Application No.:	A.08-07-021
Exhibit No.:	SCE-7 & SCE-8 (Amended)
Witnesses:	S. Glanter M. Brown

SOUTHERN CALIFORNIA EDISON

An *EDISON INTERNATIONAL* Company

(U 338-E)

SCE's 2009-2011 Energy Efficiency Application Exhibits SCE-07 & SCE-08 (Amended)

Before the
Public Utilities Commission of the State of California

Rosemead, California
March 2009

Application No.:	A.08-07-021
Exhibit No.:	SCE-7
Witnesses:	S. Galanter

SOUTHERN CALIFORNIA
EDISON

An *EDISON INTERNATIONAL* Company

(U 338-E)

SCE's 2009-2011 Revised Proposed Energy Efficiency Program Plan AB 32 Impact

Before the
Public Utilities Commission of the State of California

Rosemead, California
March 2, 2009

LAW-#1603886

Southern California Edison Company
2009 – 2011 Energy Efficiency Portfolios
AB 32 – Impact

Rulemaking 06-04-010

California Public Utilities Commission (CPUC) Decision 07-10-032 in Ordering Paragraph 13, instructs the utilities to “include in their applications for approval of 2009-2011 energy efficiency portfolios: …..a report on the status of AB 32’s implementation and proposed program changes that would complement rules and policies, if adopted, including and in particular programs targeting energy efficiency measures in the industrial sector.” The discussion in Decision 07-10-032, at p. 56, addresses the concern that “customers are unlikely to invest significantly in energy efficiency measure before they know the responsibilities they will have to reduce green house gas emissions under AB 32….” Southern California Edison (SCE) shares some of this concern but believes that the energy efficiency programs which we have designed for the period 2009-2011 provide sufficient incentives to secure the kilowatt-hour savings as proposed.

The energy efficiency programs which have been designed, in many instances, will be complementary to the goals of AB 32, i.e. a reduction in green house gas emissions. Energy efficiency generally will reduce the amount of energy required to accomplish a particular task as compared to a process that is not energy efficient; therefore, this associated reduction in energy use will be complemented with a reduction in emissions.

However, during this time period SCE will be embarking on an aggressive program to reduce green house gas emissions through the provisions of AB 32 for Voluntary Early Actions (VEA). Some of the programs being proposed by SCE cover a wide range of activities, including, urban tree planting, conversion of additional internal combustion engines to electric motors, providing incentives for plug-in hybrid and battery electric vehicles, the electrification of truck stops and the use of more electric forklifts. For example an urban tree planting program should provide a reduction in energy usage and CO_2 sequestration. When trees are planted in strategic locations by the cities there may be an associated reduction in air condition use or if more trees are planted in park areas people may choose to spend more time in a park setting rather than at home, thereby reducing the air conditioning load.

Other programs, such as the capture of methane from dairy cows will provide a new potential renewable source for the generation of electricity. Even though this program will not result in energy efficiency savings it should result in a demand savings. This generation, in a small way, should reduce the amount of generation from central power plants. Since most of the central power plants on the margin utilize natural gas for a fuel, this program will conserve that valuable commodity.

To further illustrate SCEs commitment to AB 32, we have proposed a portfolio of VEA programs to the California Air Resources Board (CARB) to secure their concurrence and approval of the programs and the methodology.

Application No.: A.08-07-021
Exhibit No.: SCE-8 (Amended)
Witnesses: M. Brown

SOUTHERN CALIFORNIA
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(U 338-E)

SCE's 2009-2011 Energy Efficiency Proposed Program Plan Workpapers (Amended)

Before the
Public Utilities Commission of the State of California

Rosemead, California
March 2009

SCE's 2009-2011 Energy Efficiency Proposed Program Plan Workpapers

This exhibit highlights some of the major changes made in SCE's Proposed Program Plan due to data that is not included in or varies from DEER 2008. This includes details on the following specific high impact measures:

- Recycling of Appliances Preventing Continued Use (page 2)
- Energy Star Room Air Conditioners (page 20)
- Upstream CFLs (page 57)

Other measures of lesser impact were also adjusted, but not detailed here, including:

- Single Family Lighting (NTG)
- CFL Fixtures (NTG)
- Strip curtains (NTG)
- Agricultural Measures (NTG)
- Customized Measures (NTG)
- Single Family Whole Building (NTG)
- Multifamily Whole Building (NTG)
- Nonresidential Daylighting Controls (NTG, EUL)
- Nonresidential- Other Lighting Controls (NTG)
- Nonresidential-Handling Multiple Approach Measures (NTG)

Recycling of Appliances Preventing Continued Use

Introduction

This section summarizes the issues encountered in DEER 2008 for the following areas in the Appliance Recycling program savings assumptions:

• Refrigerator Recycling Gross Savings
• Freezer Recycling Gross Savings
• Freezer Recycling NTFR
• Refrigerator, Freezer and Room Air Conditioning Recycling EUL (Note SCE is not planning to include the Room Air Conditioner Recycling measure in its 2009-2011 portfolio).

Summary Issues

• **Refrigerator Recycling Gross Savings**
The DEER 2008 Update deviated significantly from an established and accepted EM&V methodology for estimating gross savings for this appliance measure. The refrigerator usage data used from a 1991 study[1] is small sample based, unrepresentative of the program units and unsupportable for the intended purpose and use in the DEER. Additionally, the DEER update considers all of the refrigerators in this measure category as being "second" refrigerators which is contrary to the intent of the program and available program data.

• **Freezer Recycling Gross Savings**
The DEER 2008 Update deviated significantly from an established and accepted EM&V methodology for estimating gross savings for this measure. There is no freezer data akin to the data used from the 1991 study. The DEER 2008 Update appears to have used the same performance curve for both refrigerators and freezers.

• **Freezer Recycling NTFR**
The DEER 2008 update incorrectly lists a NTFR value of 0.702 from the 2004-05 EM&V study for the Appliance Recycling Program.[2] The correct NTFR value from this Study for freezer recycling is 0.706. See the referenced workpaper in the supporting documentation for Appliance Recycling.

• **Refrigerator and Freezer Recycling EUL**
The DEER 2008 Update uses a default Remaining Useful Life (RUL) value, based on one third of the corresponding new appliance EUL, of 5 years for refrigerators, 4 years for freezers, and 3 years for room air conditioners. Using a default assumption for RUL is inappropriate when a persistence study is available for these measures. See the referenced workpaper in the supporting documentation for Appliance Recycling.

Recommendations

- Continue claiming only the direct effects from these measures and not the interactive effects as indicated in DEER 2008.

- Start reporting accomplishment savings for refrigerators and freezers based upon actual unit sizes of recycled (average values indicated below) units collected by the program tracking data. The savings estimates address the recycled units prevented from further consumption in either the pick up dwelling or in a "would be transfer" dwelling. Currently, the DEER 2008 estimates and methodology used do not allow for the estimates to vary by unit characteristics, which the past EM&V studies have demonstrated to affect the unit energy consumption estimates of these appliances. The average values based on unit size characteristics picked up by the program are:
  - Refrigerator Recycling Gross Savings 1,461 kWh per recycled refrigerator
  - Freezer Recycling Gross Savings 1,348 kWh per recycled freezer
    Freezer Recycling NTFR = 0.706
- Refrigerator and Freezer Recycling EUL = 10 years. Room A/C EUL=7.3 years.

1 DEER 2008 documentation cites a link for this study at www.homenergy.org weblink. However, none of the studies relate directly to what is being claimed.

2 Evaluation Study of the 2004-05 Statewide Residential Appliance Recycling Program Final Report April 2008 ADM Associates www.calmac.org

The workpapers below are from SCE's 2006-2008 Appliance Recycling Program. Note that they will be updated as needed for the latest assumptions indicated above and for code and EM&V study updates.

- WPSCREAP0007- Recycling of Appliances Preventing Continued Use

Work Paper WPSCREAP0007 (Recycling of Appliances Preventing Continued Use) follows.

