

Evaluating Low Income Energy Efficiency In California: The Intersection of Cost Effectiveness, Energy Efficiency, Equity, and Politics

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ABSTRACT

Over the past several years, regulators, utilities and low income advocacy groups have been working together to standardize the Low Income Energy Efficiency (LIEE) Program offered to qualifying customers of the four major California investor owned utilities. The utility programs offer weatherization services, energy education, and energy efficient appliances to low income utility customers and are funded through a public goods charge. Additionally, the utility programs are leveraged with state and federally funded LIHEAP programs offered through a network of community action agencies.

During 2003, a team of regulators and utility LIEE program staff are struggling together to use evaluation and cost effectiveness results to recommend criteria and rules for determining which measures will remain in the LIEE programs. The team will need to consider several factors, including: measure cost effectiveness, individual utility demographics that may cause measures to be cost effective in one climate zone but not another, and program equity and standardization concerns. All of this will occur in a very public forum that will include input from contractors, community based organizations, public advocacy groups, and industry lobbyists out to prevent their favorite measure from being cut.

This paper discusses evaluation and cost effectiveness results in the context of how they will be used to design a low income program for the 21st century in a very political environment.

LIEE Program Background

California's four major investor owned utilities (Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas and Electric Company (SDG&E), and Southern California Gas Company (SCG)) have offered programs designed to support energy services to the low income community since the early 1980s. Currently, the four utilities offer both a Low Income Energy Efficiency (LIEE) Program and a rate discount program, California Alternate Rates for Energy (CARE).

Over the past several years, regulators, utilities and low income advocacy groups have been working together to standardize the LIEE Program offered to qualifying low income customers of the four major California investor owned utilities. Low income customers are defined as those living in households with annual incomes of less than 175 percent of the Federal Poverty Guidelines (FPG) or 200 percent of the FPG for seniors and the disabled.¹ The utility programs help low income customers increase their comfort while reducing their energy consumption, costs, and hardship by offering free weatherization services, energy education, and energy efficient measures. The LIEE Program is funded through a public goods charge. Additionally, the utility programs are leveraged with both the state and

¹ Low Income Weatherization Income Limits established by the California Public Utilities Commission (CPUC), Decision 01-06-010, dated June 7, 2001.

federally funded Low Income Home Energy Assistance Program (LIHEAP), which are offered through a network of community action agencies.

The LIEE Program requires installation of all feasible LIEE measures and services for which the customer is qualified. Energy efficiency measures and services available under the LIEE Program include:

- energy education,
- attic insulation,
- water heater blankets,
- energy-efficient showerheads,
- door weather stripping,
- caulking,
- minor home repairs affecting air infiltration,
- attic venting,
- attic access weather stripping,
- evaporative cooler covers,
- outlet gaskets,
- water heater pipe wrap,
- furnace filters,
- energy-efficient refrigerators,
- faucet aerators,
- compact fluorescent lamps (CFLs),
- hardwired porch lights,
- portable evaporative coolers, and
- furnace repair and/or replacement.

In response to California's 2000-2001 energy crisis, additional funding and several new measures were added to the LIEE programs in 2001.² These "rapid deployment" measures were selected with twin goals in mind: 1) increasing peak load energy savings to help ease the burgeoning energy crisis; and 2) increasing bill savings to help ease the energy burden of the State's hard-hit low income utility customers. The LIEE Rapid Deployment measures include:

- whole house fans,
- room and central air conditioning,
- duct seal and repair,
- water heaters,
- set-back thermostats, and
- evaporative cooler maintenance.

In addition to these six new measures, "rapid deployment" also made refrigerators and air conditioners available to qualifying renters. These measures had previously been available only to homeowners.

Tables 1 and 2 summarize LIEE Program budgets and impacts for the 2001 and 2002 program years (PY).³

² The "Rapid Deployment" LIEE Program was established in CPUC Decision 01-05-033, dated May 2001.

