

# **THE HIDDEN COST OF COMPLIANCE FOR LOW INCOME ENERGY EFFICIENCY**

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## **Abstract**

This paper summarizes the impacts of California's Title 24 Energy Standards on the Low Income Energy Efficiency (LIEE) Program. On October 1, 2005, California enacted the 2005 Title 24 Building Energy Efficiency Standards. One new requirement of these standards states that in certain climate zones, whenever an HVAC system is "altered," duct testing and sealing is required. In addition, there is also an enforcement component that requires one in seven homes to be certified by a Home Energy Rating System (HERS) Rater. This paper discusses the resulting programmatic and cost-effectiveness impacts to California's LIEE Program.

## **Introduction**

Within California, each of the investor-owned utilities (IOUs), Pacific Gas & Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas Company (SoCalGas), and San Diego Gas & Electric Company (SDG&E) implements a LIEE Program. There has been a significant effort over the past several years to standardize these program offerings across the state. The LIEE Program offers weatherization and energy efficiency measures to qualified low income residents.

One significant new feature of the new Title 24 Building Standards is a requirement to perform duct testing and sealing on homes any time the HVAC system is altered or replaced. One in seven homes treated is to be verified by an independent HERS Rater. This requirement is only applicable in climate zones 2 and 9 through 16. As an alternative to duct testing and sealing, the homeowner may install higher efficiency equipment.

Under the LIEE Program, contractors are to install all feasible measures at all qualified residences. HVAC alterations or replacements may be performed as necessary to meet this goal. The LIEE Program is not subject to the same cost-effectiveness rules as traditional energy efficiency programs but the measures must meet a specified level of cost-effectiveness in order to be offered.

## **LIEE Program Description**

The LIEE Program is administered within California by each of the major IOUs, PG&E, SCE, SoCalGas, and SDG&E. The primary objective of the program is to provide energy efficiency services to low income households in an effort to reduce energy use and, subsequently, reduce energy bills. The LIEE Program is delivered free of charge to the low income participants.

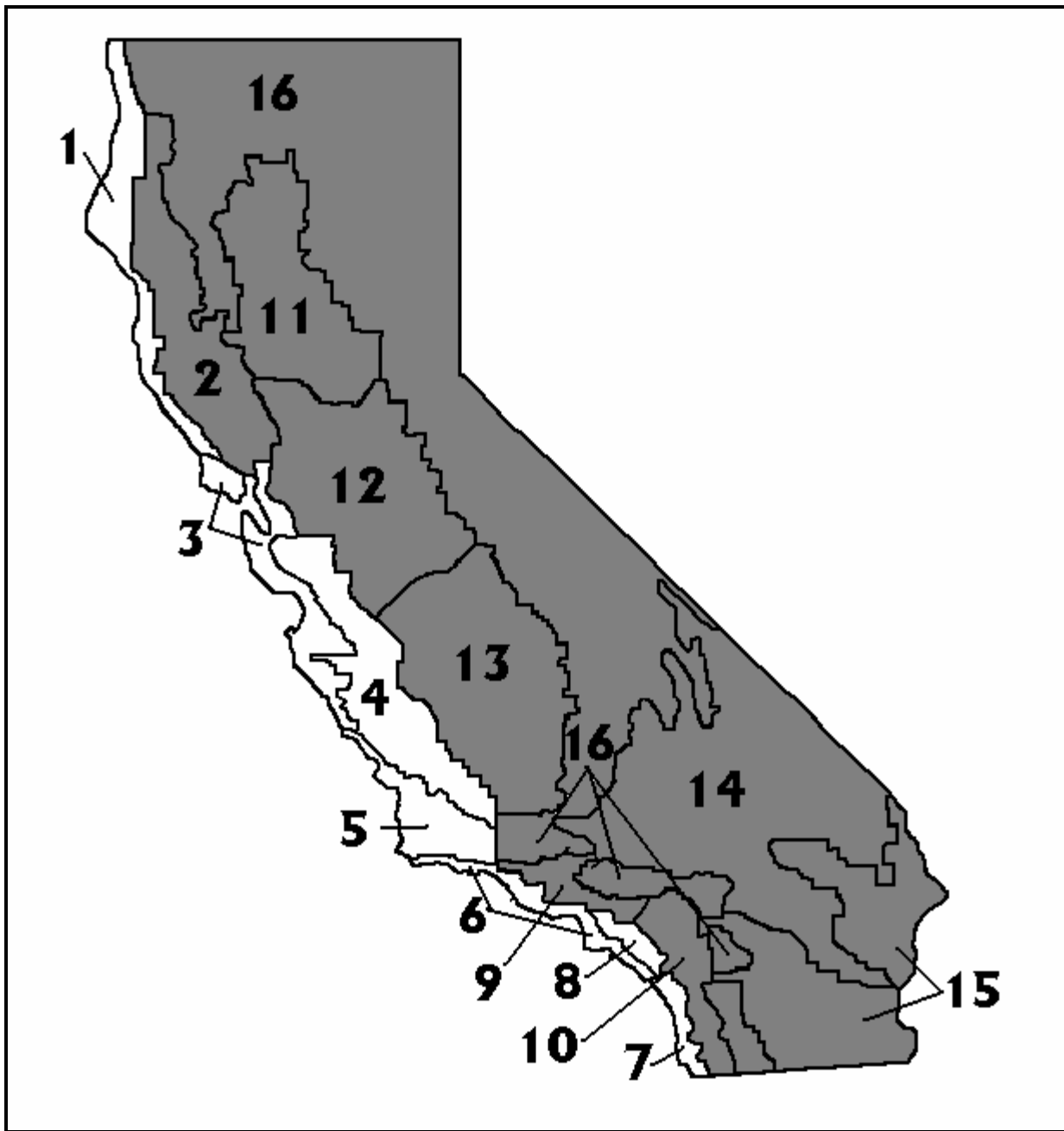
Participation is based on household income level, size, and age. The maximum household income must be less than 175% of the federal poverty level or 200% if the head of household is 60 years of age, older or disabled.

