generation is assumed to be built and fully operational for the next compliance year. Clearly the combination of existing and already announced generation will meet the majority of the SREC requirement for years 2012 and 2013. The likelihood of meeting the 65 MW shortfall in 2014 is less certain, although the forecast does not include any significant SWH penetration. In each year of full operation, an ongoing 5,000 SWH system build-out program will generate approximately 12,500 SRECs. If the SWH program began in mid 2012, in year 2014 the program would generate 31,250 SRECs for that year, over 50% of the forecasted need. By 2017, the SWH program would generate 62,500 SRECs annually.

Table 6 Forecasted Maryland SRECs Requirements Source: Lucas, 2011

Year	Existing MW	SRECs Needed	Existing or planned SRECs	New SRECs Needed	Required New Generation (MW)
2011	14.0	30,784	18,200	12,584	18.2
2012	40.0	62,472	52,000	10,472	15.1
2013	80.0	126,171	104,000	22,171	32.0
2014	112.0	190,896	145,590	45,306	65.4
2015	177.4	256,337	230,578	25,758	37.2
2016	214.5	324,672	278,898	45,774	66.1

There are at least two factors that suggest that solar energy build-out will not continue to match the SREC requirements. First, the drop of SREC value in several states, as shown in Table 7, has not gone unnoticed by the large solar developers (19). A significant loss of SREC value decrease the economic viability of "numbers driven" large scale photovoltaic installs. Last fiscal year 61% of Maryland's new installed solar capacity was created via 200 kW or larger systems. If Maryland SREC value begins to approach that of Delaware or even Pennsylvania, the economic viability for such systems will vanish. Absent large scale development and faced with low SREC values, Maryland's small-scale solar system build-out[5] will not be able to ramp up to meet the SREC goals for exactly the same reason, low SREC value.

Table 7 - Summer SREC Prices in PJM Territory   Source: SREC Trader, 2011

SREC Prices	Jul-11	Aug-11	Sep-11
Delaware			
2009-2010	--	--	--
2010-2011	$100.00	--	--
2011-2012	--	$99.99	$85.00
Maryland			
In-State			
2010	--	--	--
2011	$210.00	$199.99	$188.99
Out-of-State			
2010	--	--	--
2011	--	--	--
Massachusetts			
2010	--	--	--
2011	--	$506.00	$525.00
New Jersey			
2009-2010	$536.00	--	$606.56
2010-2011	$555.00	$564.99	$606.56
2011-2012	--	$276.16	$166.79
Ohio			
In-State			
2010	--	--	--
2011	$385.00	$401.00	$401.00
Out-of-State			
2010	$51.00	$26.00	--
2011	$51.00	$44.99	--
Pennsylvania			
2009-2010	--	--	--
2010-2011	$49.98	$25.00	$10.01
2011-2012	--	--	$20.00

The second factor is known as the "kink". In 2016, Maryland's RPS requires that 0.5% of the electricity sold in the state be produced by solar. In 2017, that percentage is increased to 0.55% and in 2018 it rises to 0.9%. The kink resulted from last minute reconciliation of the House and Senate versions of the 2010 RPS legislation. It is widely expected that the 2017 solar carve out requirement will be adjusted to be more towards the middle of the increase between 2016 and 2018. Even if it is not, by 2018, a near doubling of 2016's SRECs will be required. Thus, even in the worse case, 2018 and beyond still appear to be very promising for SREC values.

Ultimately, low SREC value plays into the strength of SWH, the most cost effective solar energy option on the market. The proposed business model works with an SREC value of just over $40 per year, well below what is required to make utility scale photovoltaic feasible.

Similar Efforts Nationally

In the US, only the Hawaii Electric Company (HECO) SWH program can be considered a mass-implementation, arguably due mostly to their lack of natural gas and reliance upon imported oil to generate electricity. The combination of a well run program, high electricity prices and mandates requiring SWH have resulted in over 40,000 installations. Outside of Hawaii, four programs that

[5] Currently, small scale systems, which includes SWH, are being added at the rate of little over 700 kW per month or 9 MW annually.

characterize US SWH programs are discussed below. The first two are traditional programs. The last two represent innovative attempts to break into the SWH market.

Wisconsin's Focus on Energy

This statewide program is administered through Wisconsin's regulated utilities. The program is very similar to the Maryland Energy Administration's SWH incentive program. A key difference is the requirement for a 5 year installation warranty. The program offers no financing or bulk purchasing and relies upon the existing industry to conduct marketing. In 2008, the maximum residential incentive paid was $2,500 which has since been reduced to $1,200. While the program has been showing steady improvements, the 870 installed projects is much less than 1% of the potential market (20).

Table 8 Wisconsin's SWH results

Year	# of Projects (residential)	# of Projects (business)	# of Projects (total)
2007	92	15	107
2008	122	33	155
2009	120	49	169
2011	218	52	270
Total Projects Installed Since 2007			701
Total Projects (with 2005-6 approximation)			870

California's Solar Initiative Thermal Program

In 2010, the California Public Utility Commission (CPUC) created a $280 million incentive program to drive the installation of 200,000 SWH systems throughout the state. The program's goals are to lower installation and permitting costs, educate the public on the benefits of SWH, expand the workforce and remove other impediments to SWH. The program is administered through the regulated electric and gas utilities. The maximum residential incentive is $1,875. Similar to Wisconsin's Focus on Energy, the program provides no financing or bulk purchasing. Unlike Wisconsin's Focus on Energy, California's program funds significant marketing through the participating utilities and directly. Nonetheless, as reflected by the numbers below, the program has not been well received. As of 9/19/2011, there have only been 117 systems added to the below totals (21).

Table 9 California Solar Program costs vs. results (10/1/2010-3/31/2011)

Total Program Expenditures		System applications	
Gas	Electric	Gas	Electric
$1,715,074	$361,231	66	70

There are likely two key reasons for California's lack of success. First, SWH is not cost effective due to the lack of an appropriate financing program. With California's average cost for installed residential SWH of $8,363, the Federal ITC and the State's incentive reduce the customer's cost to $4,000. Assuming 100% financing over 10 years at a consumer rate of 7%, the monthly payment is over $46, more than the expected savings. Second, program management is left to the electric and gas utility companies. Because the program has been set up as a zero sum game, both sets of utilities ultimately will see a net decline in revenue from any program that results in a consumer gain.

Lakeland Electric Solar Leasing Program

For over a decade, Lakeland Electric has been providing a SWH solution and was the first US utility to offer solar water heating (SWH) on an end-use, or “energy as a service” basis. Despite considerable effort, marketing efforts have not resulted in significant penetration into their 112,000 customers. As of May, 2011 there were still just over 100 active SWH accounts.

The utility's first model installed SWH systems on customer’s roofs and billed the customer for the SWH system's output on a monthly basis. The model has now matured to a 20 year fixed payment lease that is collected on the electric bill. The $34.95 monthly fee is expected to result in little to no net electric bill impact for most customers. Once a customer is accepted into the program, Lakeland's partner, Regenesis, will install an 80 gallon direct (water is used as the working fluid) SWH system. The end-user has no responsibility other than making the payment. Both Lakeland and Regenesis are staffed by long time SWH industry veterans who have modified an Alternative Energy Technology, Inc. (AET) system for their use. The program only offers one equipment option, a direct single collector with an 80 gallon tank, sized for a family of four. According to published reports, in 2002 the system's installed cost was just over $2,000 (22) and a 2008 report quoted a $1,200 bulk purchase equipment cost (1).

