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California Center for Sustainable Energy

Solar Water Heating Pilot Program:

Interim Evaluation Report

ADDENDUM: Cost-Effectiveness Study Results

FINAL

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Addendum

Cost-Effectiveness Study Results

Introduction

The purpose of this addendum to the Solar Water Heating Pilot Program (SWHPP) Interim Evaluation Report is to present the results from the cost-effectiveness study described in Section 7 of the Interim Evaluation Report. The results will help the California Public Utilities Commission (CPUC) in assessing the impacts of incentives provided under the SWHPP. The results are also intended to help the CPUC in deciding if and how to move forward with Assembly Bill (AB) 1470, which would create a statewide solar water heating (SWH) incentive program aimed at installing 200,000 SWH systems by 2017.

The first section of this addendum is an executive summary of results. The second section is a brief overview of the methodology, including brief descriptions of cost-benefit tests typically used to determine cost-effectiveness. The third section provides the results from the cost-effectiveness study for both natural gas and electricity baseline scenarios. The fourth section focuses on sensitivity analyses that help identify cost and benefit factors that have the greatest impact on achieving a cost-effective SWH incentive program. The fifth section provides conclusions and findings from the cost-effectiveness analysis. The sixth section provides key inputs and assumptions, and the last section presents three tables summarizing the benefit and cost values for each baseline scenario and test perspective.

Executive Summary

Cost-benefit analyses show that achieving a cost-effective SWH incentive program by 2017 is a feasible goal for California. The analysis also shows that SWH systems that displace electricity are largely already cost-effective without incentive, with the exception of single-family applications. In particular, the analyses indicate that a cost-effective SWH program can be achieved under reasonable changes to market conditions and industry adjustments that would be expected to accompany a statewide incentive program. Among these industry adjustments is a reduction in overall system cost of 16 percent by 2017.[1] An important factor for policy makers to consider is the relative cost-effectiveness of SWH incentives by customer type. Specifically, an incentive program that offers incentives to a mix of single-family, multifamily, and commercial SWH systems yields more cost-effective results than an incentive program that is only offered to SWH systems that serve single-family residences.

In addition to reduction in installed system costs and incentive distribution, a combination of factors can help ensure growth of a sustainable SWH market and is recommended to accompany a statewide incentive program. These recommended factors include offering low-interest loans, increasing the number of trained system installers, increasing public awareness of SWH applications and costs, and standardizing the permitting process.

Results of the benefit-cost analysis include the following findings:

- A statewide SWH incentive program should encourage participation by mix of single-family, multifamily, and commercial natural gas customers. An incentive program offered to this mix of customers will result in more natural gas being displaced and be more cost-effective than an incentive program offered only to single-family homes.
- The 200,000 SWH system goal laid out in AB 1470 represents a reduction of 585 million therms. An incentive program where there is a mix of single-family, multifamily, and commercial participants can surpass 585 million therms of natural gas reductions with fewer than 200,000 total SWH systems installed.
- Getting to a cost-effective SWH program does not require significant technology advances or dramatic changes in market conditions. A 16 percent reduction in the average installed cost (covering any and all reductions in equipment, labor, and/or permit costs) by 2017 will result in a societal benefit-cost ratio of greater than 1.0 under the Business As Usual (BAU) scenario.
- SWH systems that displace electricity are largely already cost-effective, even in the absence of incentives. The one exception is single-family applications of SWH that displace electricity.

[1] AB 1470 (2007, Huffman) requires that the SWH incentive program that is authorized end on or before December 31, 2016.

- No-interest or low-interest loans will help improve the overall cost-effectiveness of a statewide SWH program and make it more accessible to homeowners.
- A sustainable SWH market in California will require an increase in the number of trained system installers. Increased numbers of trained installers will not only help address the expanded demand for SWH systems that would result from a statewide incentive program, but also provide employment benefits that improve the cost-effectiveness of a statewide SWH program from a societal perspective. Lastly, more training could contribute to a reduction in labor cost due to increased installation efficiency.
- A standardized permitting process that addresses necessary requirements will play an important role in reducing the cost of SWH, thereby helping speed market deployment, while reducing costs to consumers and improving the cost-effectiveness of SWH incentives.

1 Methodology Overview

The analysis uses two separate cost-benefit models: one in which SWH technologies displace conventional electric water heating systems and another in which SWH technologies displace conventional natural gas-fired water heating systems. Different models are used because the benefit and cost components associated with offsetting electricity versus offsetting natural gas are substantially different. In addition, differences between electricity and natural gas led to variations in the treatment and structure of the cost-effectiveness analyses, requiring two distinct models.

Scenarios are used within the models to assess how changes in market conditions, policies, or SWH technologies could impact the cost-effectiveness of a SWH incentive program. Four scenarios are analyzed under the natural gas model and one is analyzed under the electricity model. Each of these four baseline scenarios is meant to be representative of present and potential future conditions. The first scenario, the 2008 scenario, represents current conditions and evaluates the cost-effectiveness of a SWH incentive program in 2008. The remaining three scenarios evaluate the cost-effectiveness of a SWH incentive program under different assumptions. The Business As Usual (BAU) scenario assumes there are very few changes in market conditions, costs, and performance of SWH technologies or government policies. In the Moderate Changes (MOD) scenario, the assumption is that there are greater increases in natural gas and electricity prices and a slight shift in government policies favoring increased deployment of renewable energy. The fourth scenario is a more aggressive greenhouse gas-driven (GHG) scenario wherein concerns over global climate change have resulted in substantial demand for natural gas, thereby driving up costs of both natural gas and electricity. Under this scenario it is also assumed that there is considerable improvement in SWH cost and performance.

Benefit-cost ratios are calculated for a SWH incentive program under each of the four scenarios for natural gas-displacing systems and under the 2008 scenario for electric-displacing systems. The benefit-cost ratios are evaluated from three different perspectives: participant (those participating in the program and receiving the incentive), nonparticipant (those not participating in the program but are funding the incentive program), and society. Benefits and costs are provided on a levelized basis so as to allow a comparison of the contribution of these components to the overall cost-effectiveness results. In addition, sensitivity analyses are conducted for the natural gas model for the BAU, MOD, and GHG scenarios. The sensitivity analyses explore the impact of changing certain benefit and cost component values on the cost-effectiveness results. As such, sensitivity analyses allow for identification of those benefit and cost components that have the most impact on SWH cost-effectiveness. In turn, identifying those critical benefit and cost components provides insights into ways to design a cost-effective and sustainable statewide SWH incentive program.

During the course of the cost-effectiveness analysis, it became apparent that the most reasonable approach would be to develop a statewide SWH incentive program that provides funding for diverse system sizes and applications, in order both to achieve large therm reductions and to stay within the $250 million funding amount proposed under AB 1470. Consequently, the cost-effectiveness analysis herein focuses on achieving the displacement of approximately 585 million therms of natural gas; the thermal equivalent of a statewide program corresponding to 200,000 typical single-family SWH systems. Results are presented throughout the analysis in both displaced therms and number of systems to help preserve the focus on achieving the thermal equivalent of 200,000 single-family SWH systems.

Cost-Effectiveness Test Perspectives

As explained in the Interim Evaluation Report, the cost-effectiveness methodology used in this analysis is based on a modified version of the Standard Practice Manual (SPM) approach. Originally developed for evaluating the cost-effectiveness of energy efficiency programs, the SPM has been modified for this analysis to evaluate SWH measures. The modified SPM provides benefit-cost ratio results for the Participant test, Nonparticipant test (which is similar to the Ratepayer Impact test), and the Societal test (which is similar to the Total Resource Cost test). Each test presents benefits and costs from the differing viewpoints.

While this addendum presents the results of the benefit-cost ratio of the Nonparticipant test, Itron strongly recommends against basing the cost-effectiveness of a statewide SWH incentive program on this single result. Instead, we recommend using the Societal test in conjunction with the Participant test as the indicators of the cost-effectiveness of a statewide SWH incentive program. In recent years, the Nonparticipant test has not been used in evaluating energy efficiency measures. The Nonparticipant test has been dropped from use for two main reasons:

- Typically, a benefit-cost ratio of less than 1.0 indicates a program is not cost-effective. However, the benefit-cost ratio for the nonparticipant is usually less than 1.0 because the cost includes lost profit while the benefit includes all factors accounted for in the cost except for profit. The calculation of the benefits includes the avoided cost of procuring, transmitting, and distributing the energy. The costs include the reduced energy bills for incentive program participants, which are calculated using the retail rate. The retail rate includes the cost of procuring, transmitting, and distributing the energy, along with the required profit that the investor-owned utility (IOU) receives. Just considering those two elements, the Nonparticipant test will nearly always have a benefit-cost ratio less than 1.0.