³ PY2001 Summary results are from the LIEE Rapid Deployment Monthly Reports of each utility, submitted to the CPUC February 21, 2002 and May 21, 2002 (revisions of PG&E and SCG). PY2001 impacts are from the Joint Utilities PY1998

Table 1: Summary of Utility 2001 LIEE Impacts and Budgets (PY1998 Impacts)

	PG&E	SCE	SCG	SDG&E	TOTAL
LIEE expenses *	\$38,569,947	\$18,313,491	\$22,596,860	\$11,546,629	\$91,026,927
Homes Weatherized **	29,973	1,246	33,046	10,817	75,082
Homes Treated **	43,963	85,161	37,954	19,679	186,757
KWh Savings	16,387,953	26,662,835	396,552	5,901,217	49,348,557
KW Savings	2,955	5,893		1,655	10,503
Therm Savings	748,873		746,325	233,041	1,728,239
1 st Year Bill Savings ***	\$55.38	\$38.76	\$15.11	\$38.96	\$37.05
Life Cycle Bill Savings ***	\$439.85	\$220.32	\$101.88	\$345.15	\$276.80
Homes eligible for LIEE	1,106,798	839,968	1,260,675	241,282	3,448,723

Table 2: Summary of Utility 2002 LIEE Impacts and Budgets (PY2000 Impacts)

	PG&E	SCE	SCG	SDG&E	TOTAL
LIEE Expenses *	\$62,269,590	\$13,322,482	\$30,566,960	\$12,355,709	\$118,514,741
Homes Weatherized **	41,323	1,957	42,343	7,908	93,531
Homes Treated **	70,683	26,808	49,464	14,089	161,044
KWh Savings	43,055,536	11,794,642	541,281	5,401,617	60,793,076
KW Savings	9,044	1,398		2,015	12,457
Therm Savings	1,158,898		984,163	208,474	2,351,535
1 st Year Bill Savings ***	\$78.69	\$65.93	\$16.08	\$41.20	\$50.48
Life Cycle Bill Savings ***	\$645.94	\$677.72	\$107.19	\$375.93	\$451.70
Homes eligible for LIEE	1,106,798	845,347	1,255,861	238,319	3,446,325

* LIEE Expenses include utility implementation and administrative costs. Leveraged state and federal funds are not included. LIEE Program budgets for each utility are set by the CPUC and are funded through a Public Purpose Programs Charge on customers' energy bills. LIEE budgets were increased significantly in mid-2001 through the addition of one-time State-legislated energy crisis funding (Senate Bill X1-5). The CPUC decided to maintain the increased funding levels by increasing the public goods charge-funded utility LIEE budgets for PY2003 (CPUC D.02-12-019).

** A "treated" home is an income-qualified home that has received any measure or service under the LIEE program, including energy education, compact fluorescent lamps (CFLs), weatherization and appliances. Under the LIEE program, a treated home must receive all feasible measures for which it qualifies. "Weatherized" homes are a subset of treated homes, and are defined as income-qualified homes that have received any weatherization measure (e.g., weatherstripping and caulking) under the LIEE program. (Both definitions are from CPUC D.02-12-019). SCE changed its method for counting treated homes between 2001 and 2003.

*** Average Bill Savings per customer of each utility. The wide variations between utilities are a function of the total number and mix of measures installed by each utility during the year, as well as the individual utilities' electric and gas rates. Since all feasible measures must be installed in each participating customer's home under the LIEE Program, the actual measure mix installed by each utility is highly variable and changes from year to year. Additionally, single commodity utilities do not offer measures not served by their commodities. For example, SCG – a gas company – does not offer electric measures (such as refrigerators), which generally have larger impacts than the weatherization measures they do offer. The Total Bill Savings reported in this Table are the simple average of all four utilities bill savings.

LIEE Equity Concerns

Traditionally, LIEE programs in California have been as focused on providing equity and comfort as they have been on providing energy savings to low income customers. As equity-based programs, LIEE programs are not usually held to the same strict cost effectiveness standards to which

LIEE Program Impact Evaluation report, filed with the CPUC in February 2000. PY2002 Summary results are from the LIEE Rapid Deployment Monthly Reports of each utility, submitted to the CPUC February 21, 2003. PY2002 impacts are from the Joint Utilities PY2000 LIEE Program Impact Evaluation report, filed with the CPUC in February 2002.

other publicly funded energy efficiency programs are subject. Nevertheless, there is significant interest in demonstrating that the utility LIEE programs are efficient, cost effective programs that provide tangible value and benefits for all low income customers in each of the four utilities' service areas, particularly in these economically-challenged times. In addition, California regulators recognize that the interests of both the customers being *served* by the low income energy efficiency programs and the non-participating ratepayers *paying* for the programs must benefit from them.