Valley Electric Association (VEA)

VEA officially kicked off their program on September 5, 2009 and since have made 1,000 customer site visits to determine suitability of SWH. There are currently over 550 installed systems. Including in-process systems, VEA already has 3.5% of their 17,000 members utilizing SWH.

VEA entered into a bulk purchase agreement with Rheem Manufacturing and hired a General Contractor (GC) to oversee the sub-contracted installation process. The program centers around the volume buying power of the co-op as both the equipment and installation costs have been pre-negotiated. Their process flow:

- Site Visit by GC
- Estimate back to the Valley Electric Association (VEA)
- VEA calls member with estimate
- Member signs contract and credit application
- Financing approved
- Job order is scheduled and sent to GC
- VEA warehouse assembles system equipment
- Sub Contractor pre-fab systems/Installation
- Paperwork to VEA for billing ,UCC filing, RECs

Table 10 VEA System models and costs

Systems	Rheem's Price	Installation	Total Cost	Monthly Payment
Manufactured Homes				
System 1 –65 gallon tank and (1) 3x8 collector	$1,758	$1,210	$4,002	$22.23
Site Built Homes				
System 2 –80 gallon tank and (1) 4x8 collector	$1,813	$1,210	$3,891	$21.62
System 3 –80 gallon tank and (2) 3x8 collectors	$2,336	$1,370	$4,769	$26.49
System 4 –120 gallon tank and (2) 4x8 collectors	$2,557	$1,370	$5,007	$27.82

Rheem Manufacturing is supplying four different systems based on household size and/or hot water usage. All models are indirect active systems (gycol). Material not provided by Rheem and consumed during the installation averages an additional $700. With an entry level installed cost around $4,000, the VEA model clearly shows the benefits of volume buying.

VEA provided financing carries a zero percent interest rate over a 15 year term. The end-user retains the federal investment tax credit (ITC). Since the financing represents 100% of the installed costs, in effect the program is providing a ~$1,200 incentive to the end-user. Monthly payments are collected on the utility bill.

VEA funds the program's administrative expenses by selling the retained SRECs. In the Nevada market, these SRECs are worth ~$25/MWh, significantly below Maryland's expected minimum value.

Why Has Valley Electric Worked?

The two most interesting models are the programs developed by VEA and Lakeland Utility. Both models have adopted similar approaches to drive down costs. These characteristics are:

- Standardized equipment options
- Bulk purchase agreements from limited SWH manufacturers
- Managed sub-contractor installation process and pricing
- No upfront costs to end-user
- Low monthly payment designed to be below energy savings
- Monthly payment included in utility bill

The key differences between the programs are related to equipment options, maintenance responsibility, program management, marketing focus, investment tax credit ownership and pricing.

- Lakeland offers only one system option and is sized for family of four - VEA offers four sizes.
- VEA SWH end-users are responsible for their system. The end-user is responsible if the system breaks or has issues outside of the warranty. In Lakeland's program, all system issues are retained by Regenesis.
- VEA's program management is all internal where Lakeland outsources the program to Regenesis
- VEA has been very aggressive in the use of community relations to sell the program. Utilizing their "Ambassadors" program, VEA has developed community leaders that have adopted the

program and actively promote it. In part to its cooperative ownership by the community, VEA has made SWH a core program. Lakeland's model lacks the community aspects and focuses on the program's economic aspects.

- In Lakeland the Investment Tax Credit (ITC) is retained by the system's owner, Regenesis. In VEA's program, the end-user owns the system and is entitled to the 30% tax credit, thus VEA essentially provides the end-user an interest free loan of the ITC's value. While it is tempting to solely attribute VEA's program's success to the customer's retention of the ITC, a large number of VEA's customers do not have Federal tax liability and do not benefit from the ITC.
- Despite retention of the ITC, Lakeland's pricing is $34.95 for a twenty year lease. VEA's payment varies, although the equivalent system is $21.62 for fifteen year loan term. In addition, the end-user is entitled to a ~$1,200 ITC.

Using a 6% discount rate, a net present value analysis for the customer was conducted on the two models. Energy savings were assumed to be equal to the Lakeland's monthly payment for both models and are assumed to rise by 2% a year. System life was set at 240 months. Since maintenance costs are subjective, it is left to the reader to determine an estimated amount to be subtracted from the VEA's value; however, WePower (another company offering 20 year SWH leasing) has purchased third party insurance that covers all repairs and liability associated with the system for approximately $1,000 (23). Excluding maintenance and warranty costs, there is an over $3,600 difference in present value between the models. The VEA model depends upon an interest rate buydown to zero. With a 7% interest rate the resulting $34.97 payment would be equivalent to Lakeland. Without the interest subsidy, the present value still greatly favors the VEA model, primarily due to the end-user retention of the ITC. Because of the five year faster payoff, and the resulting increased energy savings, the lower the discount rate, the more favorable the VEA model.

Table 11 Present Value Analysis VEA vs. Lakeland

Comparison of VEA and Lakeland SWH end-user cost (utilizing the comparable system option)		
	VEA	**Lakeland**
Monthly Payment	$21.62	$34.95
ITC*	$1,167	0
Residual Value	0	0
Discount rate	6%	6%
Term (months)	180	240
System life (months)	240	240
Saving w/o maintenance costs	$13.33	$0
Maintenance	Unknown	0
Energy inflation rate	2%	2%
Present Value	$4,304	$883
Present Value w/o interest sub.	$2,722	$883
* ITC received in 12 month		

The fundamental reasons that 3.5% of VEA's customers have adopted SWH are not just economics. Other factors include:

- Customer perception of the long term personal commitment
  - VEA's long term commitment is shorter and the customer owns the asset
  - Lakeland has a lease agreement – in essence homeowners paying rent
- Community involvement
  - VEA's community is classic small-town with established relationships
  - VEA's process is not profit driven – customer's interests protected
  - VEA conducted 18 month open and transparent pilot proving customer value proposition

Lessons Learned

There are two successful SWH programs in the US: HECO and VEA. Both share two fundamental attributes. First, the program provides an economically attractive cost for SWH to the customer. In both models, a customer will save money by installing a SWH system. Second, each has a committed and holistic approach to a SWH program.

A commonality between unsuccessful programs is their focus on the incentive as the primary driver for customer adoption. Little to no focus is paid to the customer's value proposition. Quite simply, the programs throw money at the problem in the hope that volume will eventually drive down installed costs until SWH becomes economically viable. Despite the clear advantages, unsuccessful programs offer little to no collective purchasing of equipment, installation or maintenance, and leave these negotiations to the party with the least buying power; the homeowner. Similarly, SWH financing is not part of the program and is left to the customer to obtain. The lack of a holistic program approach to SWH, limited competition and poor demand for the solution, virtually ensures the program cannot offer an economically compelling proposition to potential customers. Finally, many unsuccessful programs further compound the problem by creating bureaucratic, time consuming and temporal processes that must be followed to receive incentives.