- Using a Nonparticipant test to evaluate the effectiveness of an energy efficiency measure is inconsistent with methodology used by IOUs to evaluate other investments, such as supply-side resources. Utilities invest in new power plants or new infrastructure to meet the needs of a portion of their ratepayers, but this new investment is not evaluated on the basis of equity. For example, the decision whether to build new distribution lines for a residential subdivision is not viewed as nonparticipants (customers outside of the subdivision) subsidizing participants (customers within the subdivision).[2]

For these reasons, Itron believes that the AB 1470 requirement that the CPUC establish whether a SWH incentive program is cost-effective for rate-payers and in the public interest is best accomplished by evaluation of the benefit-cost ratios of the Participant test and Societal test.

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[2] Synapse Energy Economics, Inc. *Portfolio Management: How to Procure Electricity Resources to Provide Reliable, Low-Cost and Efficient Electric Services to All Retail Customers*. October 2003.

2 Cost-Effectiveness Model Results

This section presents the results of the cost-effectiveness model for SWH systems that displace conventional electric water heating systems and conventional natural gas-fired water heating systems. The benefit-cost ratios for a natural gas-displacing incentive program are presented for four scenarios: 2008, BAU, MOD, and GHG. Additionally, levelized benefits and costs are discussed for SWH systems that displace conventional natural gas-fired water heating systems. The levelized costs and benefits are used to identify the relative magnitude of the contribution of each benefit and cost component to the overall cost-effectiveness results. In addition, levelized costs and benefits present these contributions in units ($ per therm) that are more easily comparable to water heating energy bills seen by energy consumers. In contrast to natural gas-fired water heating systems, cost-effectiveness results for an electricity-displacing incentive program are presented for only one scenario: 2008.

Most water heating systems in California use natural gas. Therefore, this analysis is focused on what can be done to create a cost-effective SWH incentive program by 2017 for SWH systems which displace natural gas. In addition, sensitivity analyses are conducted on the baseline natural gas-fired water heating scenarios to identify possible ways to drive the results towards benefit-cost ratios that exceed 1.0. Both the baseline and modified scenarios are used to determine the extent to which a SWH incentive program can be cost-effective for ratepayers and in the public interest.

Natural Gas

This section presents the benefit-cost ratios for each scenario for SWH systems that displace conventional natural gas-fired water heating systems.

Benefit-Cost Ratio Results

This section presents the cost-effectiveness results for an incentive program under the four baseline scenarios: 2008, BAU, MOD, and GHG.

2008 Scenario

Based on the results of the model, a SWH incentive program is not cost-effective for the participant, the nonparticipant, or society under the 2008 baseline scenario for systems which displace conventional natural gas-fired water heating systems. The 2008 baseline scenario is based on the installations carried out in just one year, but does include the expected future benefits such as reduced energy bills for the life of the system, sales of environmental attributes, and other factors which extend beyond the first year.

Table 1 presents the benefit-cost ratio for each of the perspectives and each sector under the 2008 scenario.

Table 1: Benefit-Cost Ratios for 2008 Scenario (Natural Gas)

Sector	Percent of Total Systems	Participant	Nonparticipant	Societal
Single-Family	60%	0.80	0.49	0.73
Multifamily	26%	0.88	0.52	0.50
Commercial	14%	0.99	0.65	0.77
Total 581 systems (4 million therms)	**100%**	**0.93**	**0.58**	**0.65**

Business As Usual Scenario

Under the BAU scenario, the benefit-cost ratios are calculated over the lifetime of the program, rather than for a single year. Natural gas prices are assumed to increase by 4.0 percent each year. A 4.0 percent rate increase per year was chosen because this value fell in between the CEC-forecasted rate of 2.5 percent per year[3] and the five-year average rate increase of 7.0 percent per year. Table 2 shows the results of the benefit-cost ratios for each of the perspectives and each sector in the BAU scenario. The monetary sums of the benefits and costs for each perspective are summarized in Table 20. Under the BAU scenario, 57,910 systems are installed, resulting in a displacement of 895 million therms over the lifetime of the systems. This surpasses the thermal equivalent AB 1470 goal of 585 million therms from 200,000 single-family systems.

Table 2: Benefit Cost Ratios for BAU Scenario (Natural Gas)

Sector	Percent of Total Systems	Participant	Nonparticipant	Societal
Single-Family	60%	0.89	0.65	0.91
Multifamily	26%	0.95	0.61	0.60
Commercial	14%	1.13	0.74	0.98
Total: 57,910 systems (895 million therms)	**100%**	**1.04**	**0.70**	**0.85**

The results presented in Table 2 show that a SWH incentive program is cost-effective from the participant perspective for commercial installations. From the societal perspective, the program is not cost-effective for any sector; however, the commercial sector benefit-cost ratio is just under 1.0. The incentives for commercial installations are nearest to cost-

3 California Energy Commission. *2007 Final Natural Gas Market Assessment: In Support of the 2007 Integrated Energy Policy Report*. December 2007. CEC-200-2007-009-SF.

effectiveness because larger systems have a lower installed cost-per-therm savings. The multifamily sector is the least cost-effective from a societal perspective. It was assumed that the buildings which install a SWH in the multifamily sector would be made up of 33 percent of two- to four-unit buildings and 67 percent of the five or more unit buildings. The improvement in installed system cost per therm saved is minor for two- to four- unit buildings compared to a small single-family system. Additionally, the multifamily systems are eligible for larger incentives than single-family systems. The combination of these two factors causes the societal benefit-cost ratio to be lower for multifamily than for single-family.

In the BAU scenario, a SWH incentive program is not cost-effective. In particular, the benefit-cost ratios for the single-family and multifamily participant test are below 1.0 and the overall societal benefit-cost ratio is also below 1.0. In Section 3, sensitivity analyses are used to explore possible modifications to the BAU scenario that can help result in benefit-cost ratios of greater than 1.0 for the participant test and the societal test, and, by extension, result in a cost-effective SWH incentive program.

For the remaining baseline scenarios, MOD and GHG, cost-effectiveness improves from the participant and society perspectives, as compared with the BAU scenario. SWH is not cost-effective from the nonparticipant perspective, regardless of the scenario.

Moderate Changes Scenario

Under the MOD scenario, natural gas prices are assumed to grow at 7.0 percent per year and the value of the environmental attributes is assumed to increase in conjunction with greater demand for carbon credits. Table 3 shows the values for the benefit-cost ratios. The monetary sums of the benefits and costs for each perspective are summarized in Table 21. Under this scenario, a SWH incentive program is cost-effective from the participant and the societal perspectives. Additionally, an incentive program for single-family systems becomes more cost-effective than for multifamily systems from the participant perspective. This is because the MOD scenario assumes that an increased number of single-family new construction will adopt SWH beginning in 2011 due to Title 24 energy efficiency requirements. The cost of installing SWH in new homes is assumed to be 20 percent lower than for installation in existing homes. A higher percentage of systems installed at a lower cost (without sacrificing efficiency) increases the benefit-cost ratio for the single-family sector.

Table 3: Benefit-Cost Ratios for MOD Scenario (Natural Gas)

Sector	Percent of Total Systems	Participant	Nonparticipant	Societal
Single-family	60%	1.23	0.70	1.37
Multifamily	26%	1.17	0.69	0.92
Commercial	14%	1.48	0.80	1.49
Total: 57,717 systems (894 million therms)[4]	**100%**	**1.36**	**0.76**	**1.30**

Greenhouse Gas-Driven Scenario

Table 4 provides the benefit-cost ratios under the GHG scenario. The monetary sums of the benefits and costs for each perspective are summarized in Table 22. The reason for the improvement in the cost-effectiveness is highly dependent upon two primary factors: an annual growth rate of 10 percent for natural gas prices and the assumption that carbon credits become increasingly important. In addition to the increase in the value of carbon credits, energy displaced through the use of SWH systems becomes eligible to contribute towards energy efficiency program goals and renewable portfolio standards.