The LIEE Program offers households energy efficiency education and installs energy efficient measures. Measures include weather stripping, insulation, replacement windows, energy efficient refrigerators, energy efficient water heaters, compact fluorescent lamps, furnace repair and replacement, and air conditioner replacements. Households are serviced by contractors selected by each IOU. Contractors are instructed to provide all feasible measures to all households. There is also emphasis on causing the least amount of disruption possible to the resident.

## **Title 24 Energy Standards**

In 1978, California passed a legislative mandate to reduce energy consumption in California. Title 24, Part 6, of the California Code of Regulations, is titled California's Energy Efficiency Standards for Residential and Nonresidential Buildings. This Standard is commonly known as Title 24. Since 1978, there have been several updates to Title 24 in an effort to keep California's energy use to a minimum, to reflect common practice in the construction industry, and to incorporate other standards that directly affect Title 24.

The California Energy Commission (CEC) has divided California into 16 climate zones that have similar heating and cooling degree days. These climate zones are illustrated in Figure 1.



**Figure 1: California Climate Zones**

On October 1, 2005, the latest version of Title 24 went into effect. There were many significant changes in this version, such as time-dependent valuation, which places a greater value on energy consumed during peak periods, and a requirement for duct testing and sealing in climate zones 2 and 9 through 16 when the HVAC system is altered or replaced. According to Title 24<sup>A</sup>, an alteration of the HVAC system is defined as one or more of the following actions.

- Install or replace an air handler.
- Install or replace an outdoor condensing unit of a split system air conditioner or heat pump.

<sup>A</sup> 2005 Building Energy Efficiency Standards, Residential Compliance Manual. CEC-400-2005-005-CMF. March 2005, Pp. 267-268.

- Install or replace a cooling or heating coil.
- Install or replace a furnace heat exchanger.

There are several exceptions to this rule, such as the following.

- Ducts that have already been sealed, tested, and certified by a HERS rater.
- Duct systems with less than 40 linear feet of duct in unconditioned spaces.
- Duct systems that are insulated or sealed with asbestos.

Meeting the duct testing and sealing requirements is measured by one of the following approaches.

- Total leakage is less than 15% of fan airflow.
- Leakage to the outside is less than 10% of fan airflow.
- Leakage is reduced by more than 60% compared to before the alteration and a smoke test shows that all accessible leaks have been sealed

If the duct system cannot be sealed to meet any of the three leakage targets, then compliance can be achieved by sealing all accessible leaks and obtaining HERS rater verification.

Title 24 also allows for several options to avoid duct testing and sealing. Table 1 below details the options which allow the homeowner to be exempt from the duct testing and sealing requirements separated by climate zone.

**Table 1: Alternatives to Duct Testing and Sealing**

Climate Zone*	Option 1	Option 2	Option 3
	0.92 AFUE	SEER-14 & EER-12, with either TXV or refrigerant charge measurement, plus Increased Duct Insulation.**	SEER-14 & EER-12 with either TXV or refrigerant charge measurement, plus either 0.92 AFUE or 0.82 AFUE with Increased Duct Insulation***
CZ2	Yes	No	Yes
CZ9	No	No	Yes
CZ10	No	Yes	Yes
CZ11	No	No	Yes
CZ12	Yes	No	Yes
CZ13	No	Yes	Yes
CZ14	No	No	Yes
CZ15	No	Yes	Yes
CZ16	Yes	No	Yes

\* There are no duct sealing requirements in climate zones 1 and 3-8.