In 2001, the CPUC ordered the utilities to develop a cost benefit test that included non-energy benefits to assess LIEE program cost effectiveness, both for the overall program and for the individual low income program measures. Throughout 2002 and 2003, a team of regulators and utility LIEE program staff has been working together to marry program evaluation and cost effectiveness study results into an equitable low income program design to be used by all four California investor owned utilities in 2004.

The LIEE Teams

The California Public Utilities Commission (CPUC) has created several teams to standardize the LIEE Program and utility reporting in California and to conduct LIEE program research and analysis.

The Statewide LIEE Standardization Project was formed to comply with Commissioner Neepser's December 29, 1999 Assigned Commissioner's Ruling to standardize the LIEE programs offered by the four utilities to achieve greater equity for low income rate payers throughout the state and to standardize policy and procedural elements of the LIEE Program. The major accomplishments of the Standardization Project are the Statewide LIEE Policy and Procedures Manual and the Statewide Weatherization Installations Standards. The Standardization Team (whose members include representatives from PG&E, SCE, SDG&E, SCG, CPUC Energy Division and CPUC Office of Ratepayers Advocates) is currently directed to conduct research to: 1) recommend a standard Natural Gas Appliance Testing protocol for the four utilities to use in implementing the LIEE Programs; and 2) assess LIEE Program cost effectiveness by utility for the overall program and on an individual measure basis.

The Reporting Requirements Manual (RRM) Working Group is a public group whose members include utility staff, CPUC Energy Division staff, CPUC ORA staff, and members of the low income advocacy public. The RRM Working Group is responsible for developing and updating utility reporting criteria. Utility members, CPUC Energy Division staff and CPUC ORA staff form several technical subcommittees of the RRM Working Group with responsibility for overseeing LIEE Program evaluations, bill savings analysis, and cost effectiveness test development.

All reports from the LIEE Teams are subject to public input through both workshops and filed comments before they are considered and adopted by the Commission.

Statewide LIEE Program Evaluations

Evaluations of the LIEE Program are normally conducted every other year. However, because of changes to the Program made through the statewide Standardization process and the Rapid Deployment directives, the utilities have performed evaluations of both the 2000 and 2001 programs. Process and impact evaluations of the 2001 Statewide LIEE Programs have just been completed,⁴ and

⁴ *Process Evaluation of the 2001 Statewide Low-Income Energy Efficiency (LIEE) Program: Volume I*, prepared for SCE, SCG, SDG&E and PG&E. By Kema-Xenergy, Oakland CA. Filed with the CPUC, May 1, 2003. *Impact Evaluation of the 2001 Statewide Low-Income Energy Efficiency (LIEE) Program: Volume II*, prepared for SCE, SCG, SDG&E and PG&E.

impact evaluations of the 2002 programs will be conducted again this year. Following completion of the 2002 evaluations, the utilities will resume their schedule of biannual evaluations.

Of particular interest to California policy makers in the 2001 evaluations are the successes of the Rapid Deployment effort and the impacts from the new Rapid Deployment measures, which were added to the low income program with the express purpose of achieving rapid energy savings during the energy crisis. Although Rapid Deployment measures were added to the LIEE Program in May 2001, successful implementation did not begin for most utilities until fourth quarter 2001, following a ramp-up period during which the utilities and regulators developed standardized policies and procedures and installation standards for the new measures. The Standardization Team needed to determine what measure efficiency levels to require and whether these measures could be available in quantities large enough to serve the statewide LIEE Program needs. Contract change orders had to be negotiated by each utility with their LIEE contractors covering costs and installation procedures for the new measures. Then, each utility's implementation contractors had to be trained and, in some cases, obtain additional licenses required for measure installation.