Work Paper WPSCREAP0007
Revision 0

Southern California Edison Company
Strategic Planning & Technical Services

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Recycling of Appliances Preventing Continued Use

At a Glance Summary

Measure Name	Recycling of Appliances Preventing Continued Use
Savings Impacts Common Units	Refrigerator or freezer
Customer Base Case Description	Operable and inefficient appliance usage, whether by current owner or prevented transfer recipients
Code Base Case Description	Same as Customer Base Case
Costs Common Units	Refrigerator or freezer
Measure Equipment Cost ($/unit)	N/A
Measure Incremental Cost ($/unit)	N/A
Measure Installed Cost ($/unit)	See SCE's program tracking system for measure pricing
Building Type	Residential Misc. Commercial
Building Vintage	All
Climate Zone	All
Measure Load Shape	Residential: "Refrig-RC" Misc. Commercial: "Refrigeration"
Effective Useful Life (years)	10 years
Program Type	Retrofit (RET)
Net-to-Gross Ratios	Refrigerator Recycling 0.614 Freezer Recycling 0.706
Important Comments	none

Work Paper RunID: WPSCREAP0004.2-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)
001	Recycling of refrigerator 10-14 CuFt	921.57	0.14201	921.57	0.14201
002	Recycling of refrigerator 15-19 CuFt	1283.99	0.19787	1283.99	0.19787
003	Recycling of refrigerator 20-24 CuFt	1665.86	0.25671	1665.86	0.25671
004	Recycling of refrigerator 25-27 CuFt	1988.73	0.30646	1988.73	0.30646
005	Recycling of refrigerator 28-32 CuFt	2110.91	0.32529	2110.91	0.32529
006	Recycling of freezer 10-14 CuFt	1123.53	0.17313	1123.53	0.17313
007	Recycling of freezer 15-19 CuFt	1336.02	0.20588	1336.02	0.20588
008	Recycling of freezer 20-24 CuFt	1549.82	0.23883	1549.82	0.23883
009	Recycling of freezer 25-27 CuFt	1749.98	0.26967	1749.98	0.26967
010	Recycling of freezer 28-32 CuFt	1961.00	0.30219	1961.00	0.30219
011	Average Refrigerator	1461.10	0.22516	1461.10	0.22516
012	Average Freezer	1347.90	0.20771	1347.90	0.20771

Document Revision History

Revision #	Date	Author/ Affiliation	Description of Change
Revision 0	3/05/2009	Shahana Samiullah, EM&V	• Combined refrigerators and freezer recycling work papers • Added extended Athens Research gross savings estimates by appliance size • Removed references to draft 2004-05 EM&V • Removed references to DEER2004-05 for NTG.

Note: The information provided in this work paper was developed using the best available technical resources at the time this document was prepared.

Table of Contents

List of Tables

List of Figures

Section 1. General Measure and Baseline Data

1.1 Measure Description and Background

Recycling of appliances preventing continued use is offered through SCE's Appliance Recycling Program (ARP). The program prevents continued use of operable and inefficient refrigerators in residences and businesses, whether by current owners or potential transfer recipients, by picking up such units and recycling them in an environmentally safe manner. Targeted refrigerators and freezers of any vintage must be consumer refrigerators and must be at least 10 cu. ft. in size. The program also allows commercial customers who use the eligible refrigerators or freezers to participate in the program, but these account for a negligible portion of the program. The program offers a monetary incentive and a free pickup of each eligible refrigerator or freezer turned in for recycling and accepts a maximum of two appliances from a customer in a given year.

1.2 DEER Differences Analysis

The measures as implemented by the Appliance Recycling Program (ARP) are not addressed in DEER 2008.[i] A "Remove and recycle second refrigerator in unconditioned space", and similar measures for freezers as well as conditioned space, appears in the DEER 2008 database for single-family residences only (e.g. Technology ID D08-RE-Appl-RecRefFrzr-rmv-Refg-1655kWh-0kWh-uncond); however, this measure and similar measures for freezers are inconsistent with the operational characteristics of SCE's recycling program. Some of the DEER 2008 recycling measures appear to itemize various scenarios involving not only the appliance for which further use is prevented by the program but irrelevant potential occurrences involving other actions by the participant – e.g., whether or not a used/new appliance replaces the recycled appliance. This is as irrelevant to this ARP measure, prevented further use of an inefficient appliance, as the next use of a replaced appliance, in the context of a new appliance rebate program.

In addition, DEER 2008 also considers all refrigerators that are recycled through this program to be "second" refrigerators. Program data suggests that the majority of the refrigerators recycled through this program to be primary refrigerators. Most importantly, the next disposition of the unit in either the owner or tenant transfer recipient dwellings is unknown to the program.