To mass deploy SWH a program really must only do two things. Save customers money and make SWH easy to buy. Both are much harder to do than say.

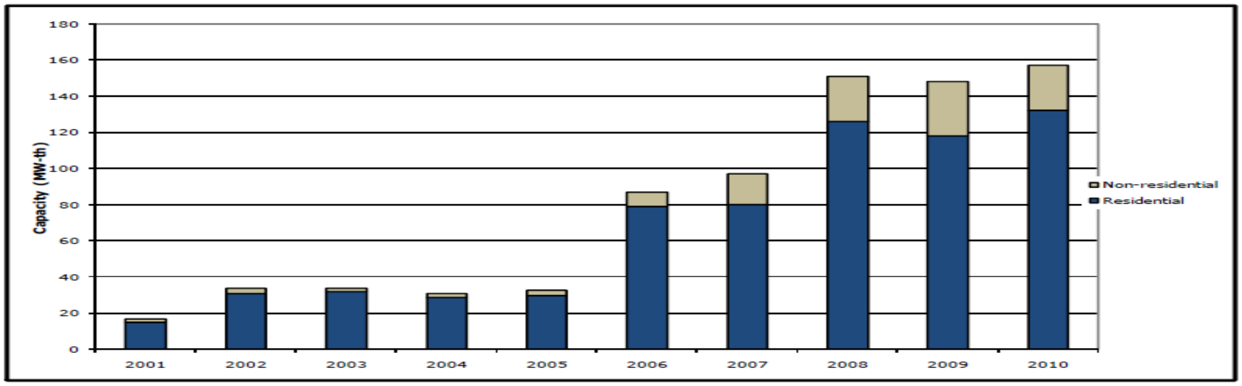
Markets

National

Nationally, the SWH market has grown to approximately 30,000 systems annually and represents a $800 million industry (24) (13). The markets total revenue is about equally composed of equipment sales and labor charges. While the commercial component of the market is increasing, as shown in Fig. 12, it has a relatively minor impact.

Figure 12 - SWH Commercial v Residential *Source: (Interstate Renewable Energy Council, 2011)*

Annual Installed U.S. Capacity for Solar Heating and Cooling (2001-2010)

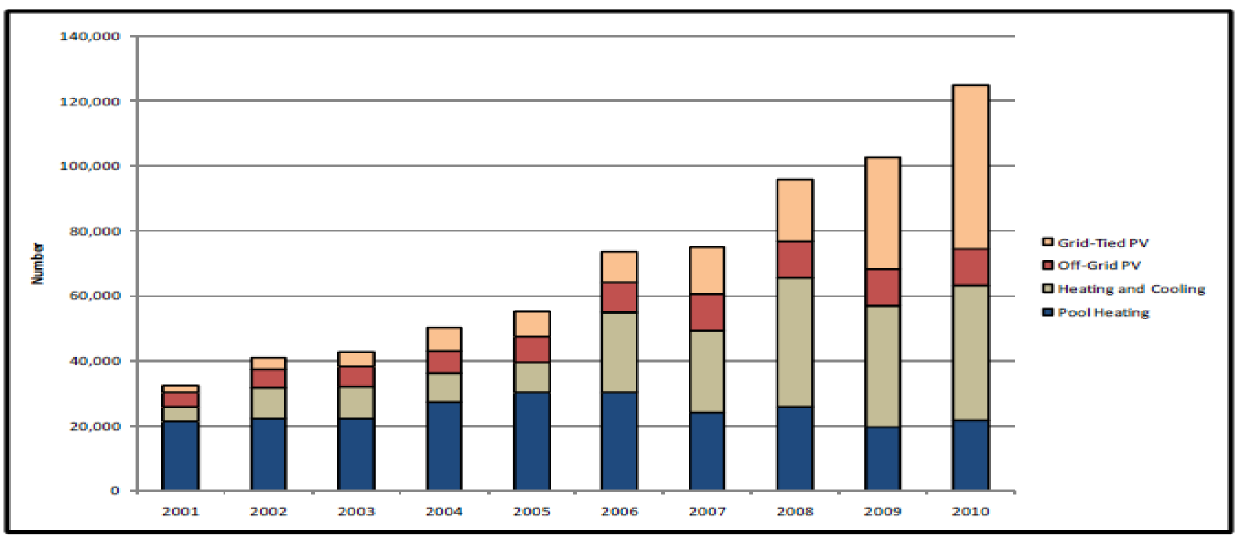


Based on analysis of collector shipment data from EIA and GTM/ SEIA.

Fig. 13 shows that contrary to popular impression, solar thermal is a significant fraction of the total solar energy market. When pool heating is included, solar thermal applications have historically dominated photovoltaic applications.

Figure 13 Breakdown of Solar Technology *Source: (Interstate Renewable Energy Council, 2011)*

Number of Annual U.S. Solar Installations by Technology (2001-2010)



State of Maryland

Table 12 shows the several annual statistics for Maryland SWH. There was an almost 40% increase in new installations of Maryland SWH systems between 2010 and 2011. Despite this large percentage increase the actual number of systems being deployed remains low. The percentage gain is more reflective of the low base than a change in market conditions. The average size of the a Maryland SWH system was just over 50 square feet and represented two 3' X 8' solar collector panels. It is notable that for both full fiscal years the median number of installs per contractor was a single system.

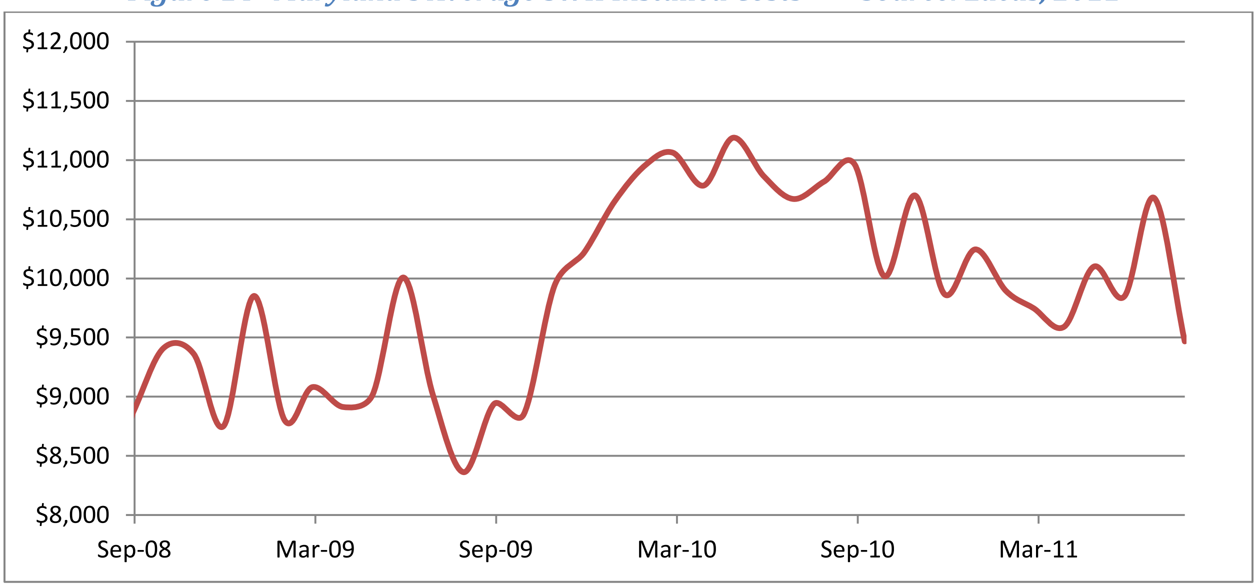
*Table 12 Maryland's SWH statistics (8) * Maryland's fiscal year ends 6/30*