Table 4: Benefit-Cost Ratios for GHG Scenario (Natural Gas)

Sector	Percent of Total Systems	Participant	Nonparticipant	Societal
Single-family	55%[5]	1.89	0.86	2.29
Multifamily	29%	1.69	0.87	1.68
Commercial	16%	2.32	0.99	2.74
Total: 51,399 systems (876 million therms)	**100%**	**2.08**	**0.95**	**2.36**

Levelized Benefits and Costs

Calculating levelized costs allows the benefits and costs to be evaluated on a per therm basis. The figures on the following pages also help to show the relative magnitude of the different benefits and costs. For example, the largest benefit for participants arises from bill reductions, and this is also the largest portion of the nonparticipant costs due to lost revenue. Price elasticity and hedging have small levelized cost values and cannot be seen in the

4 Under the MOD scenario, the increase in adoption by new construction results in more systems being adopted when the incentive is higher, leaving less funding available for the remaining years.

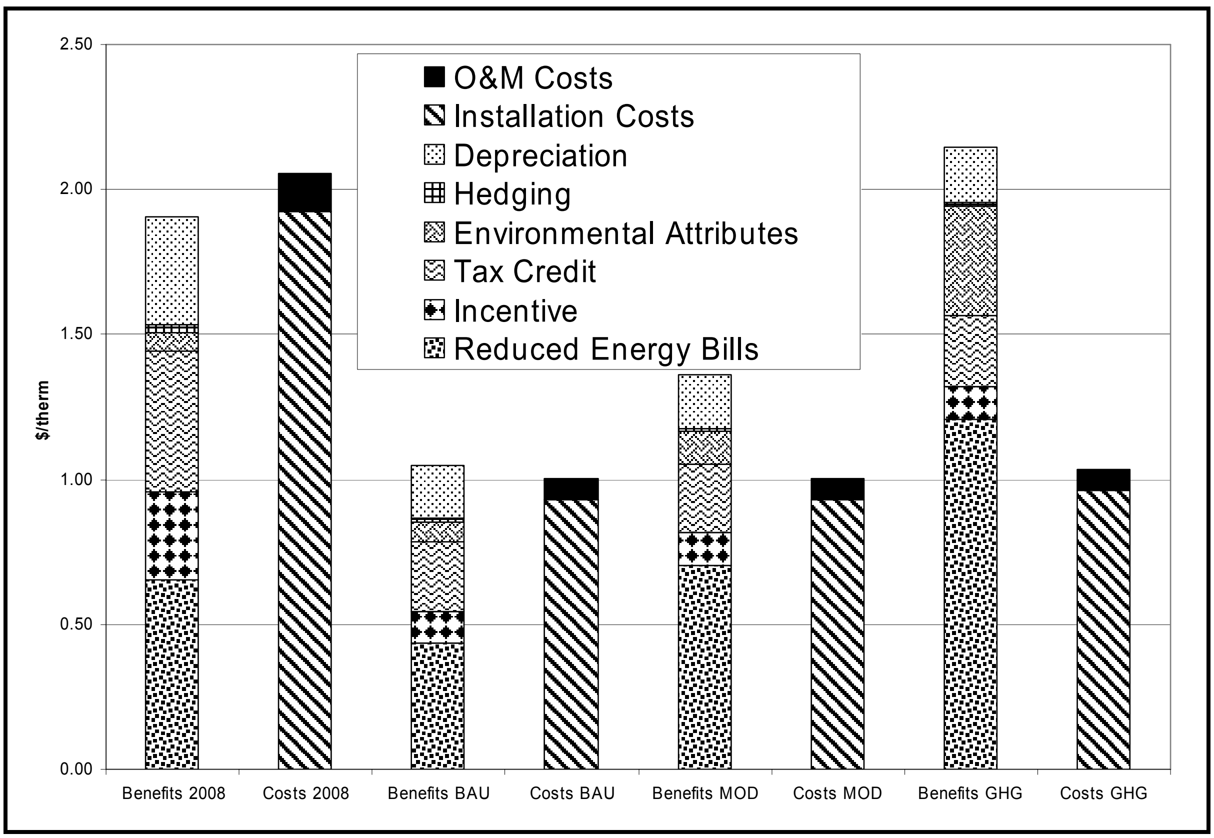
5 The number of residential systems as a percent of total systems decreases as new residential systems are mandatory beginning in 2011 and do not qualify for an incentive. This also results in a decrease in the total number of systems installed through the program as that funding is now being used for larger systems which receive a greater incentive amount.

figures as their relative magnitude is very small compared to the other benefits and costs. For the nonparticipant and society, the avoided commodity and transmission and distribution (T&D) costs are the largest factor and have the most impact on cost-effectiveness.

Participant Levelized Benefits and Costs

Figure 1 presents the levelized benefits and costs from the participant's perspective. In the 2008 scenario, the levelized costs exceed the levelized benefits, with the primary source of the cost being the installation costs. The installation costs per therm are lower in the BAU, MOD, and GHG scenarios than for the 2008 scenario due to discounting the installation costs in future years to net present value. For the BAU, MOD, and GHG scenarios, reduced energy bills have the largest benefit value; this is driven by the assumption about the annual increase in natural gas prices. Natural gas prices are assumed to increase at an annual rate and this annual rate increases from the BAU (4.0 percent) to the MOD (7.0 percent) scenario and again from the MOD scenario to the GHG (10.0 percent) scenario. If the retail natural gas price were to exceed the levelized costs then SWH would be cost-effective to the participants.

Figure 1: Participant Levelized Benefits and Costs by Scenario (Natural Gas)*

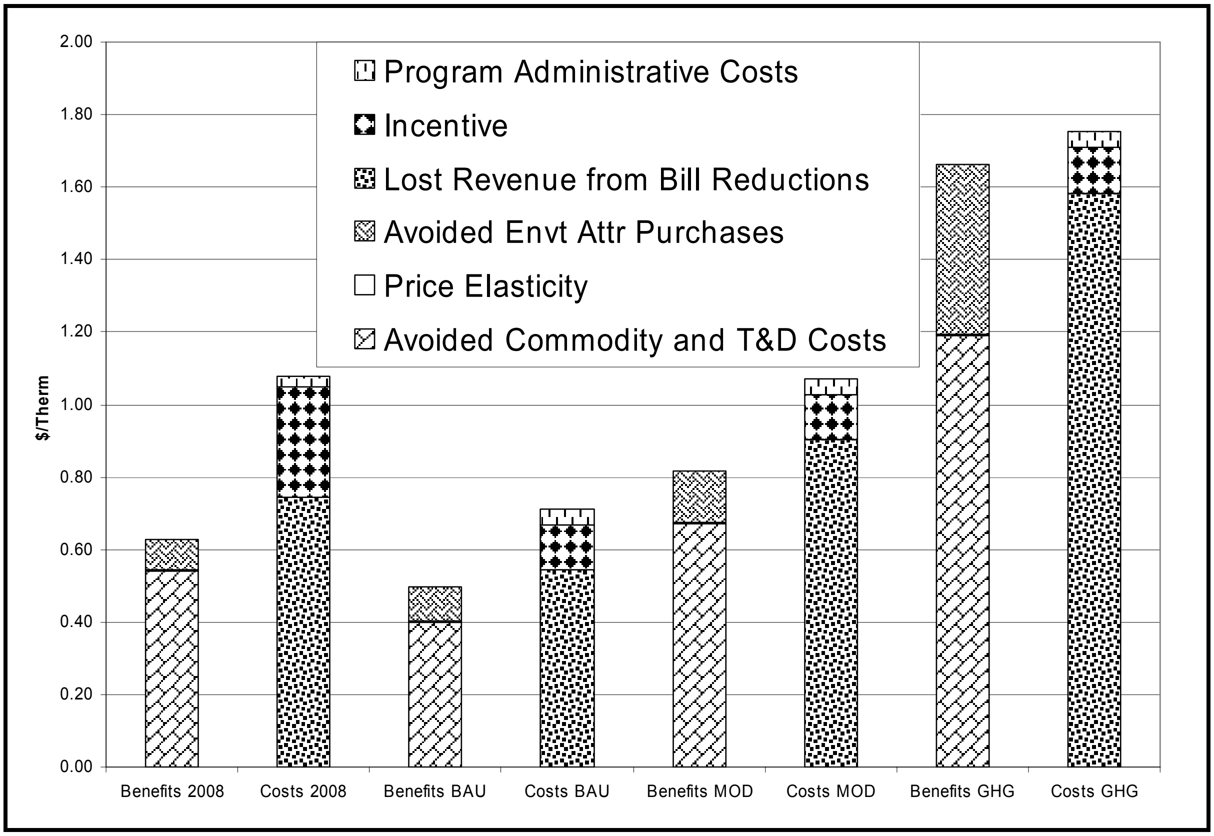


* Some benefit and cost components are negligible and therefore unidentifiable within the figure.