The process evaluation identified LIEE Program design elements and processes that changed in PY2001 to assess the effectiveness of these changes in addressing the Program's "rapid deployment" objectives. The report was just filed with the CPUC in May 2003, but it is expected that utilities will be encouraged (or ordered) to adopt successful LIEE Program strategies in their PY2004 Program plans.

The impact evaluation utilized a billing analysis approach. Monthly household electricity and natural gas consumption, both before and after program intervention, were modeled in regression equations as a function of program participation variables and other explanatory variables such as weather and dwelling type. Engineering-based program savings variables were incorporated into the analysis for some measures to develop more detailed measure-specific results than could be obtained from a simple billing analysis.

Table 3 summarizes Program Year (PY) 2001 LIEE annual impacts.

Table 3: Summary of PY2001 LIEE Program Impacts

Impact Category	Utility				Total
	PG&E	SCE	SCG	SDG&E	
Non Weather Sensitive kWh Impacts	7,484,499	16,942,327		4,502,875	28,929,700
Space Heating kWh Impacts	171,099	54,807		28,855	254,761
Space Cooling kWh Impacts	1,349,205	1,889,973		59,814	3,298,992
Total kWh Impacts	9,004,803	18,887,106		4,591,544	32,483,453
Non Weather Sensitive Therm Impacts	291,836		451,009	98,739	841,585
Space Heating Therm Impacts	388,884		289,398	183,882	862,164
Total Therm Impacts	680,720		740,407	282,621	1,703,749

Table 4 summarizes PY2001 Program impacts by measure.

Table 4: LIEE Program Impacts by Measure – Annual Impacts

Measure	kWh		Therms
	Heating and Other	Cooling	Heating and Other
CFL	9,011,942		
Porch Light	1,660,087		
Refrigerator	17,951,706		
Faucet Aerators	63,570		196,901
Low Flow Showerhead	176,977		475,940
Water Heater	13,452		56,582
Water Heater Blanket	30,959		95,452
Water Heater Pipe Wrap	21,007		16,710
Attic Insulation	31,166	94,071	147,970
Caulking	47,460	16,118	92,208
Duct Sealing	476	4,902	30,862
Minor Home Repair	98,935	49,471	234,811
Programmable Thermostat	136	804	842
Weatherstripping	65,432	10,536	149,381
Central AC		358,313	
Evaporative Cooler Installation		2,324,859	
Evaporative Cooler Maintenance		305,982	
Room AC		118,338	
Whole House Fan		15,598	
Evaporative Cooler Cover	763		9,295
Furnace Filters	10,094		31,865
Furnace Repair			51,143
Furnace Replacement			113,789

To support measure cost effectiveness assessment criteria, detailed measure impacts were developed. Separate impacts were developed for weather-sensitive measures for each of the sixteen California Energy Commission Title 24 Climate Zones. Past evaluations grouped LIEE Program weatherization measures together rather than tried to determine individual measure impacts, the idea being that weatherization measures are highly interactive measures with small individual energy savings that are hard to break apart. In fact, it is somewhat arbitrary to ascribe specific impacts to these measures individually based on the results of billing analyses, and previous LIEE Program evaluations were satisfied with determining average savings per house. However, for the PY2001 evaluation, energy savings were determined for each measure, given that the cost effectiveness analysis required individual energy savings. Additionally, measure impacts were broken out by dwelling type (single family, multi-family and mobile home), fuel type (gas and electric), *and* by the sixteen California Energy Commission climate zones for each weather-sensitive measure. For PG&E, a dual-fuel utility serving a large, demographically diverse area of California, that meant analyzing over twenty measures for fourteen climate zones, three dwelling types, and two fuel sources. PG&E's LIEE program measure impact database has over 1,235 lines representing each of the individual measure calculations. This level of detail was undertaken to support a Commission-mandated effort to assess the cost effectiveness of individual program measures.

Cost Effectiveness Assessment

In addition to the program impact and process evaluations, the utilities were also directed to assess LIEE program cost effectiveness.⁵ LIEE cost effectiveness is being assessed at both the LIEE *program* level at each utility, and at the *individual measure* level, using new low income cost effectiveness tests incorporating such non-energy benefits as comfort, health and safety as well as direct energy-related benefits.⁶ The results of these tests are being used to help determine which measures are retained in the LIEE program.