Fiscal Year	Total Awards	Average installs per Contractor	Median installs per Contractor	Total SWH Contractors	Installs by largest single Contractor	Average price per foot²	Average square foot collector area	Average Total System price
2010	307	7	1	42	95	$ 190	52	$9,901
2011	423	10	1	43	157	$ 185	58	$ 10,730
2012 *	12	2	2	7	4	$191	51	$ 9,789

* As of August 30, 2011

Fig. 14 shows the trend for the average Maryland installed cost for residential SWH (18). At $10,000, the average price paid for the system is at the top of national price range. It is interesting to contemplate the impact of Maryland's incentives on this price. The MEA incentive for SWH heating has been at a steadily decreasing percentage of installed costs. What has been consistent is the $10,000 cap on installed costs.

Figure 14 Maryland's Average SWH Installed Costs Source: Lucas, 2011



In 2009, the average factory sales price for a flat plate SWH collector was $19.43 per square foot, an increase of 12% from 2008 (25). Given that Maryland's average collector was 50 square feet, collectors had a wholesale collector cost of $972 plus shipping. Solar water heater tanks are more expensive than traditional tanks, nonetheless, these tanks can be purchased at retail for less than $1,500. Thus even if the collector costs are doubled, equipment costs cannot explain the price being charged in Maryland.

Certainly the high price for SWH is related to the extremely low volumes installed by most contractors. In 2011, over half of the contractors completed only one SWH install. Resulting inefficiencies include low purchasing power, high distribution costs (as most systems are not stocked locally and must be individually shipped), no economies of scale and a steep learning curve. Without repetition, the contractor cannot be expected to gain confidence and the necessary skills to minimize installation costs. In FY 2011, the top two contractors were responsible for 235 of the 423 installs. Despite their volume, both contractors had average installed price similar to the state-wide average. One must conclude that Maryland customers are faced with limited price competition for SWH.

Prince George's County

Historical sales of SWH into Prince George's County have been almost non-existent. In FY 2010, MEA awarded 12 SWH grants, 2 commercial and 10 residential. In FY 2011, grants totaled 15, all of which were residential (8).

Table 13 shows the potential Prince George’s County market with a population of 863,420 housed in 304,000 residential units. Over two thirds of these units are attached or detached single family residences. In keeping with this ratio, almost two-thirds of total housing units are owner occupied and 37% are rentals.

Table 13 Breakdown of PG housing units

Occupied Units 2010 Total: 304,042	Percent	Number of Units	Number of Buildings
Single-Family Detached	52.3%	159,014	159,014
Attached	15.9%	48,343	48,343
2 Apartments	0.6%	1,824	912
3 or 4 Apartments	1.7%	5,169	1,477
5 to 9 Apartments	7.3%	22,195	N/A
10 or more Apartments	21.6%	65,673	N/A
Mobile Home/Other	0.5%	1,520	1,520
Totals	99.9%	303,738	

The initial focus of the Task Force was multifamily properties inside the beltway. Unfortunately, it was quickly determined that the majority of the county’s multifamily units were using natural gas to heat their water. Table 14 reflects that 57% of Prince George’s residential units heat their water via natural gas. As shown by the California energy savings data, SWH is not economically competitive with natural gas that currently has an approximate cost of $0.04/kWh.

Table 14 Current Water Heating Source

Occupied Units 2010 Total: 304,042	Percent	Number of Units
Utility Gas	57.5%	174,824
Bottled Tank or LP	1.1%	3,344
Electric	34.5%	104,894
Fuel Oil	6.1%	18,547
All Other	0.4%	1,216
No Fuel Used	0.3%	912
Totals	99.9%	303,738

The average household in Prince George's contains 2.74 residents. The composition of housing inventory is shown in Table 15. As discussed, the county's relatively large household size is very favorable to SWH economics.

Table 15 Breakdown of household size

Occupied Units 2010 Total: 304,042	Percent	Number of Units
No Bedroom	0.9%	2,736
1 Bedroom	12.6%	38,309
2 or 3 Bedrooms	54.3%	165,095
4 or more Bedrooms	32.1%	97,597
Totals	99.9%	303,738

Potential Business Models

All solar hot water heating (SWH) business models are derived from the end-user's ownership of the system. System ownership is direct, leased, or none. The first two are easily understood. The last, no system ownership, means that only the end product, hot-water, is owned by the end-user. Hot water as a service equates SWH to other forms of energy that are metered and sold at retail.

The sellers of SWH services are contractors, retailers or government, and utilities. Each of these parties can operate in all three ownership modes. The strengths, weaknesses and value proposition of each combination can be evaluated by considering these main drivers:

- Ability to maximize potential market
- Realized incentive value,
- Access to and cost of capital,
- Ability to reduce costs,
- Realized and perceived consumer value.

Why Volume Changes Everything

Mass deployment will not occur unless the customer value proposition is compelling. Nationally[6], other than VEA, the existing customer value proposition from an economic point of view is non-existent. The economics will not improve unless there is volume.

Despite the chicken and egg dilemma above, the benefits of building a high volume model include:

- Nationally, the only successful SWH program is predicated on volume
- Volume is the primary way to reduce equipment costs
- Volume enables installers to be installers and not marketers
- Volume allows specialization; reducing installation time and uncertainty premium

[6] Nationally means the continental US. While Hawaii's programs are successful, the state's unique attributes are not replicable in Maryland.

- Capital is attracted to larger deals
- Volume allows program/marketing costs to be spread over larger base

The presumption that high volume is necessary to obtain a rapid and mass deployment requires a holistic approach to the program. The typical incentive program/business model is not predicated on volume and has the results to prove it. Only VEA's model is designed around generating low margins on high volume installations. Unfortunately, VEA's model cannot be readily replicated as it is designed on negative margins.

Financing

Every examined business model for deploying SWH relies upon consumer financing. This simple assumption, that SWH is a consumer asset financed by consumer debt, is a major factor in why SWH has not scaled.

Building a utility scale infrastructure on the back of consumer financing is a fatal flaw for two major reasons. First, while consumer financing costs are historically low, unless the funds are obtained in conjunction with the financing of the home, they usually carry high transaction costs, short repayment terms and high interest rates in comparison to utility cost of capital. While VEA's model has significantly softened these attributes, there are few parties like VEA that are willing to absorb the associated costs. Second, the reliance on consumer financing significantly limits the size of the potential market. Even if it made sense economically, people may be reluctant to take on a long term personal obligation for several reasons including: 1) payment term exceeds the expected length of occupancy, 2) lack of equity in home, 3) weak credit, and 4) tenant occupancy of home. Additionally, current economic conditions have severely disrupted consumer's ability to obtain the necessary financing.