Nonparticipant Levelized Benefits and Costs

From a nonparticipant's perspective, the levelized costs always exceed the levelized benefits, independent of which scenario is considered. Figure 2 shows the primary sources of costs and benefits from a nonparticipant's perspective.

Figure 2: Nonparticipant Levelized Benefits and Costs by Scenario (Natural Gas)*



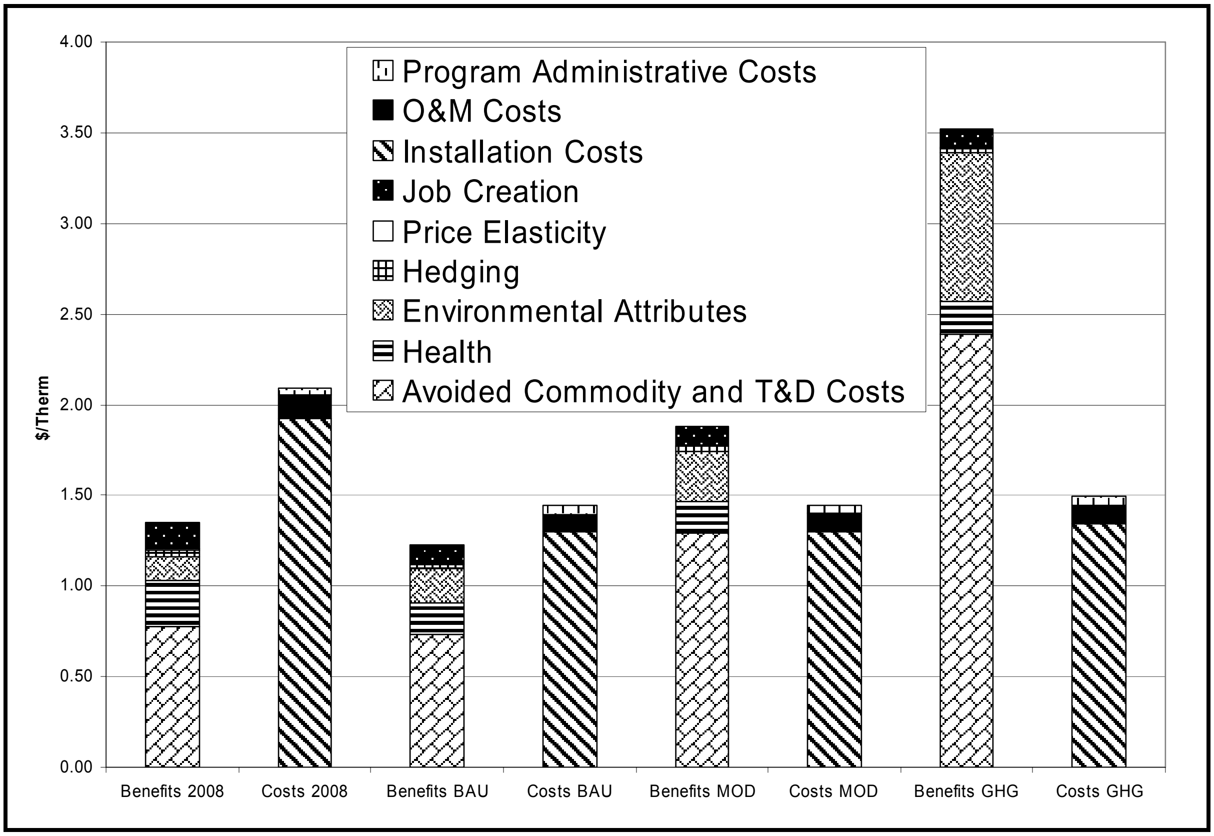
* Some benefit and cost components are negligible and therefore unidentifiable within the figure.

The primary benefit to nonparticipants is the avoided commodity and T&D costs. The utility faces lower costs as they no longer have to procure as much energy. The predominant cost to the nonparticipant is the increase in retail rates which will result from the reduced energy bills paid by participants. If it is desired for the technology to be cost-effective from the nonparticipant's perspective, the current distribution of benefits and costs would need to be modified. If some of the benefits that are attributed to the participant or society could be transferred to the nonparticipant (or to the utility on the nonparticipant's behalf), this would help to achieve cost-effectiveness from the nonparticipant's perspective. An example would be if utilities directly install SWH systems on either residential or commercial buildings and charge the customers for the produced therms at a lower rate than the energy source being displaced. The utilities would have a revenue stream from the sale of solar therms produced by the SWH systems, decreasing the amount of lost revenue from reduced energy bills. Also, the financial revenues from environmental attributes would then belong to the utility. Investing in SWH using this approach would be consistent with the methodology used to build traditional utility-owned production facilities.

Societal Levelized Benefits and Costs

Figure 3 presents the levelized benefits and levelized costs from a societal perspective. The greatest source of benefits stems from the avoided commodity and T&D costs which are assumed to increase at the same annual rate as natural gas prices. The levelized benefit of price elasticity is relatively small compared to the other levelized benefits and is not visible in Figure 3. In 2008 and BAU, the levelized benefits for society are less than the levelized costs. For the MOD and GHG scenarios, from the societal perspective, the levelized benefits exceed the levelized costs.

Figure 3: Societal Levelized Benefits and Costs by Scenario (Natural Gas)*



* Some benefit and cost components are negligible and therefore unidentifiable within the figure.

Levelized Benefits and Costs Conclusions

The levelized costs outweigh the levelized benefits in the 2008 scenario for all three perspectives when SWH incentives are given to offset natural gas use for water heating. A statewide incentive program in the 2008 market would not be cost-effective from any perspective, including the participant. When market transformation by 2017 is taken into account, the benefits begin to exceed the costs for the participant under the BAU scenario. However, under the BAU scenario assumptions, the costs still exceed the benefits from society's perspective. In the MOD and GHG scenarios, benefits exceed costs for the participant and society tests. Figure 3 showed that the largest cost to society is the installed system cost. If the installed system cost of a SWH can be decreased by 2017, the societal benefit-cost ratio could be greater than 1.0 under the BAU scenario. The extent that installed system costs would need to decrease is explored in the sensitivity analyses.

Incentive Program Impacts

Table 5 summarizes the program impacts under each baseline scenario in terms of the amount of money paid in incentives, the amount of natural gas displaced, and the total number of systems installed. The model is constrained by the $200 million cap on the incentive funding available under an AB 1470 program. The differences in the total systems installed under the BAU scenario, the MOD scenario, and the GHG scenario stem from the assumptions regarding the number of new homes that adopt SWH starting in 2011 in response to potential Title 24 requirements. These assumptions are presented in Table 18.

Under the BAU scenario, $198.4 million is spent on incentives, resulting in the installation of 57,910 systems and the displacement of 895 million therms of natural gas over the expected life of the systems (25 years). AB 1470 sets a goal of installing 200,000 SWH systems by 2017. If all of the 200,000 systems installed are single-family systems, each displacing 117 therms,[6] then 585 million therms would be displaced by SWH over the life of the systems. While the goal set by AB 1470 regarding the number of systems would not be met under the presented scenarios, if the goal was equated to a number of therms to be displaced then this goal would be surpassed.

[6] Table 7 shows that the average savings from a SWH installed on a single-family home would be 117 therms. This is lower than values found in other reports such as the CARB Scoping Plan because of the inclusion of low-cost systems, which are also less efficient.