\*\* Increased duct insulation refers to an additional R-4 insulation wrap on existing ducts and R-8 duct insulation for all new ducts.

\*\*\* Package systems may use Option 2 or 3 without meeting the requirement for a TXV (or refrigerant charge measurement).

## Cost-Effectiveness Methodology

In D. 01-12-020, the California Public Utilities Commission (Commission) instructed the Reporting Requirements Manual (RRM) Working Group and the LIEE Programs Standardization Project Team (hereinafter the Standardization Team or Team) to develop joint recommendations for updating the traditional utility cost test and participant cost test for the purpose of evaluating the cost-effectiveness of the LIEE Program and its individual measures, adding test elements to capture non-energy benefits (NEBs) associated with the low income programs. The Commission also instructed the Standardization Team to assess all current LIEE program measures using these updated cost-effectiveness tests after the Commission had approved the specific methodology.

On March 28, 2002, the RRM Working Group and the Standardization Team filed a joint report recommending a specific set of criteria to be used to assess the cost-effectiveness of measures offered through the LIEE Program.<sup>B</sup> In D. 02-08-034, the Commission adopted these criteria and instructed the utilities<sup>C</sup> to use this methodology to augment their Program Year 2003 LIEE program applications with an evaluation of the proposed programs and measures to be offered in that year.

The cost-effectiveness framework uses two benefit-cost tests: a Utility Cost Test and a Modified Participant Cost Test. Both tests compare benefits and costs (for the utility and the participant respectively). Costs include the purchase cost of the measure plus the labor cost to install it. Benefits include energy saved plus a variety of NEBs, including comfort, water savings, health benefits, and others. These NEBs were assigned dollar values by a previous study conducted for the RRM Working Group and were incorporated into an Excel workbook for application to the assessment of measures.<sup>D</sup> Energy savings are converted to dollar values differently for the two tests. In the Modified Participant Test, energy savings are converted to bill savings through the use of retail energy prices. In the case of the Utility Cost Test, energy savings are converted to reductions in the utility's cost of providing the energy. This involves using avoided costs to value energy savings.

The general test recommended by the Cost-Effectiveness Subcommittee and adopted by the Commission entails comparing each utility's measure-specific benefit-cost ratio to that particular utility's overall program benefit-cost ratio. Where the measure-specific benefit-cost ratio is at least as high as a particular individual IOU's overall program ratio (as calculated by either the Utility Cost Test and/or the Modified Participant Test), the measure is included in the Program.<sup>E</sup> Measures that are already in the Program must pass one or the other of these tests in order to be retained. New measures must pass both tests in order to be added.<sup>F</sup>

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<sup>B</sup> *Final Report for LIEE Program and Measure Cost-Effectiveness*, Submitted by the Cost-Effectiveness Subcommittee of the RRM Working Group and Standardization Project Team, March 28, 2002.

<sup>C</sup> Pacific Gas & Electric Company, Southern California Gas Company, Southern California Edison Company, and San Diego Gas & Electric Company.

<sup>D</sup> The study was conducted for the Working Group by TekMarket Works, SERA, Inc., and Megdal Associates in 2001. It was further modified by the Cost-Effectiveness Subcommittee of the RRM Working Group and the LIEE Standardization Team in 2002. The original study and workbook can be downloaded from <http://www.calmac.org>. See TekMarket Works, *The Low Income Public Purpose Test (LIPPT)*, May 25, 2001.

<sup>E</sup> In the event that an individual utility's overall program benefit-cost ratio is greater than one, a measure is deemed cost-effective if it also has a benefit-cost ratio greater than one.

<sup>F</sup> Guidelines for deciding on program measures were described in CPUC Decision 02-08-034. The Decision is downloadable from <http://www.cpuc.ca.gov/static/official+docs/index.htm>.

For the purposes of evaluating measures, the Standardization Team used the overall Program benefit-cost ratios resulting from the current analysis. The overall Program benefit-cost ratios are provided in Table 2. To illustrate the use of these program ratios, note that, in this current analysis, a new measure would need a Modified Participant Ratio of 0.56 or greater to pass that test in the PG&E service area. The same measure would need a Modified Participant Ratio of 0.92 or better to pass this test in the SCE service area.