To deploy a utility scale infrastructure, you need a utility with utility margins and costs of capital.

Recommendation

Solar Water Heating as a Washington Suburban Sanitary Commission (WSSC) Utility Service

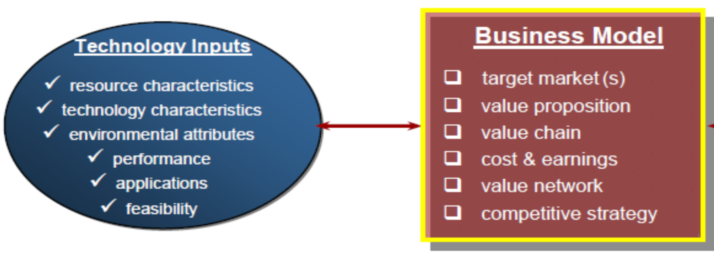
Currently, the method of selling hot water is for one utility to sell the water and another to sell the energy used to heat water. There is nothing which precludes hot water as being the only product sold. While novel, in such an "energy as a service" business model, having the local water utility provide hot water via its owned solar infrastructure is both feasible and practical. With extremely low cost of capital and existing billing relationships with most county residents, WSSC can be the low cost provider of SWH services. Therefore, the Task Force recommends that Prince George's County residents and small businesses have access to solar heated water as a utility service from WSSC. Utility service is defined as utility owned equipment, installed on the user's structure, that provides hot water partially heated by solar energy and for which WSSC is entitled to reasonable compensation.

Recommended Business Model

A business model uses technological characteristics and potentials as inputs, filters them through customers and markets, and results in economic outputs (26). This is normally done by examining how the provider can maximize the customer's value proposition and then attempt to capture a portion of that value for themselves. The ideal model will create a win-win-win proposition for the consumer, WSSC and the community at large. Our framework for understanding value is defined by:

- Value Proposition – What is the value created, both from the customer and WSSC's perspectives?
- Target Market – Who will benefit, to what extent, and how are revenues generated?
- Value Chain – What internal capabilities does WSSC have and what must be obtained externally?
- Value Network – How does WSSC fit into the supply chain to customers?
- Cost and Earnings – What is the cost structure and profit potential given the value proposition, chain and network?
- Competitive Strategy – How does WSSC maintain its favorable position?

Figure 15 - The Business Model Concept ***Source:*** (27)



Value Proposition

Customer

- Low cost, renewable, hot water
- Immediate monthly savings for electric, propane and heating oil customers
- Reduced emissions
- Simple, hassle free, utility service
- New top-quality water heater – elimination of repair/replacement costs
- Ease of purchase
- No new financial obligation
- Being part of the energy solution

WSSC

- Expanded service offering
- Capital based rate of return
- Commissioning fees
- Program fees
- Community supported marketing

- Local, State and National recognition for developing the first successful SWH program in the continental US
- Green halo

Community

- Creates jobs
- Enables access to SWH for low income households – where the savings are most critical
- Reduces emissions – health benefits
- Renewable distributed SWH's generation of energy reduces the cost, and improves the reliability of electricity
- Delays, or eliminates, the need for new electricity generation plants, transmission lines and distribution upgrades

Target Market

The primary initial target market will be single family and attached residential units that heat their water with sources other than natural gas and perceive the value proposition as saving money. As previously shown in Table 14, this suggests that 130,000 Prince George's County's households are potential customers. The primary value obtained is an immediate average $40 monthly savings on their electricity bill. In a marketing assessment done for VEA, the ideal candidate was defined as households of two or more with an income in excess of $50,000 (2), a target demographic that is extremely favorable for Prince George's County. Assuming that 20% of the households met the above criteria, the VEA assessment concluded that its market potential, including some commercial systems, was 25% of their total utility accounts. A similar 25% penetration of Prince George's County 130,000 non-gas customers would result in 32,500 systems without any adjustments for the county's superior demographics,

The secondary target market consists of households that are willing to pay a premium for clean and renewable energy. Some portion of the 175,000 households using natural gas will perceive the value proposition as reducing emissions and being part of the energy solution for just a few pennies a day. The differential between costs of heating water with SWH against natural gas will be a significant determinant for the penetration percentage.

Value Chain

WSSC's key strengths and capabilities include:

- Access to low cost capital
- Credibility in the marketplace
- Customer billing is already in place with no major incremental costs
- Customer sales and service interfaces
- Risk management/Insurance
- Sophisticated and large scale purchasing
- Repair and maintenance management

Key weaknesses and functionality that will need to be obtained:

- SWH product expertise |
- SWH installation | ➔ Can be outsourced to known third parties
- SWH repair and warranty |
- SWH Marketing/Sales |
- Solar Renewable Energy Credit (SREC) off-take or value-capture[7]
- Tax Equity (WSSC is not eligible for Federal Investment Tax Credit (ITC))

Value Network

The five major business components of utility scale SWH are marketing/program management, capital, equipment, installation and maintenance/warranty service. The utility can influence, or directly control, lower costs for each via scale and centralized purchasing.

Marketing

The number of the potential buyers of SWHS will be determined by access to financing, perceived value and the ease of purchase. SWH as a utility service eliminates the need for consumer financing, which greatly expands the potential market size, simplifies the buying process and improves the economics. These synergistic impacts reinforce each other as sales volume increases, creating a positive feedback loop. WSSC's ability to dramatically expand potential users of SWH fundamentally changes the market dynamics.

Most SWH marketing programs today utilize a shotgun approach to marketing. One sophisticated program forecasts customer acquisition costs of $1,600 per system and is heavily dependent upon television and direct mail advertising. WSSC incremental costs of direct mail are trivial. In addition, WSSC can target high water consumption users with customized estimated savings associated with a SWH system, greatly increasing the impact of the message.

It is envisioned that WSSC's creation of a SWH utility infrastructure would be promoted by Prince George's County government and community groups. Community driven marketing can significantly lower the hurdles and costs for marketing SWH. Approaching the build-out of a SWH infrastructure as a community goal allows grass roots marketing to be effective. Instead of selling SWH as a luxury good, SWH is positioned as a benefit to the individual and community from financial and environmental perspectives. In return, by standardizing product offerings, providing quality control and making the costs affordable, WSSC creates an environment that enables the rapid growth of SWH's benefits throughout the community.

By developing alternative marketing channels for its SWH solution, WSSC's trusted solution can create entrepreneurial and fund-raising opportunities for Prince George's small businesses and community organizations respectively. Using a client-server computer analogy, WSSC becomes a server capable of

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[7] For detailed discussions about SRECs, how their value is determined and who is required to have them please refer to the SREC section of this report and Appendix I.

delivering a SWH solution. Client entities (small business and community organizations) can then develop their own marketing programs that directly address their customer base. Marketing channel partners can include traditional sources such as installers and roofers[8], or community based organizations such as PTA's and environmental clubs. Such a diversified approach to marketing allows rapid and effective idea/approach transfer between the competing marketers, increases the likelihood of success and reduces client acquisition costs.