Table 5: Estimated Program Impacts

Scenario/Sector	Total Incentives Paid ($ Millions)	Therms Displaced (Millions)	Total Systems (Collector Area ft^2)
BAU			
Single-Family	20.8	100.7	34,541 (1,667,935)
Multifamily	59.3	188.6	15,067 (3,899,240)
Commercial	118.3	605.7	8,302 (9,582,228)
Total	**198.4**	**895.0**	**57,910**
MOD			
Single-Family	20.6	100.0	34,348 (1,658,270)
Multifamily	59.3	188.6	15,067 (3,899,240)
Commercial	118.3	605.7	8,302 (9,582,228)
Total	**198.3**	**894.4**	**57,717**
GHG			
Single-Family	16.9	81.8	28,030 (1,354,190)
Multifamily	59.3	188.6	15,067 (3,899,240)
Commercial	118.3	605.7	8,302 (9,582,228)
Total	**194.5**	**876.2**	**51,399**

Table 6 shows the average incentive amount paid to each customer type. Incentives are assumed to decrease over time, as described in Table 19. The information presented in Table 6 is independent of the scenario, as the same methodology for decreasing the incentive level is applied to all scenarios. The incentive amount has not been discounted. Multifamily two- to four-unit buildings have the highest incentive per unit of energy displaced. When installing a SWH system, multifamily customers receive an equivalent of $0.30 to $0.34 per therm that is displaced. In contrast, commercial customers—specifically, health facilities—receive a much lower incentive per therm displaced. Commercial SWH installations are more cost-effective than single-family and the two- to four-unit multifamily installations because the systems are larger and have a better match between the load and energy availability. The incentive calculation for multifamily and commercial systems is the same; however, commercial systems displace more therms so the incentive per therm is lower.

Table 6: Average Incentives Paid and Therms Displaced for Each Customer Type

Customer Type	Average Incentive Paid	Average Annual Therms Displaced	Incentive per Therms Displaced Over 25 Years
Single-Family (Retro)	$602	117	$0.21
Single-Family (New)	$602	117	$0.21
Multifamily (2-4 unit)	$1,664	194	$0.34
Multifamily (5+ units)	$12,118	1,604	$0.30
Restaurant	$7,174	1,381	$0.21
Health	$48,425	10,691	$0.18
Lodging	$38,986	8,112	$0.19

Electric

This section presents the benefit-cost ratios for each scenario for SWH systems that displace conventional electric water heating systems. A cap on the total amount of funding available for incentive payments was not imposed for electricity displacing systems. Commercial installations were not included in the electric model as the proportion of commercial customers that use electric for water heating is very small and not representative of California companies.

Benefit-Cost Ratio Results

Table 7 presents the results of the benefit-cost ratios for 2008 both with and without an incentive. It should be noted that this model does not take into consideration the probable decrease in installations if incentives were not available. A SWH incentive program for systems that displace conventional electric water heating systems is currently cost-effective for single-family participants and multifamily participants when an incentive is available. When no incentive is offered, SWH is not cost-effective for single-family participants. The results also show that SWH is cost-effective for multifamily participants even if there is no incentive. Despite a SWH incentive program being cost-effective for the participants, it is not cost-effective for society.

Table 7: Benefit-Cost Ratio Results for 2008 (Electric)

Scenario/Sector	Percent of Total Systems Installed	Participant	Nonparticipant	Societal
2008 (with incentive)				
Single-Family	92%	1.14	0.41	0.95
Multifamily	8%	1.27	0.51	0.82
Total: 9,327 systems	**100%**	**1.23**	**0.48**	**0.86**
2008 (no incentive)				
Single-Family	92%	0.95	0.50	0.95
Multifamily	8%	1.15	0.61	0.82
Total: 9,327 systems	**100%**	**1.10**	**0.57**	**0.86**

Electricity prices are relatively high compared with natural gas prices and, as a result, SWH is more cost-effective for systems that displace conventional electric water heating systems. Despite a benefit-cost ratio greater than 1.0 under a 2008 scenario when incentives are available, SWH that displaces electricity is not cost-effective for single-family applications when incentives are not available. Therefore, this class of SWH systems will likely not be installed without an incentive program. A strong demand among homeowners with electric water heating systems could also have spill-over effects and increase demand among homeowners with natural gas water heating systems.

3 Sensitivity Analyses

Sensitivity analyses were run in order to investigate which factors could be influenced by policy and industry in order to create a sustainable SWH market by 2017, which is the goal of an incentive program designed under AB 1470. In addition, some external factors (e.g., home value increase) were investigated in order to determine their impact on the benefit-cost ratios.

Sensitivity Analysis Benefit-Cost Ratio Results

This section presents the results of the sensitivity analyses. Benefit-cost ratios are presented for all three perspectives for each of the scenarios. The sensitivity analyses are grouped according to whether SWH cost-effectiveness can be influenced by policymakers or industry members, or whether the influencing factor is external.

Policy-Influenced Factors

This section focuses on factors that could improve SWH cost-effectiveness and could be influenced by policymakers. As part of implementing any potential statewide incentive program, policymakers will need to make a decision regarding how the funding will be distributed between single-family, multifamily, and commercial installations. Other factors that may have an impact on the cost-effectiveness of SWH are the system type eligibility requirements and the availability of financing for single-family customers (e.g., AB 811).

Customer Type Distribution

The baseline scenarios assumed that the majority of systems installed through an incentive program would be single-family systems. The distribution for the BAU, MOD, and GHG baseline scenarios assumed that incentive funding would be distributed between systems installed on single-family, multifamily, and commercial buildings. Sensitivity analyses were run to look at the impact from including only single-family installations and the impact from excluding all single-family installations.

Table 8 shows that single-family, multifamily, and commercial customers with natural gas-fueled water heaters should all be eligible for incentives as participation from all three sectors would result in more therms being displaced, a participant benefit-cost ratio greater than 1.0, and a societal benefit-cost ratio of 0.85. Although this combination does not result in the AB 1470 goal of 200,000 systems being installed, it does surpass the AB 1470 goal in terms of the amount of natural gas displaced. Installing 200,000 single-family systems would result in the displacement of 585 million therms of natural gas over the lifetime of the systems. Installing 57,910 systems among the single-family, multifamily, and commercial sectors would result in the displacement of 895 million therms of natural gas and would surpass the AB 1470 goal in terms of equivalent therms.

Table 8: Benefit-Cost Ratios Based on Distribution of Systems Installed in the Single-Family, Multifamily, and Commercial Sectors

Scenario	Participant	Non-participant	Societal	Incentives Paid ($ millions)	Therms Saved (millions)[7] (Systems Installed)
BAU					
60% single-family, 26% multifamily, 14% commercial	1.04	0.70	0.85	$198.4	895.0 (57,910)
All single-family	0.89	0.65	0.91	$198.8	959.7 (329,262)
No single-family	1.07	0.71	0.86	$197.0	894.7 (24,748)
MOD					
60% single-family, 26% multifamily, 14% commercial	1.36	0.76	1.30	$198.3	717.2 (57,717)
All single-family	1.23	0.70	1.37	$197.4	952.6 (327,039)
No single-family	1.38	0.78	1.31	$197.0	894.7 (24,748)
GHG					
55% single-family, 29% multifamily, 16% commercial	2.08	0.95	2.36	$194.5	876.2 (51,399)
All single-family	1.89	0.86	2.29	$169.4	818.7 (280,447)
No single-family	2.12	0.96	2.40	$197.0	894.7 (24,748)

7 The therms are over the expected life of the system (25 years).

<u>*Limitation on System Type*</u>

The baseline scenarios assume that Direct Force Circulation (DFC) systems may be installed in climate zones 1 and 3 through 9. However, there is disagreement within the SWH industry as to whether DFC systems should be installed in any climate zone.[8] The appeal of the DFC systems is the relatively lower installation cost when compared to systems which use an anti-freeze solution such as glycol; however, DFC systems are also more susceptible to freezing when temperatures drop. An incentive program may restrict eligibility of DFC systems in order to ensure that the systems installed through the program will perform for at least 25 years. The sensitivity analysis considers the possibility that a statewide program would not allow DFC systems to receive an incentive and Table 9 presents the results. There is no impact on the cost-effectiveness of the incentive program under any scenario, however excluding DFC systems would result in 0.7 million therms of additional natural gas savings under the BAU or MOD scenario.