The cost effectiveness approach adopted by the Commission in Decision 02-08-034 entails the application of two tests: a Modified Participant Cost Test, which assesses measures from the perspective of LIEE participants;⁷ and a Utility Cost Test, which is calculated from the point of view of the utility. Both tests are designed to incorporate a set of non-energy benefits as well as direct energy-related benefits. These non-energy benefits are meant to capture a variety of effects like changes in comfort and reduction in hardship, which are not captured by the energy savings estimates derived from load impact billing evaluations, and are ignored in more traditional cost effectiveness approaches like the total resource cost test. The comprehensive non-energy benefits developed for the modified tests were initially designed for use at the program level and required additional adjustments to ensure reasonable and consistent results at the measure level.

The specific costs included in the Modified Participant and Utility tests depended upon the specific application. In assessing overall program cost effectiveness, both direct measure costs and a variety of indirect costs (administration costs, outreach, shareholder earnings, etc.) are considered. In evaluating the cost effectiveness of individual measures, however, only installed measure costs are included. These are sometimes called incremental costs, or marginal costs. There was a lot of discussion among Team members on this particular issue (for example, some Team members wanted to include opportunity costs, and some wanted to include both direct and indirect costs). In the end, the Standardization Team decided that, from an economic perspective, cost effectiveness analysis should consider only those costs that are truly affected by the immediate decision at hand and be based on costs that are known or could be reasonably be estimated. In applying the cost effectiveness framework to individual measures, the decision at hand is whether or not a specific measure should be retained or dropped from the program. Insofar as retaining or dropping a specific measure will have a relatively minor impact on indirect costs, the Team decided these indirect costs should be ignored in this application of the measure level cost effectiveness tests.

⁵ *Final Report for LIEE Program and Measure Cost Effectiveness*, submitted to the CPUC by the Cost Effectiveness Subcommittee of the Reporting Requirements Manual (RRM) Working Group and the LIEE Standardization Project Team, March 28, 2002; *The Joint Utilities Revised Results of Measure Cost Effectiveness*, submitted to the CPUC by the LIEE Standardization Project Team, January 6, 2003; and *LIEE Measure Cost Effectiveness Final Report*, submitted to the CPUC by the LIEE Standardization Project Team, June 2, 2003.

⁶ The Low Income Public Purpose Test (LIPPT) model was created for the RRM Working Group (including representatives from PG&E, SCE, SDG&E, SCG, CPUC Energy Division, CPUC Office of Ratepayers Advocates, and the public) by TecMRKT Works, SERA Inc., and Megdal Associates in 2001. The cost effectiveness methodology was later modified by the Cost Effectiveness Subcommittee of the RRM Working Group and the LIEE Standardization Team in 2002 to incorporate two separate tests, the Utility Test and a modified Participant Test, both that incorporate non-energy benefits working in conjunction with Equipoise Consulting, Inc.

⁷ The Participant Test was modified to use utility LIEE program costs in order to create a benefit cost ratio, since low income customers do not incur out-of-pocket expenses to obtain LIEE measures. The CPUC Office of Rate Payer Advocates wanted to estimate and use for this test the opportunity costs incurred by low income customers in lieu of any out-of-pocket expenses incurred; however, the final Team decision was to base the benefit cost ratio on known costs (in this case, the direct costs incurred by the utilities to install the measures), hence the Modified Participant Test.

Both the Modified Participant Test and the Utility Test use installed costs to represent measure costs. The Utility Test uses avoided costs to value energy savings, while the Participant Test employs retail rates to value energy savings. To determine LIEE measure cost effectiveness, each utility’s measure-specific benefit-cost ratio is compared to that utility’s overall program benefit-cost ratio. For a measure to “pass” and be considered cost effective, its measure-specific benefit-cost ratio must be at least as high as that utility’s overall program ratio for either the Utility Test or the Modified Participant Test.

Table 5 shows the overall 2003 LIEE program benefit-cost ratios that must be exceeded for each utility.