Capital
Building the community's SWH infrastructure requires utility cost of capital. The build-out of a utility scale solution on the back of consumer financing is impractical and costly. Inconsistently, even the novel Lakeland Electric and VEA models require consumer financing to build out their systems. Clearly, utilities have a significantly better cost of, and access to, capital than consumers. With a 20 year system life, SWH economics are dependent upon the lowest capital costs possible.

Equipment
As shown by VEA's and Lakeland Electric's negotiated equipment costs of ~$2,000 and ~$1,200, respectively, SWHS manufacturers are clearly interested in discounting their prices to obtain volume. Similar to the existing marketing channels, SWH's supply chain is immature and inefficient. Up to 10% of the equipment's cost can be eliminated via reduced shipping costs by merely buying in truckload, versus single drop-ship, quantities. By utilizing existing competency in large scale purchasing, WSSC can drive costs much lower than individually purchasers. With the entire 2010 US SWHS market being 30,000 systems, a single buyer of 5,000 systems can clearly disrupt pricing.

Installation
Similar to equipment, the lack of volume has led to an inefficient market for installation services. Currently, the median number of annual installs per contractor in Maryland is 1. As the number of systems installed ramps up, installers will become more experienced and efficient. Even if technology and efficiency gains fail to materialize, with 5,000 installs WSSC's buying power should lower installation costs. Another benefit of centralized buying is that installation quality should improve. With significant revenue at risk, installers will be highly motivated to keep their client satisfied.

Maintenance/Warranty Service
Insurance contracts are available in the market to eliminate risk to WSSC for maintenance or liability. Even without unloading risk, the centralized buying of maintenance services for SWH allows significantly lower costs than those available to the typical consumer.

Cost and Earnings

Using a very simplified model that makes the listed assumptions, over 20 years WSSC could realize a gross margin with a present value of $1,800 per system. Assuming a 5,000 annual install rate over 5 years, around $45 million would be available to pay for program and marketing costs (25,000 x $1,800). These numbers are further improved if program costs can be included in the cost basis used for ITC and accelerated depreciation calculations, or if SREC value received is higher. Further beneficial margin

[8] The optimum time to install a SWHS is during a roof install.

improvements are likely as costs for equipment and installation can reasonably be expected to fall in subsequent years.

Table 16 - Present Value of Lifetime Cash Flows

Present value (PV) of system benefits to WSSC	
PV of $25 @ 3% for 20 years	$ 4,508
SREC value	$ 1,500
Federal ITC	$ 1,800
PV of Benefits	**$ 7,808**
PV of system costs to WSSC	
Equipment	$ 2,000
Installation	$ 2,500
Warranty/Service/Insurance	$ 1,500
PV of Costs	**$ 6,000**
Net to pay program costs and reserves	**$ 1,808**

Assumptions:

1. System life is 20 years
2. Long term cost of capital is 3%
3. Customer charge is $25 per month and never increases over lifetime
4. No customer charge-offs
5. Lifetime Warranty/Service/Insurance is purchased upfront for $1,500
6. Federal ITC is calculated at 30% of PV of system costs and does not include program and marketing costs
7. SRECs are sold for an upfront payment of $600 each (a significant discount)
8. Each system is eligible for 2.5 SRECs (low estimate)
9. No credit for accelerated depreciation
10. No deduction for tax equity partner's increased required rate of return

Since WSSC cannot take advantage of the Federal ITC or accelerated depreciation, a tax equity partner (TEP) will need to own the system for the first five (5) years[9]. There are multiple methods for sharing ownership of utility assets, including a contracted buy-out, "flip", or arm's length transaction. In a contracted buy-out arrangement, a TEP would initially purchase the equipment. In year 6, the equipment could be sold to WSSC[10]. A flip transaction refers to the formation of a new entity that is jointly owned by WSSC and a TEP. During the first five years the TEP would own most of the entity. After the tax benefits have been realized, the ownership would be flipped to WSSC upon the buy-out of the TEP. The arm's length transaction would have no agreed upon terms and would be subject to both party's future interests. All but the last transaction are complicated and require professional guidance.

In years 1 through 5, since the TEP would own the system and no WSSC capital would be at risk, WSSC would only benefit from fees associated with program management and billing. After five years, the installations during the first year would possess a known and consistent income stream that could be purchased by WSSC and readily bonded. At a capitalization rate of 6%, the fair market value of the income stream for a system installed in the first year ($25 per month for 15 years at 6%) is $3,000. Thus, assuming 5,000 installed systems, WSSC's capital requirement in year 6 would be $15 million. Given WSSC's current 3% bonding cost of capital, the resulting 3% (6% - 3%) net yield spread would produce a net present value of $3.25 million for the first year's installs.

[9] IRS regulations require the ITC to be recaptured if the qualifying asset is disposed of during a five year period.
[10] IRS regulations require that the purchase be at least fair market value at the time of purchase. Thus to some degree the future sales price is uncertain.

Other than lower than expected customer adoption, the most significant financial risk is a collapse in the Maryland SREC value. Several states, notably Pennsylvania and New Jersey, have already experienced a dramatic drop in their SREC value and the Maryland Energy Administration has suggested that Maryland's SREC value may be threatened. Ultimately, the risk of a short-term market imbalance may be beneficial to SWH. Competing utility scale solar projects, which have comprised the majority of Maryland's new solar capacity, are dependent upon high SREC values. As the most cost effective solar technology, SWH can thrive with SREC values that will make these other projects unfeasible.

Competitive Strategy

Because of WSSC's competitive advantages of low cost capital and existing customer billing relationships, the only major competitive threat to this model is a similarly advantaged utility entering the market. Unlike the gas and electric utilities, WSSC's existing revenues are not impacted by the customer's decision to utilize SWH. With billing relationship with gas and electric customers, WSSC can cost effectively capture more customers in the service area than any other utility. While Washington Gas is currently considering options in SWH, their existing customer relationship is with consumers utilizing natural gas to heat water. The weak economics of SWH against natural gas suggest that their best alternative is to partner with WSSC as the SREC off-taker and tax equity partner.

Pepco can clearly compete in this space. Pepco has been approached about putting together such a program but have not expressed any interest to date. Pepco does have existing relationships with most customers in the WSSC service area; however, existing revenues are decreased by SWH. Additionally, Pepco's subsequent entry into the market would not benefit from the initial County and community out-reach programs that will be put into place for WSSC.

While a competitor could potentially develop a lower cost for SWH utility service, it would be difficult and unlikely to possess enough margins to pay for the program costs. Being the first mover, WSSC will benefit by establishing the competitive price and the envisioned community support. As alternative marketing channels (Sierra Club, Neighborhood Associations and roofers) develop, it will be increasingly difficult for another competitor to establish the volume to achieve the necessary economies of scale.

Adding Value Through Research and Development

As the birthplace of commercial SWH, Maryland once had the leadership role in SWH. Restoring our leadership position has clear benefits to Maryland's residents and the economic vitality of SWH. By leveraging our universities, Maryland can make a meaningful impact in the public's understanding of SWH's inherent value while greatly expanding SWH's potential benefits and lowering their costs.

Prove Real World Energy Savings

There is a surprising lack of data on real world performance of SWH; more so for Maryland specific data. Even the nationally recognized SWH certification authority uses primitive data to model expected performance. With a relatively modest investment, Maryland can establish the benchmarks and data that allow accurate energy savings forecasts. Moving this new found and proven knowledge into the collective consciousness is central to mass acceptance of SWH.