Table 9: Benefit-Cost Ratios Assuming Changes in Eligibility Requirements

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline (895.0 million therms)	1.04	0.70	0.85
No DFC (895.7 million therms)	1.04	0.70	0.85
MOD			
Baseline (717.2 million therms)	1.36	0.76	1.30
No DFC (717.9 million therms)	1.36	0.76	1.30
GHG			
Baseline (876.2 million therms)	2.08	0.95	2.36
No DFC (876.6 million therms)	2.07	0.95	2.36

<u>*Financing for Single-Family Systems*</u>

The availability of financing allows homeowners who otherwise may not be able to fund the upfront cost to install a SWH system. Residential financing is included as a possible policy factor due to the recent implementation of AB 811. However, financing could come from other sources such as a bank loan or a loan from the company installing the system and the

[8] Inclusion of direct forced circulation systems does not pre-suppose or endorse the inclusion of direct forced circulation systems in a statewide incentive program for SWH systems that displace conventional natural gas-fired water heating systems.

results in Table 10 would be the same. The model makes no assumption about or accommodation for the source of the loan funds and does not include obtaining the funds as a cost to either the nonparticipant or society. There is also no means by which to capture the benefit that would accrue to either the nonparticipant or society from receiving interest payments. It should also be noted that the sensitivity analysis assumes that all single-family installations are funded with a 10-year loan and the model does not take into account any secondary impacts of financing, such as an increase in the adoption rate or profits earned from interest payments. Further, the model assumes that the interest payments on the loan are tax-deductible, which would require that the loan is part of a home loan, home equity loan, home improvement loan, or property tax.

Table 10 shows that a SWH incentive program becomes more cost-effective from both the participant's perspective as well as society's perspective with a zero-interest loan. As the loan interest rate increases, the benefit-cost ratio decreases for the participant and society. If the interest rate increases to 8.5 percent, a SWH incentive program becomes less cost-effective from the societal perspective than if there was no financing at all.[9]

Table 10: Single-Family Benefit-Cost Ratios Assuming Financing for All Systems

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	0.89	0.65	0.91
0% loan	1.40	0.65	1.17
3.5% loan	1.18	0.65	0.99
8.5% loan	0.95	0.65	0.80
MOD			
Baseline	1.23	0.70	1.37
0% loan	2.06	0.70	1.92
3.5% loan	1.80	0.70	1.63
8.5% loan	1.52	0.70	1.31
GHG			
Baseline	1.89	0.86	2.29
0% loan	3.34	0.86	3.37
3.5% loan	2.88	0.86	2.86
8.5% loan	2.39	0.86	2.31

To achieve market transformation by 2017, actions need to be taken that address both the financial barriers and non-financial barriers. If a loan program is developed, it should be

[9] As long as interest rates for the financing are less than the discount rate, financing will reduce the present discounted value of the costs. The discount rate for the participant is 10 percent.

accompanied by a strong marketing program which educates the public on the benefits of SWH as well as the financing options available. Providing education along with financing is expected to have a greater impact on adoption of SWH than financing alone.

Title 24 Requirements

The BAU baseline scenario assumes that 20 percent of new homes will install a SWH. Two sensitivity analysis scenarios were explored in relation to future Title 24 requirements: 1) incentives are paid for new single-family homes that opt to install SWH as part of the prescriptive package and so the percentage of new homes that install a SWH increases from 20 percent to 30 percent beginning in 2011; 2) SWH becomes a mandatory measure for new homes beginning in 2011; therefore, new homes are no longer eligible for incentives in 2011 and are not included in the model after 2010.

Table 11 shows the benefit-cost ratios for single-family customers under the Title 24 sensitivity analyses. Ratios are only presented for single-family installations because new construction multifamily and commercial buildings were not included in the model. The analysis shows that when the percentage of new homes which receive an incentive through the program increases, the societal benefit-cost ratio improves. When the percentage of new homes which receive an incentive through the program decreases, the societal and participant benefit-cost ratios decrease. This is because the cost for installing a SWH on a new construction home is approximately 20 percent less than installing a SWH on an existing home. Installing a larger portion of systems which cost less but provide the same therm savings will result in a more cost-effective program from both the participant and societal perspectives.

Table 11: Single-Family Benefit-Cost Ratios Assuming New Homes Are Required to Install SWH After 2011

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	0.89	0.65	0.91
30% of new homes installed beginning in 2011	0.90	0.65	0.93
No incentive for mandated installations under Title 24	0.87	0.63	0.87

Industry-Influenced Factors

This section focuses on changes to benefits and costs which can be influenced by the SWH industry, either by manufacturers of SWH systems or by installers of SWH systems. The sensitivity analyses explore the impact that a reduction in labor costs and equipment costs would have on the benefit-cost ratios for each scenario.

Labor Costs

The labor cost sensitivity analysis investigates the impact that a reduction in labor costs may have on the cost-effectiveness of an incentive program. This analysis looks at two methods for reducing labor costs. The first method assumes that all single-family low-cost systems are installed by the homeowners themselves. The second method assumes that installation efficiency increases, which results in a 25 percent decrease in labor costs. The impact of each of these methods is explored separately. Table 12 presents the benefit-cost ratios from each perspective for both of the labor cost sensitivity analyses.

Low-cost SWH systems account for 11 percent of all single-family installations in all scenarios. Assuming that all low-cost systems are self-installed has a negligible impact on the cost-effectiveness of a SWH incentive program from the participant perspective. Self-installation of low-cost systems has no impact on cost-effectiveness from the societal perspective as the savings in installation costs are offset by the decrease in the job creation benefits.

The 25 percent decrease in labor costs has a larger impact on the SWH incentive program cost-effectiveness than assuming low-cost systems are self-installed. This assumption is meant to reflect a reduction in the number of labor hours needed to install the system and does not imply a decrease in the installer's hourly wage. A 25 percent reduction in labor costs only leads to a 5 percent reduction in the total installed system cost. This decrease in labor costs is assumed for all types of installations (single-family, multifamily, and commercial). The benefit from decreased labor costs is again offset by a reduction in job creation. However, it should be noted that the model does not take into account a potential increase in demand for SWH systems if the price decreases.

Table 12: Benefit-Cost Ratios Assuming Changes in Labor Costs

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	1.04	0.70	0.85
All low-cost systems are self-installed	1.05	0.70	0.85[10]
25% decrease in labor costs	1.10	0.70	0.89
MOD			
Baseline	1.36	0.76	1.30
All low-cost systems are self-installed	1.36	0.76	1.30
25% decrease in labor costs	1.42	0.76	1.36
GHG			
Baseline	2.08	0.95	2.36
All low-cost systems are self-installed	2.08	0.95	2.36
25% decrease in labor costs	2.18	0.95	2.47

Equipment Costs

The equipment costs sensitivity analysis explores the effect of a decrease in equipment costs and the effect of increased adoption of low-cost systems. On average, equipment costs account for 70 percent of the total installed system cost. A 25 percent reduction in equipment costs would result in an 18 percent decrease in total cost. The second sensitivity analysis looks at the impact of increasing the adoption rate of low-cost systems from 11 percent to 25 percent.

Table 13 shows the changes in the benefit-cost ratios for each scenario with a 25 percent decrease in equipment cost. A 25 percent reduction in equipment costs drives the BAU societal ratio from less than 1.0 to greater than 1.0. If equipment costs or labor costs can be decreased, this may lead to an increase in adoption rates which may have a positive impact on the SWH market.

Table 13 also shows the impact of increasing the percentage of systems installed through the incentive program that are low-cost. Increased adoption of low-cost systems has very minimal impact on the cost-effectiveness of a SWH incentive program. This is because the benefit in reduced cost is offset by the lower energy savings provided by these systems.

10 If the increase in self-installations does not result in a reduction in job creation, the societal benefit would be 0.86.

Table 13: Benefit-Cost Ratio Assuming Changes in Equipment Costs

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	1.04	0.70	0.85
25% decrease in equipment costs	1.26	0.70	1.03
Greater adoption of low-cost systems	1.05	0.70	0.85
MOD			
Baseline	1.36	0.76	1.30
25% decrease in equipment costs	1.64	0.76	1.56
Greater adoption of low-cost systems	1.36	0.76	1.30
GHG			
Baseline	2.08	0.95	2.36
25% decrease in equipment costs	2.50	0.95	2.83
Greater adoption of low-cost systems	2.08	0.95	2.36

Total Installed System Cost

The total installed system cost needed to reach a benefit-cost ratio of 1.0 or greater from the societal perspective was investigated. The societal perspective was used because it is assumed that if the Societal test results in a ratio equal to or greater than 1.0 then the Participant test will also have a ratio greater than 1.0. Table 14 shows that a 16 percent reduction in the total installed cost across all sectors is necessary under the BAU scenario in order to have a cost-effective incentive program. Total installed cost reductions could result from an aggregate of equipment, labor, permitting, or other cost reductions.