Table 5:LIEE 2003 Program Cost Effectiveness

Utility	Modified Participant Test	Utility Test
PG&E	0.56	0.32
SCE	1.17	0.78
SDG&E	0.71	0.35
SCG	0.61	0.18

The Standardization Team conducted the analysis of measure cost effectiveness at a fairly disaggregated level. For all measures, cost effectiveness ratios were developed by residence type and (where applicable) fuel type. For measures with weather-sensitive effects, the analysis was also conducted by climate zone. This disaggregated approach was designed to recognize the variation in benefits and costs across specific applications of the measures in question. However, it also yielded situations in which measures were cost effective in some applications (for some utilities, some residence types, some climate zones, or one fuel) but not others. In these cases, the Standardization Team needed to come up with a set of consistent rules governing how to decide to offer the measure for some or all applications.

Since both the PY2001 impact evaluation and the cost effectiveness study had the same deadlines, the PY2001 impact results were still being developed while the initial cost effectiveness analyses were being run. Early cost effectiveness analyses were performed using the PY2000 measure impacts, while the Standardization Team waited for the more disaggregated PY2001 impact results to become available. Initial PY2001 impact realization rates⁸ were more dramatic than expected, which could have put the Standardization Team in the unenviable position of recommending that some measures that became cost effective under the new PY2001 impacts be dropped, while other measures that became non-cost effective were retained. This situation was resolved when the Team’s request to delay the LIEE Measure cost effectiveness report until the PY2001 impact report could be completed was approved.

Comparing PY2000 and PY2001 Impact Evaluation Results

The same consultant performed both Statewide LIEE PY2000 and PY2001 impact studies using very similar methods and assumptions. If both studies were to come up with exactly the same savings for each measure, their expected realization rate (the old PY2000 impact divided by the new PY2001 impact) would be 1.0. This is not what happened. Realization rates ranged from over 4.0 to as low as .25. However, the average realization rate for all measures comes very close to 1.0. PG&E’s total electric measure realization rate is .94, for SCE it is 1.06, and for SDG&E it is 1.02. The average for the

⁸ The realization rate is the old PY2000 impact divided by the new PY2001 impact. Some of the realization rates are as high as 4.0 or higher, while others are as low as .25.

three electric utilities is .993. This result indicates that the overall estimated energy savings for all individual measures are very similar between PY2000 and PY2001 and that the econometric analysis is accurate and stable. The problem lies in trying to disaggregate those savings down from the household to the individual measures. The small individual savings associated with each measure and the problem of many measures going into the households of many participants makes this a very difficult problem. The consultant tried to adjust for this effect with a series of weights, but since the overall savings for the household was about the same, the only effect when the weights change is that the savings are reallocated between measures such that some measures have more energy savings, and others less.

The utilities are currently discussing possible solutions that include grouping measures together when conducting the billing analysis. If the impact of the total measure group is estimated, there may be enough savings to show up econometrically. The idea is that many of the weatherization measures are installed together in households and it may make more sense to include them as one variable. However, this would preclude assessing the cost effectiveness of each measure individually as currently desired by the Commission. Alternately, the impact evaluation may be designed to use an econometric study to determine overall savings, but use engineering studies to break the results down into individual measure impacts.

The Standardization Team decided to use the newer PY2001 impact results. This decision was largely based on the specific design of the PY2001 impact evaluation. Estimating overall LIEE program savings was the primary focus of previous impact evaluations, although savings were developed for individual measures and groups of measures. In response to the CPUC's instructions to assess cost-effectiveness of individual measures and to use these results in measure selection, the Standardization Team requested the PY2001 impact analysis be refined to more effectively isolate individual measure impacts. This refinement included an extensive review and revision of the preliminary engineering estimates used to develop weights for measure savings in the billing analysis model.

While the Standardization Team considers the PY2001 impact study estimates the best available estimates for the purposes of cost effectiveness assessment, the Team recognizes that all estimates are subject to statistical error. Estimates of savings from measures with low impacts are particularly subject to high percentage errors resulting from inherent difficulties in isolating these impacts in the statistical analysis of changes in energy consumption. Subsequent years' program impact evaluation studies may yield measure savings estimates that differ somewhat from those used in the current measure cost effectiveness study, and reconsideration of the program measure mix may be necessary over time as such changes occur.