Invest in SWH Installation Technology Development

While increased penetration of photovoltaics has greatly improved their installation technology and lowered costs, these gains have not transferred to SWH. Developing technology through Maryland's Universities that lowers SWH's installed costs directly benefits Maryland residents and has the potential to generate licensing revenue.

Leverage Established University of Maryland (UMD) SWH Technology

A fundamental issue with SWH is the high capital costs compared to the relatively small annual energy savings. Two complimentary approaches can be used to address this issue. The first, lowering capital costs is readily apparent. The second is to increase the possible uses of SWH. UMD has applied for a patent on their liquid desiccant waterfall that helped them win the 2011 Department of Energy Solar Decathlon. Their technology uses SWH to remove humidity from indoor spaces, greatly reducing the energy required for air conditioning. The combination of lower capital costs and increased energy savings holds real potential to drive mass-deployment.

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APPENDIX 1 - Solar Renewable Energy Credit (SREC)

Background

Maryland significantly strengthened its commitment to the RPS model with the passage, in the 2010 Legislature, of the Administration sponsored Senate Bill 277 and House Bill 471 - Renewable Energy Portfolio Standard - Solar Energy. Shown below are the percentages of electricity required to be provided by solar before and after this legislation. Also shown is the new and old penalty for non-compliance, the alternative compliance payment (ACP). Each year, the amount of electricity required to be generated, and what actually was generated, for each type of renewable energy is determined by the Maryland Public Service Commission (PSC). For each megawatt-hour (MWh) of electricity that was not properly generated, an ACP must be paid to the Strategic Energy Investment Fund (SEIF).

Maryland's RPS Solar Carve Out and ACP as amended 2010 SB277/HB471

Year	Solar % (prior to 2010)	Solar % (amended)	Solar ACP (prior to 2010)	Solar ACP (amended)
2011	0.040%	0.050%	$350	$400
2012	0.060%	0.100%	350	400
2013	0.100%	0.200%	300	400
2014	0.150%	0.300%	300	400
2015	0.250%	0.400%	250	350
2016	0.350%	0.500%	250	350
2017	0.550%	0.550%	200	200
2018	0.900%	0.900%	200	200
2019	1.200%	1.200%	150	150
2020	1.500%	1.500%	150	150
2021	1.850%	1.850%	100	100
2022	2.000%	2.000%	100	100
2023	2.000%	2.000%	50	50
2024	2.000%	2.000%	50	50
2025	2.000%	2.000%	50	50
2026	2.000%	2.000%	50	50
2027	2.000%	2.000%	50	50

Table 5 - RPS Solar Carve out and Penalty before and after

Players

After the deregulation of electricity generation the "Electric Company" has been split into several organizations with specific functions and roles in the electric market. Figure 5 shows the participants in Maryland's electricity generation and distribution market:

- Load Serving Entities (LSE) – are in the business of producing electricity usually on a large scale. Includes coal and nuclear, as well as renewable energy as sources of power generation.
- PJM Interconnection, LLC (PJM) [Pennsylvania, Jersey, Maryland] – the operator of electricity transmission for 13 states and the District of Columbia. PJM is charged with the overall reliability of the transmission system, the administration of the competitive wholesale electricity market, as well as operating a spot market for wholesale power transactions for short-term (hourly) electricity.
- Public Service Commission of Maryland (PSC) – regulator of electricity in Maryland. Their principal focus is to ensure the reliability of Maryland's electric supply. The PSC supervises the wholesale auctions that determine the pricing of Standard Offer of Service (SOS) electricity.

- Distributers – often considered the electric company. These entities own and operate the Maryland electrical grid that distributes electricity to the end user. They provide SOS electricity to the end user.
- Supplier – a competitive provider of electricity service who may take title to, or just broker, the electricity that it sells to the end user.
- Small Solar Power Generators (SSPG) – homeowners and businesses that generate power from the installation of photovoltaic panels (PV) or solar water heaters (SWH). For all practical purposes, all of this power is consumed by the end user.
- Aggregator – third party that is free to buy and sell SRECs to any interested party.

The following graphic shows how all these parties are interconnected.

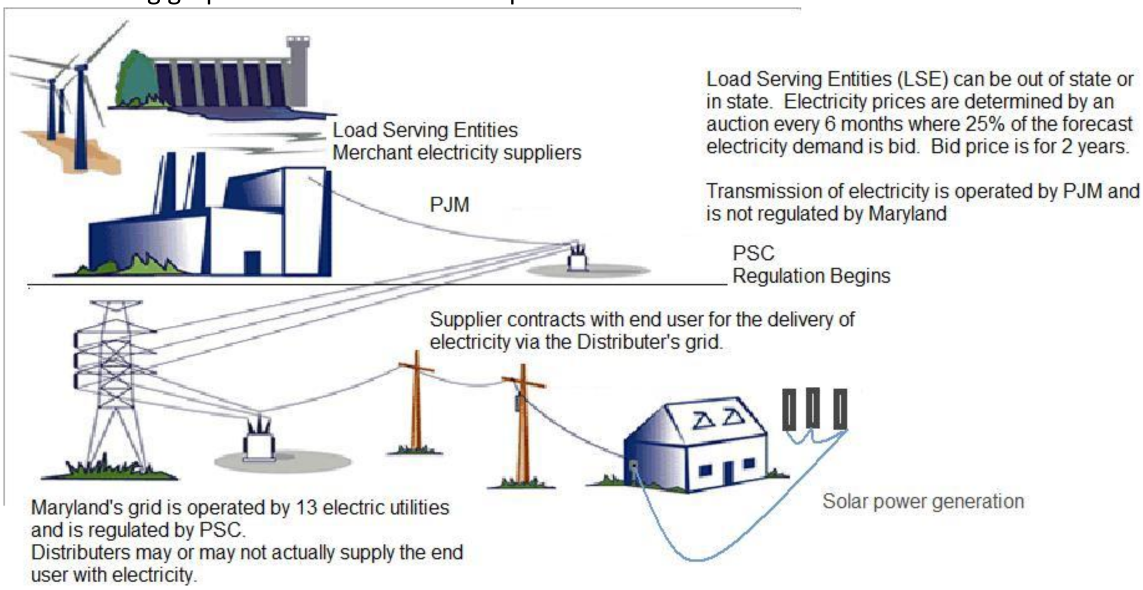

Figure 1 - How Electricity Players are connected

Renewable Energy Portfolio Standard

A renewable energy portfolio standard (RPS) requires a certain amount of energy to be generated from renewable sources. It differs from a goal in that it: 1) assigns responsibility for achieving the requirement to a specific party[11] and 2) creates a penalty for failure to obtain the requirement. Each megawatt-hour (MWh) of electricity produced by a targeted renewable source is eligible for the issuance of one Renewable Energy Credit (REC). Maryland defines its renewable energy goal as a percentage of the annual retail sales of electricity.[12] Each year, RECs equal to the renewable energy goal defined by the RPS must be presented by the obligated party to the PSC and retired, or a compliance fee, known as an alternative compliance payment (ACP), is assessed. In Maryland, the obligated party is the LSE.