Table 14: Benefit-Cost Ratios for a Decrease in Total System Cost

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	1.04	0.70	0.85
16% decrease in total costs	1.23	0.70	1.00

Job Creation and Retention

The sensitivity analysis considers the impact on the cost-effectiveness of a SWH incentive program if job creation and retention are not included as benefits to society. This is presented as an industry-influenced factor because the industry will have to increase training and modify its business models in order to meet the demand created by a statewide incentive program. The results are shown in Table 15. If job creation does not occur, the societal benefit-cost ratio decreases.

Table 15: Benefit-Cost Ratios Assuming Changes in Job Creation

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	1.04	0.70	0.85
No value for job creation	1.04	0.70	0.78
MOD			
Baseline	1.36	0.76	1.30
No value for job creation	1.36	0.76	1.23
GHG			
Baseline	2.08	0.95	2.36
No value for job creation	2.08	0.95	2.29

The effects of job creation and retention are underestimated in this model. The impact of SWH adoption on the economy only quantifies installation labor hours and does not include any manufacturing, sales, marketing, or administrative jobs related to SWH. The model also does not consider multiplier effects. Job creation would typically result in an increase in consumer spending. The increase in consumer spending would have secondary effects which would ripple through the economy. For example, job creation results in $1 more in income for a SWH installer. The installer spends 40 cents of the $1 on goods and services within California. The firms and individual who receive the 40 cents spend 16 cents on goods and services, and this process continues. The total amount of money received by Californians as a result of the $1 stemming from job creation is $1.66. In this case, the multiplier is 1.66.[11]

External Factors

While some factors which affect cost-effectiveness may be able to be influenced by policy or by stakeholders within the SWH industry, there are also external factors. External factors explored in the sensitivity analyses include the increase in home resale value from installing SWH, and avoided health costs (health benefits).

Increase in Single-Family Home Resale Value Resulting from Installing SWH

The two methodologies for estimating the increase in resale value of a single-family home as a result of installing a SWH are described in Section 7 of the Interim Evaluation Report. The first method assumes that the home value would increase $20 for every $1 in first-year fuel savings. The second method assumes that the home value would increase by $1.50 for every $1 spent on the system. The increase in resale value for multifamily and commercial systems is not quantified in this model because a methodology specific to multifamily and commercial customers was not available.

[11] This example is for illustrative purposes and is not meant to indicate that the multiplier for California is 1.66.

Table 16 presents the benefit-cost ratios for a SWH incentive program when the increase in single-family home value is included as a benefit to the participant and society. The increase in resale value improves the cost-effectiveness to the participant and to society. Given the current real estate market and the uncertainty in the appropriate methodology to use to determine resale value, the resale value should not be relied on when determining how to transform California's SWH market by 2017.

Table 16: Benefit-Cost Ratios Assuming an Increase in Resale Value

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline (no resale value)	1.04	0.70	0.85
$20 to $1 first-year fuel savings	1.13	0.70	0.94
$1.50 to $1 system cost	1.23	0.70	1.04
MOD			
Baseline	1.36	0.76	1.30
$20 to $1 first-year fuel savings	1.47	0.76	1.41
$1.50 to $1 system cost	1.52	0.76	1.46
GHG			
Baseline	2.08	0.95	2.36
$20 to $1 first-year fuel savings	2.19	0.95	2.47
$1.50 to $1 system cost	2.22	0.95	2.50

Avoided Health Costs

Installing SWH systems on homes and businesses has a positive impact on the environment, as the NOx and particulate matter emitted during the use of conventional energy sources would be reduced. Society benefits from the installation of SWH systems through cleaner air and, as a secondary impact, avoided health costs. Table 17 shows that excluding the avoided health costs results in a decrease in the societal benefit-cost ratio for all scenarios.

Table 17: Benefit-Cost Ratios Assuming Changes in Avoided Health Costs

Scenario	Participant	Nonparticipant	Societal
BAU			
Baseline	1.04	0.70	0.85
No value for health benefit	1.04	0.70	0.73
MOD			
Baseline	1.36	0.76	1.30
No value for health benefit	1.36	0.76	1.18
GHG			
Baseline	2.08	0.95	2.36
No value for health benefit	2.08	0.95	2.24

4 Conclusions

Results of the cost-benefit evaluations show that a SWH incentive program for systems that displace natural gas can be cost-effective. Such a program is dependent on assumptions regarding future natural gas prices, program participation rates by each sector, and SWH system costs. The dynamics at play for SWH systems that displace electricity are quite different than for those that displace natural gas. In California, 89 percent of single-family homes, 82 percent of multifamily buildings,[12] and 99 percent of commercial buildings[13] have natural gas water heaters. Therefore the cost-effectiveness analysis for displacing electricity has been limited to the 2008 scenario, while the analysis of natural gas displacing systems looks at four different scenarios.

Electricity-displacing SWH systems are cost-effective in 2008 for the multifamily sector without an incentive, but are only cost-effective for single-family homes with an incentive. A SWH incentive program for natural gas-displacing systems is not cost-effective under the BAU scenario without additional market changes, but would be cost-effective under the MOD or GHG scenarios.

Sensitivity analyses were conducted for natural gas-displacing systems in order to determine which factors could improve cost-effectiveness, with the goal of reaching a societal benefit-cost ratio of greater than or equal to 1.0 under the BAU scenario. The sensitivity analyses revealed two key changes in the marketplace which, if they occurred together, would result in a cost-effective program. These changes include:

- A statewide incentive program should be offered which promotes participation by single-family, multifamily, and commercial natural gas customers in order to maximize the displacement of natural gas and the program cost-effectiveness.
- A 16 percent reduction in the average total installed cost across all sectors would result in a societal benefit-cost ratio greater than 1.0 under the BAU scenario.

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[12] KEMA-XENERGY, Itron, and RoperASW. *2003 California Statewide Residential Appliance Saturation Survey*. Publication # 400-04-009. Prepared for California Energy Commission. 2004.

[13] Itron, Inc. *California Commercial End-Use Survey.* Publication # 400-2006-005. Prepared for California Energy Commission. 2006.

Additional factors which could improve program cost-effectiveness include:

- The availability of loans through an AB 811 program, a bank, or a SWH company would improve incentive program cost-effectiveness by increasing participation rates in the incentive program.
- SWH installations on new construction single-family homes should be prioritized under Title 24 in order to further transform the market. The cost of a SWH installation on a new construction home is about 20 percent less than the cost of a retrofit system.
- An increase in the number of trained system installers would be needed in order to meet the assumed adoption rate in the model. This improves incentive program cost-effectiveness by creating jobs and may also lead to a reduction in labor costs.

Other market barriers must be addressed in conjunction with the above suggested changes in order to increase the adoption rate. Experiences gained from the SWHPP demonstrate that differences in permitting requirements can create confusion, delay, and additional SWH costs. A standardized permitting process will help speed market deployment and reduce costs to consumers. Similarly, providing consumers with objective information on SWH costs and performance will likely help increase deployment and consumer satisfaction with installed SWH systems.

5 Inputs and Revised Assumptions

This section summarizes the differences between the baseline scenarios discussed earlier in this report and presents any revised assumptions from the methodology laid out in the Interim Evaluation Report.

Baseline Scenario Input Values

Table 18 highlights the differences in the inputs between each baseline scenario.

Table 18: Inputs Used in the Cost-Effectiveness Models

Input	BAU	MOD	GHG
The split within single-family:			
Retrofit	80%	80% (2008–2010) 70% (2011–2017)	80% (2008–2010) 100% (2011–2017)
New construction	20%	20% (2008–2010) 30% (2011–2017)	20% (2008–2010) 0% (2011–2017)
Natural gas annual rate increase	4.0%	7.0%	10.0%
Carbon credit price:			
Min. (2008)	$8.00	$20.00	$100.00
Max. (2027)*	$160.68	$220.46	$271.83
EEC price	$0.00	$0.00	$20.00
REC price	$0.00	$0.00	$8.00

* Carbon credit prices are assumed to increase every five years until they reach a maximum price in 2027.