Selecting PY2004 LIEE Program Measures

The utilities, regulatory staff and members of the interested public are currently using the cost effectiveness results to decide what measures to include in the PY2004 LIEE Program. The Standardization Team has just completed the first steps in the public process. In its June 2, 2003 report to the CPUC, the Standardization Team developed a consistent, impartial procedure for assessing measure cost effectiveness, and a set of guidelines regarding what to do with measures that are cost effective under certain criteria for some utilities but not for others.

The Team conducted the cost-effectiveness analysis at a very disaggregated level. For all measures, the analysis was done separately by utility, residence type and, where applicable, by fuel (electricity and natural gas). For weather sensitive measures like ceiling insulation, the analysis was also conducted separately by climate zone. While this disaggregated analysis was justified on the basis of differences in impacts and costs across these categories, it sometimes yielded cases where measures

were cost-effective for some, but not all, categories. To help deal with these problematic measures, the Team adopted the following general rules of thumb:

1. When a measure is consistently cost-effective for some *residence types*, but not all, offer the measure for the residence type(s) for which it is cost-effective, but not others.
2. When a measure is consistently cost-effective for some *utility service areas*, but not all, even in the same climate zones and for the same fuels, offer the measure in all service areas if it is cost-effective in at least two. Drop the measure if it is cost-effective in fewer than two service areas. This preserves the spirit of standardization.
3. When a measure is consistently cost-effective for one *fuel*, but not both, offer the measure for the fuel for which it is cost-effective, but not the other.
4. When a measure is consistently cost-effective for some *climate zones*, but not all, offer the measure in the climate zones for which it is cost-effective, but not in the others.
5. When a measure's cost effectiveness varies asystematically across climate zones, residence types and fuels, make judgments that come closest to preserving the spirit of the above guidelines.

These rules of thumb did not totally avoid the need for judgment, but served as a useful guide to maintain consistency across recommendations. In its instructions to the Standardization Team to assess LIEE measure and program cost effectiveness, the CPUC recognized the possibility that not all non-energy benefits attributable to LIEE program measures may be fully reflected and quantified in the cost effectiveness tests. Thus, the CPUC allowed the Team some leeway to recommend retaining measures that failed both cost effectiveness tests if the Team believed non-energy benefits existed, which were associated with the measure, beyond those captured in the original non-energy benefit study.

For example, the weatherization measures (including caulking, door weatherstripping, attic hatch weatherstripping, evaporative cooler covers, and outlet gaskets) that have long been a staple of the LIEE programs are highly interactive and notoriously hard to evaluate, particularly on an individual measure basis. While reported impacts for these measures have been low, policy makers have always felt that the un-quantified comfort, health and safety benefits attributed to the weatherization measures justified their continued inclusion in a public benefits program. However, preliminary measure results show that several traditional weatherization measures (such as caulking and door weatherstripping) do *not* pass the LIEE program cost effectiveness tests, even after incorporating non-energy benefits previously quantified for the Modified Participant Test.

The Standardization Team met several times to discuss what to do about these infiltration-reducing weatherization measures and finally decided to recommend that they be retained for the 2004 LIEE program for the following reasons:

- These are generally low-cost, low savings measures and the degree of uncertainty surrounding their estimated energy savings is relatively high. It is very difficult to isolate their impacts on energy consumption through engineering analysis, billing analysis, or a mix of the two.
- There may be significant interactions between infiltration-reduction measures and other weatherization measures and these measures may enhance savings from other measures through thermodynamic interactions.
- Infiltration-reduction measures lower draftiness and thereby provide significant non-energy benefits relating to comfort. While comfort benefits are included in the cost effectiveness

tests, they are allocated across a wide range of measures encompassing both infiltration-reduction and non-infiltration-reduction measures. The Team believed the allocation of these benefits by energy savings probably understates the benefits associated with infiltration-reduction measures.

- These measures are installed in a high percentage of participating homes. Their costs may be overstated by contractors, who disproportionately assign “windshield costs” to them. Dropping these measures could adversely affect the costs (and cost effectiveness) of other measures in the future, if contractors assign more of their indirect costs to those measures.