[11] The specific party is known as either the obligated or compliance party

[12] In 2008 – the last report available- there was 64 million MWh of retail electricity sales, of which 5 million MWh were exempt. Most of the exempted amount was for industrial loads over a certain threshold or sales through certain electric co-ops.

The Legislature placed a special emphasis on supporting solar energy and a portion of the overall goal was "carved-out". Solar Renewable Energy Credits (SRECs) are those RECs specific to the solar carve-out. To further show the importance of solar energy, the Legislature set the solar ACP at over 20 times the penalty for other renewable sources. Effective 1/1/2012 all solar power generation must be located within Maryland's borders to be eligible for a SREC.

The purpose behind the creation of a REC is to create a string of payments that defray the costs of developing the power generation. The renewable energy generator's sale of the REC to the obligated party would create a long term incentive to the generator. Maryland's solar RPS legislation intended that the LSE provide the small-scale solar power generator financing via an upfront payment for long-term contracts of the small solar generator's SRECs.

The value of a SREC is ultimately determined by the price the LSE (obligated party) is willing to pay. The theory is that a SREC scarcity will lead to prices close to the ACP, while a glut could drive the value close to zero. Because an ACP can be paid instead of the retirement of a SREC, the market value of a SREC is effectively capped at the alternative compliance payment (ACP). Today, other than the cap, and the number of SRECs required annually, the state has little influence on the value of the SREC, with a resulting uncertainty of SREC market value. The uncertainty creates issues in both the forecast of electricity prices impact on ratepayers and the ability of small generators to obtain financing of solar power generating assets.

Lifecycle of an SREC

The following list outlines the creation, awarding and retirement process of a Maryland small-scale SREC:

- Solar generator builds solar water heating (SWH) project;
- Solar generator applies to PSC for certification as a Solar Tier 1 renewable energy facility;
- Solar generator applies to establish an account with a PSC authorized solar renewable energy credit tracking system in its name not later than 30 days after PSC certification of the renewable energy facility;
- Solar generator certifies, using PVWATTS or revenue-quality meter, energy production at least annually;
- One Solar Renewable Energy Credit (SREC) is awarded by the credit tracking system for each MWh of energy production so certified;
- Solar generator offers to sell their SRECs to any LSE (obligated parties);
- The solar generator is free to sell their SRECs to any third party if no offers from an LSE are received (under the regulated terms);
- An aggregator (third party) buys the SRECs from the solar generator and then attempts to resell them to an LSE;
- The PSC requires an LSE to produce an annual report certifying that a certain percent of their electricity used for retail delivery is met via solar
    - Proof of compliance is shown by the submission of individual SRECs against the annual requirement and the associated SRECs are retired by the credit tracking system;
- Should the LSE be unable to produce SRECs sufficient to meet the requirement, the LSE is responsible for the payment of the ACP to the SEIF for each missing MWh.

SREC Trading

PJM-Energy Information System's (PJM-EIS) Generation Attributes Tracking System (GATS) is the PSC authorized system used for tracking the SREC's status, ownership, transaction price and dates of transfer. Efforts to create a "true" marketplace for SRECs include: (USPV, Inc 2010)

Auction Platforms
Platforms including SRECTrade and EnviroTrade, offer monthly auctions where offers and bids are matched and a clearing price determined. Results have been disappointing with SRECs being sold for $325 in April, 2010, almost 20% lower than the expected sales price to the LSE.

Exchanges
Flett Exchange offers the only open and transparent real-time marketplace for Maryland SRECs today. This exchange's value has been limited due to extremely low transaction levels.

Spot Market Sales
The spot market, the matching of buyers and sellers via existing relationships, is where the vast majority of transaction takes place.

Appendix II - Destination state for Solar Thermal Collectors

Shipments of Solar Thermal Collectors by Destination, 2008 and 2009

(Square Feet)

Destination	2008	2009
Alabama	8,905	2,938
Alaska	6,529	2,878
Arizona	939,228	745,462
Arkansas	2,512	18,655
California	3,746,327	3,537,009
Colorado	88,680	75,985
Connecticut	230,978	197,196
Delaware	26,482	42,207
District of Columbia	80	1,675
Florida	5,174,765	3,771,020
Georgia	64,518	105,060
Guam	512	362
Hawaii	780,394	520,103
Idaho	10,460	5,854
Illinois	397,234	317,495
Indiana	16,099	98,391
Iowa	7,656	46,121
Kansas	8,553	4,562
Kentucky	28,588	43,849
Louisiana	12,189	9,145
Maine	60,451	35,638
Maryland	27,773	67,250
Massachusetts	108,554	112,073
Michigan	48,915	126,913
Minnesota	137,897	38,655
Mississippi	4,759	1,121
Missouri	6,053	3,758
Montana	8,452	10,541
Nebraska	6,772	2,627
Nevada	233,456	180,192
New Hampshire	29,232	16,694
New Jersey	230,584	185,862
New Mexico	54,751	61,991
New York	411,268	301,014
North Carolina	136,015	118,354
North Dakota	1,242	2,380
Ohio	85,475	191,420
Oklahoma	7,869	5,173
Oregon	452,032	387,217
Pennsylvania	232,063	220,479
Puerto Rico	276,346	101,210
Rhode Island	23,106	11,700
South Carolina	18,913	9,693
South Dakota	1,282	2,426
Tennessee	7,278	3,864
Texas	90,077	176,752
Utah	17,039	37,221
Vermont	66,685	36,984
Virgin Islands of the U.S.	8,745	4,540
Virginia	213,860	108,345
Washington	26,304	29,755
West Virginia	11,786	1,269
Wisconsin	119,242	80,640
Wyoming	716	994
Shipments to United States/Territories	14,715,681	12,220,712
Exported	2,247,116	1,577,061
Total Shipments	**16,962,797**	**13,797,773**

Source: U.S. Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."

Appendix III - Solar Thermal Collector Average Costs for 2008 & 2009

Solar Thermal Collector Shipments by Type, Quantity, Revenue, and Average Price, 2008 and 2009

Type	2008			2009		
	Quantity (Thousand Square Feet)	Revenue (Thousand Dollars)	Average Price (Dollars per Square Feet)	Quantity (Thousand Square Feet)	Revenue (Thousand Dollars)	Average Price (Dollars per Square Feet)
Low-Temperature						
Liquid and Air	14,015	26,518	1.89	10,511	20,411	1.94
Medium-Temperature	2,560	50,109	19.57	2,307	51,483	22.32
Air	28	W	W	22	W	W
Liquid						
ICS/Thermosiphon	321	6,631	20.66	147	4,830	32.80
Flat Plate	1,842	32,043	17.40	1,783	34,642	19.43
Evacuated Tube	351	9,009	25.69	328	8,481	25.88
Concentrator	19	W	W	27	W	W
High-Temperature						
Parabolic Dish/Trough	388	4,640	11.96	980	24,814	25.32
U.S. Total	**16,963**	**81,348**	**4.80**	**13,798**	**96,708**	**7.01**

W = Data withheld to avoid disclosure of proprietary company data.
Note: Totals may not equal sum of components due to independent rounding.
Source: U.S. Energy Information Administration, Form EIA-63A, "Annual Solar Thermal Collector Manufacturers Survey."