Revised Assumptions to Methodology

The assumptions used as a basis for the cost-effectiveness study are described in detail in Section 7 of the Interim Evaluation Report; therefore, they are not repeated here. However, in the process of the analysis some assumptions were changed or added and those changes are discussed in this section. The methodology that was utilized is not an attempt at program design. Assumptions had to be made about how a future program could be designed in order to do the analysis. It is possible that other incentive program designs could result in equivalent or better cost-effectiveness results. Additionally, the methodology is limited in that it does not allow for feedback mechanisms. For example, despite the positive impact of providing loans for single-family SWH installations, the model does not increase the adoption rate of single-family customers under this scenario.

<u>Adoption Rate</u>

The adoption rate methodology was modified. The original adoption rate was based on the assumption that 200,000 SWH systems would be installed by 2017. However, it was realized that 200,000 systems could not be installed at the current incentive level within the AB 1470 proposed budget. Therefore, the S-curve used to model the adoption rate was changed to instead model the amount of incentive funding spent each program year. The funding was distributed between the single-family, multifamily, and commercial sectors and the number of systems installed each year within each sector was calculated by determining how many systems could receive an incentive that year. This revised methodology ensures that incentive funding lasts through the end of the program and is a more realistic scenario than one where funding is exhausted very early in the program.

Avoided Costs

The values for the avoided natural gas and electricity costs used in the model are based on the avoided costs provided by Energy and Environmental Economics, Inc. (E3)[14] in its avoided cost workbooks. The values of the E3 avoided costs are escalated at the same rate as the annual growth rate of natural gas prices for each of the scenarios. For example, under the BAU scenario, the avoided costs include the avoided cost of purchasing natural gas and any associated transmission and distribution costs, which increase by 7.0 percent each year. This maintains consistency in the difference between the reduced energy bill values and the avoided cost values.

Depreciation

Depreciation was included as a benefit as part of the original assumptions; however, the details were not specified. Depreciation is a tax deduction. Tax deductions reduce the amount of tax liability, but are not a dollar-for-dollar benefit to the taxpayer. The model assumes a federal tax rate of 34 percent and a state tax rate of 8 percent for the purposes of calculating the depreciation benefit for both multifamily and commercial customers. Depreciation is included as a benefit only for the participant, consistent with the treatment of the tax credit.

Single-Family System Financing

Financing for homeowners was added to the model. Three different interest rates are considered: 0 percent interest, 3.5 percent interest, and 8.5 percent interest.[15] The term of the loan is assumed to be 10 years. Interest payments are assumed to be claimed by participants as a tax deduction. Based on the survey results, the average homeowner who installs a SWH system has an income of $75,000 or greater. For the purposes of this analysis, a federal tax rate of 34 percent is assumed.

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14 Energy and Environmental Economics, Inc., Avoided Cost Workbooks. http://www.ethree.com/cpuc_avoidedcosts.html

15 The 8.5 percent interest and 10-year loan term are based off of the interest rate and loan term that the Sacramento Municipal Utility District applies to residential customers wishing to obtain financing to install a SWH system.

Tax Credits and Tax Deductions

Tax credits and tax deductions will be included as benefits for the participant. From a societal perspective, the tax credits and tax deductions are not a benefit. While Californians represent 12 percent of federal tax revenue, California taxpayers only receive 10 percent of the tax benefits. For this reason, the model will not include tax credits as a benefit in the Societal test.

Building Resale Value

The increase in resale value from installing a SWH is not included in the initial analysis of the scenarios, but is explored in the sensitivity analysis. The rationale for not including the resale value is based on a number of factors, including the current economic climate. Both methodologies for calculating resale value represented over 50 percent of the total benefits and have a significant impact on the benefit-cost ratio. Given the uncertainty regarding the methodologies for determining resale value and the magnitude of the impact on cost-effectiveness, this particular benefit is excluded from the initial results.

Carbon Credit Prices

Carbon credit prices were originally assumed to double every five years. However, in scenarios such as the GHG scenario, the result was a carbon credit price of over $1,000 by the end of the 25-year time period. The carbon credit prices used in each scenario are provided in Table 18.

Program Incentive Cap

The model assumes the $250 million of funding available is strictly imposed. This model assumes that 10 percent of the funding is used for program administration and 10 percent is used for marketing to provide education regarding the program, leaving $200 million for incentive payments.

Declining Incentive Structure

A statewide program for SWH which has the aim of transforming the market and encouraging cost-effectiveness should have decreasing incentives over time. The structure used in the model for a declining incentive over time is shown in Table 19. The maximum incentive amount will decrease for single-family systems in year 2011 and again in year 2014. For commercial and multifamily systems the incentive amount is based on the solar orientation and collector rating. The multiplier for the incentive per collector will decrease from $20 to $15 in 2013. The maximum total incentive for commercial and multifamily installations is assumed to remain at $75,000. It is assumed that $200 million in incentives will be available under AB 1470.

Table 19: Incentive Structure

Year	Single-Family Incentive Max.	Multifamily/Commercial Incentive
2008	$1,500	$20
2009	$1,500	$20
2010	$1,500	$20
2011	$1,000	$20
2012	$1,000	$20
2013	$1,000	$15
2014	$750	$15
2015	$750	$15
2016	$750	$15
2017	$750	$15

It is important to recognize that market response to incentive levels is not taken into account in the model. The model simply assumes that nearly all incentive money will be spent by 2017. Additionally this incentive structure is only used as a realistic example. Other incentive structures could result in the same average incentive per therm for each sector and achieve similar program cost-effectiveness results.

Environmental Attributes

This analysis considers the current situation in the SWH market but also includes potential outcomes. This model assumes that SWH becomes eligible to create environmental attributes which are used by IOUs to show compliance with a particular program, such as a renewable portfolio standard (RPS) goal where the goal is based on a percentage of the utility's load. A reduction in energy demand due to the installation of SWH systems would decrease the amount of renewable energy or renewable energy certificates (RECs) that would need to be procured in order to meet the RPS goal. This model includes the avoided costs of RECs and other environmental attributes as a benefit to nonparticipants.

Title 24 Requirements

The cost-effectiveness model also makes assumptions related to California's Energy Efficiency Standards for residential and non-residential buildings, also known as Title 24 requirements. In particular, the percentage of new single-family homes which are required to install a SWH is taken into account in the analysis. The assumptions differ based on the scenario. The BAU scenario simply assumes that 20 percent of new single-family homes will install a SWH in absence of a Title 24 requirement. The MOD scenario assumes that 20 percent of new single-family homes will install a SWH system until Title 24 takes effect in 2011. Beginning in 2011, 30 percent of new single-family homes will install a SWH system and these systems are eligible for an incentive. The GHG scenario assumes that 100 percent of new single-family homes are mandated to install SWH beginning in 2011 and that these systems are not eligible to receive an incentive.

6 Benefit and Cost Monetary Values for Each Baseline Scenario and Test Perspective

Table 20: Benefit and Cost Values for BAU Scenario (Natural Gas)

Sector	Participant ($ millions)	Nonparticipant ($ millions)	Societal ($ millions)
Single-Family			
Benefits	96.6	50.7	142.5
Costs	108.8	76.5	156.5
Multifamily			
Benefits	264.7	95.7	242.9
Costs	279.3	156.7	402.2
Commercial			
Benefits	577.6	297.2	714.1
Costs	510.7	402.5	731.8

Table 21: Benefit and Cost Values for MOD Scenario (Natural Gas)

Sector	Participant ($ millions)	Nonparticipant ($ millions)	Societal ($ millions)
Single-Family			
Benefits	130.5	83.9	209.5
Costs	106.1	119.4	152.7
Multifamily			
Benefits	327.8	158.7	370.7
Costs	279.3	230.4	402.2
Commercial			
Benefits	757.4	489.5	1,099.8
Costs	510.7	608.9	738.1

Table 22: Benefit and Cost Values for GHG Scenario (Natural Gas)

Sector	Participant ($ millions)	Nonparticipant ($ millions)	Societal ($ millions)
Single-Family			
Benefits	173.6	135.8	303.4
Costs	91.8	158.6	132.6
Multifamily			
Benefits	472.9	313.8	674.8
Costs	279.3	361.3	402.2
Commercial			
Benefits	1183.5	966.2	2023.6
Costs	510.7	975.5	738.1