**Table 2: LIEE Program Benefit-Cost Ratios**

Utility	Benefit-Cost Ratios	
	Modified Participant Test	Utility Test
PG&E	0.56	0.33
SCE	0.92	0.80
SDG&E	0.64	0.36
SCG	0.70	0.19

The Commission-approved cost-effectiveness guidelines used in this analysis also allow the Team to consider NEBs that may not be fully reflected by estimates contained in the NEB workbook.

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). Since all proposed measures have impacts that are weather sensitive (that is, they affect heating and cooling), the analysis was conducted separately by climate zone. The following rules apply in the event that this disaggregated analysis yields cases where measures are cost-effective for some, but not all, categories.

1. When a measure is consistently cost-effective for some, but not all, residence types, the measure may be accepted for the residence type(s) for which it is cost-effective, but not others.
2. When a measure is consistently cost-effective for some, but not all, utility service areas, even in the same climate zones and for the same fuels, the measure may be accepted in all service areas if it is cost-effective in at least two, but rejected if it is cost-effective in fewer than two service areas.<sup>G</sup> This guideline is necessary, since cost-effective administration of the program requires a certain amount of consistency among utility areas.
3. When a measure is consistently cost-effective for one, but not both, fuels, the measure may be accepted for the fuel for which it is cost-effective, but not the other.
4. When a measure is consistently cost-effective for some, but not all, climate zones, the measure may be accepted in the climate zones for which it is cost-effective, but not the others.
5. When a measure's cost-effectiveness varies asystematically across climate zones, residence types and fuels, the Team will make judgments that come closest to preserving the spirit of the above guidelines.

<sup>G</sup> This guideline, along with other necessary rules of thumb, was developed by the LIEE Standardization Team for the PY2003 measure assessment. These guidelines and rules of thumb were discussed in the final report (Op. Cit) and in Commission Decision 03-11-020, which can be downloaded from <http://www.cpuc.ca.gov/static/official+docs/index.htm>.

## Cost-Effectiveness Results

The new duct testing and sealing requirements are only applicable to alterations and replacements of HVAC systems. For the LIEE Program, this requirement applies to the measures listed in Table 3.

**Table 3: Eligible Measures That May Require Duct Testing and Sealing**

Measure	Eligibility
Evaporative Coolers	Climate zones 10-16 only; single family and mobile homes only
High Efficiency Central Air Conditioners	Climate Zones 14 and 15 only
Minor Home Repairs <sup>H</sup>	All Climate Zones and Residence Types

To date, this analysis has only been fully completed for the furnace replacement sub-measure within Minor Home Repairs. Other measures may be evaluated pending adoption of these measures by the Commission. Therefore, cost-effectiveness results will only be described for the Minor Home Repairs, Furnace Replacement sub-measure. This sub-measure is widely implemented across California and is a simple measure that can be used to illustrate the impact of Title 24. The cost-effectiveness calculations also involve a number of inputs and assumptions. These inputs and their associated values are listed in Table 4.

**Table 4: Cost-Effectiveness Inputs and Assumptions**

Input	Value
Avoided cost of Natural Gas, 2006 (\$/therm)*	\$0.87
Baseline Rate of Low Income Resident (\$/therm)	\$1.29
Installed Cost of 80% Furnace	\$1,500.00
Installed Cost of 92% Furnace	\$2,750.00

\* The Avoided Cost is calculated using a “Winter Emergency” adder with the Methodology and Forecast of Long Term Avoided Cost for the Evaluation of California Energy Efficiency Programs. Prepared for CPUC Energy Division, October 2004.

Cost-effectiveness results for furnace replacements are shown in Table 5. The minimum threshold values are presented for each utility and test across the top of each table. As shown, this measure is no longer cost effective for PG&E and is still not cost effective for SDG&E. This measure is only cost effective for SoCalGas when considered from the utility test. This result is mainly due to the proportionally large number of participants in SoCalGas service territory combined with other IOU-specific factors such as the passing value of the utility test and the percent of homes with operational furnaces that were estimated based on prior program experience. Climate zones that contained cost effectiveness ratios under the prior analysis but do not under this analysis are the result of no recent participation in that climate zone.

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<sup>H</sup> There are multiple sub measures included under minor home repairs. Minor home repairs are constituted by services that either reduce infiltration (e.g., window repairs), mitigate a hazardous condition, or accommodate the installation of Program measures (e.g., attic venting). Furnace repairs and replacements and water heater repairs and replacements fall under the category of minor home repairs, and are provided only when necessary to mitigate NGAT fails and pursuant to the installation of infiltration-reduction measures. For the purposes of qualifying a home for the Program, all minor home repairs (combined) count as a single measure.