The duct seal and repair measure was another problematic measure. Proponents of the duct seal and repair measure argued in public workshops that the LIEE Program’s method of paying for the measure only if the contractor can seal the duct up to an 80% minimum threshold is what makes this measure non-cost effective. Contractors will not even attempt to perform duct sealing on a very leaky home that could see definite benefits from duct seal and repair if there is a chance that they will not meet the required threshold necessary for cost reimbursement. As such, they argued that energy savings impacts might not capture the true benefits of duct sealing and repair. In this case, the Standardization Team followed the dictates of the five rules of thumb. This measure was cost effective only for one utility in one climate zone and the Team recommended dropping the measure. Advocates for this measure can request that the measure be considered in the future and submit alternate measure criteria for testing cost effectiveness at that time.

Table 6 summarizes the Standardization Team’s final recommendations on individual measures, based on the PY2001 impacts.

Some Conclusions

California is currently in the midst of a grand experiment to make its LIEE programs cost effective. As described in this paper, a team of regulators and utilities has been working together for the past several years to standardize the programs. For the past year, this Standardization Team has worked closely to use evaluation and cost effectiveness results to recommend criteria and rules for determining which measures will remain in the LIEE programs in 2004. The Team’s LIEE Measure Cost Effectiveness Report was just completed and submitted to the CPUC on June 2, 2004.

This paper discussed the complexities of conducting cost effectiveness analysis at the individual measure level. Difficulties are only compounded when measure details are further disaggregated by climate zone, housing type and fuel type. The Standardization Team spent a great deal of time developing detailed rules of thumb for weighing the multiple possible results of the measure cost effectiveness tests. Even then, decision-making occasionally relied on group judgment calls. Determining the LIEE measure inclusion and exclusion using strict cost effectiveness criteria becomes even more difficult when the objective of the program is one of equity. Low income program decisions are highly political, particularly in these difficult economic times.

In the end, the cost effectiveness conclusions are somewhat murky. Although the cost effectiveness analysis is a solid, thoughtful study, reliable measure impacts at the extreme level of disaggregation required for this analysis remains highly problematic. Ultimately, the CPUC must determine the direction of the LIEE programs. Hopefully, with the input of regulators, utility staff, legislators, low income advocates, contractors, and other interested parties, they will.

Table 6: Recommendations on Individual Measures

Measure	Recommendation
<i>Non-Weather-Sensitive Measures</i>	
Hard-wired CFL porch lights	Retain in all climate zones for single family homes, but Drop for multi-family and mobile homes
Compact fluorescent lamps	Retain in all climate zones and residence types
Faucet aerators	Retain in all climate zones and residence types
Low flow showerheads	Retain in all climate zones and residence types
High efficiency refrigerators	Retain in all climate zones and residence types
Water heater blankets	Retain in all climate zones and residence types
Water heater pipe wrap	Retain in all climate zones and residence types
High efficiency water heaters	Drop from Program
<i>Weather-Sensitive Measures</i>	
Outlet gaskets	Retain in all climate zones and residence types
High efficiency central ACs	Drop in all climate zones and residence types
High efficiency room ACs	Retain in Climate Zones 11, 12, 13, 14, and 15
Caulking	Retain in all climate zones and residence types
Ceiling insulation	Retain in all climate zones and residence types
Duct testing and sealing	Drop in all climate zones and residence types
Evaporative cooler covers	Retain in all climate zones and residence types
Evaporative cooler maintenance	Drop in all climate zones and residence types
Evaporative coolers	Retain in Climate Zones 11-16 for single family and mobile homes; Drop from Program for multi-family homes and in Climate Zones other than 11-16
Furnace filters	Retain , but only as part of furnace repair or replacement
Gas furnace repairs	Retain in all climate zones and residence types
Gas furnace replacements	Retain in all climate zones and residence types
Minor home repairs	Retain in all climate zones and residence types
Setback thermostats	Drop from Program except where required by code in conjunction with furnace repair or replacement
Weatherstripping attic doors	Retain in all climate zones and residence types
Weatherstripping doors	Retain in all climate zones and residence types
Whole house fans	Drop from Program

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