**Table 5: Cost-Effectiveness Results for Furnace Replacement**

Progra T24 Zone	PG&E						SCG						SDG&E					
	Participant Test 0.56			Utility Test 0.33			Participant Test 0.70			Utility Test 0.19			Participant Test 0.64			Utility Test 0.36		
	MF	MH	SF	MF	MH	SF	MF	MH	SF	MF	MH	SF	MF	MH	SF	MF	MH	SF
1	0.13	0.53	0.43	0.07	0.30	0.25												
2	0.17	0.58	0.58	0.10	0.33	0.33												
3	0.18	0.41	0.50	0.10	0.23	0.29												
4	0.11	0.29	0.41	0.06	0.16	0.23												
5							0.30	0.68	0.63	0.31	0.69	0.64						
6							0.18	0.25	0.33	0.18	0.25	0.33						
7													0.08	0.22	0.19	0.06	0.19	0.16
8							0.12	0.32	0.30	0.12	0.33	0.30						
9							0.13	0.37	0.34	0.13	0.37	0.35						
10							0.27	0.44	0.45	0.27	0.45	0.46	0.21	0.34	0.34	0.17	0.29	0.29
11	0.14	0.33	0.41	0.08	0.19	0.24												
12	0.17	0.43	0.50	0.09	0.24	0.29												
13	0.14	0.36	0.42	0.08	0.20	0.24	0.23	0.36	0.45	0.23	0.37	0.45						
14							0.23	0.45	0.44	0.23	0.45	0.44						
15							0.10	0.27	0.22	0.11	0.27	0.22	0.08	0.20	0.17	0.07	0.17	0.14
16							0.27	0.62	0.57	0.28	0.63	0.58						

As a comparison, the table below illustrates previously reported cost-effectiveness results for furnace replacement alone without the new Title 24 requirements. Although there are several factors affecting cost-effectiveness other than the requirement for duct testing and sealing, there is a trend towards lower benefit-cost ratios.

**Table 6: Previous Cost-Effectiveness Results for Furnace Replacement**

Progra T24 Zone	PG&E						SCG						SDG&E					
	Participant Test 0.56			Utility Test 0.32			Participant Test 0.61			Utility Test 0.18			Participant Test 0.71			Utility Test 0.36		
	MF	MH	SF	MF	MH	SF	MF	MH	SF	MF	MH	SF	MF	MH	SF	MF	MH	SF
1	0.74	1.53	1.26	0.80	1.66	1.37												
2	0.56	0.56	0.56	0.61	0.61	0.61												
3	0.47	0.53	0.53	0.51	0.58	0.58												
4	0.45	0.44	0.44	0.48	0.48	0.48	0.46	0.29		0.32	0.20							
5	0.34	0.68	0.56	0.37	0.74	0.61	0.18	0.23		0.12	0.15							
6	*	*	*				0.17	0.21		0.11	0.14							
7							0.46	0.38		0.30	0.25	0.05	0.15	0.15	0.03	0.10	0.10	
8							0.13	0.15		0.09	0.10							
9							0.13	0.17		0.09	0.12							
10							0.20	0.19		0.13	0.13	0.06	0.18	0.18	0.04	0.12	0.12	
11	0.52	0.51	0.51	0.57	0.55	0.55												
12	0.47	0.47	0.47	0.51	0.51	0.51												
13	0.42	0.42	0.42	0.45	0.45	0.45	1.27	0.36		0.84	0.24							
14	*	*	*				0.29	0.36		0.19	24.00	0.09	0.18	0.20	0.06	0.12	0.13	
15							0.13	0.14		0.09	0.09	0.04	0.07	0.06	0.02	0.05	0.04	
16	0.62	0.85	0.70	0.68	0.92	0.76	0.33	0.34		0.22	0.22							

Analyses of the costs and benefits of duct testing and sealing are still under development. Once these costs and benefits are quantified, the model will be re-evaluated with this information. Additionally, the air conditioner replacement measure will be analyzed both with higher efficiency units and with duct testing and sealing. These analyses will be completed during the month of November, 2005 and will be incorporated into the final version of this paper.



## **Conclusions**

There are significant impacts on the cost-effectiveness of measures due to Title 24 duct testing and sealing requirements. These impacts are currently being quantified and mitigation strategies are being pursued such as increasing the efficiency of units to avoid duct testing and sealing. With a major emphasis being placed on single-visit retrofits, higher efficiency units offer an intriguing alternative to duct testing and sealing. This alternative, however, comes with the tradeoff of higher efficiency units operating with more duct leakage vs. lower efficiency units with lower duct leakage. As the program progresses there will be an attempt to quantify the condition of the duct systems before treatment as an additional input to the analysis.