The DEER strategy also seems to invoke the same failed logic of evaluations prior to the 2004-05 EM&V study, adjusting prevented transfer net savings for the hypothetical alternative action of a would-be recipient of a recycled appliance. This has been shown to be an aspect of market effects, which, if treated as part of direct net savings (as per the California Protocols) would be dependent upon the state of the surrounding used appliance market – not the persuasiveness or importance of the monetary incentive and free pick-up in motivating the decision to recycle the appliance that is the sole interest and objective of the program.

This work paper also provides the basis for the EUL estimate regarding recycling measures that is far superior to the DEER EUL approach to ARP and other programs, in which, quite arbitrarily, the remaining useful life is assumed to be a third of the appliance EUL. See Section 1.6 for a discussion regarding EUL.

1.3 Codes and Standards Requirements Analysis

There are currently no known codes and standards applicable to this measure.

1.4 EM&V, Market Potential, and Other Studies

Several EM&V studies have been conducted since 1997. The most recent EM&V study by ADM was conducted for the 2004-05 ARP Program. It provides modeled results on energy savings for the ARP measures, which are given on page 2-9, Table 2-6[ii]. Energy savings for refrigerator and freezer recycling measures are estimated to be equal to the full annual energy consumption for recycled refrigerators and freezers but adjusted for "partial use" among refrigerators and freezers that are recycled. The full-year energy consumption estimate for refrigerators in the 2004-05 EM&V study is 1,775 kWh/year for refrigerators and 1,406 kWh/year for freezers based on Table 2-5, page 2-8 in the 2004-05 EM&V Study[iii]. BR Labs in Huntington Beach, CA estimated the annual energy consumption for refrigerators and freezers based on metered data. The study was conducted using the DOE protocol and used a regression model to predict full-year unit energy consumption (UEC) for all population units. This full-year energy consumption was then adjusted for partial use by using average part use factors in Table 2-6, page 2-9 of the 2004-05 EM&V study. Table 2-6 provides the partial use-adjusted energy savings of 1,655 kWh per recycled refrigerator and 1,265 kWh per recycled freezer. The unit savings is the prevented continued usage of inefficient refrigerators and freezers. This approach properly decouples the problem of estimating savings associated with appliances that have an estimable probability of being in various places on the grid absent the program from the unnecessary complication of forcing the appliance into a whole-dwelling simulation model as was done in DEER 2008, with all the unnecessary error that this clearly entails. Based on this study, this work paper uses Athens Research's gross savings work, which combines the 2004-05 regression results and the most recent program tracking data (mid 2007- 2008), and the targeting assumptions of the 2009-11 program to produce gross savings (UEC adjusted for partial usage) estimates projected for the 2009-11 program cycle. The Athens Research analysis updates the 2004-05 EM&V study estimates for changed distribution of appliance vintages using changes in the input ages evaluated when the regression model is applied to tracking data.

1.5 Base Case for Savings Estimates: Existing and Above Code

The base case is the old, inefficient unit that is not prevented from continued usage either by owners or by transfer recipients. Hence, the base case for this measure is the UEC of the participating refrigerator adjusted slightly downward to allow for part use where hypothetical secondary usage is prevented by the program.

1.6 Base Case and Measure Effective Useful Life

The effective useful life (EUL) of recycled refrigerators is based on the effective useful life of prevented usage or savings for such units. The EUL estimation approach for the recycling of a refrigerator that prevents continued use requires special retention analysis methods, because the program measure is the removal, rather than the installation, replacement, or improvement of energy-using equipment. A retention study conducted by KEMA for SCE estimated the EUL for the 2002 Appliance Recycling Program from a survival curve[iv]. This survival curve is a combination of the survival curve for the savings generated from removing appliances from premises that otherwise would have kept the appliance, and the survival curve for savings generated from avoiding the transfer of a used unit to another household. In this retention study, the EUL was based on an RUL, which is estimated to be 10 years.

1.7 Net-to-Gross Ratios for Different Program Strategies

The applicable net-to-gross (NTG) ratio for the refrigerator and freezer recycling measures are based on the 2004-05 EM&V study [2] and given below in Table 1.

Table 1. Net-to-Gross Ratios

Program Approach	Program Name	NTG
Refrigerator Recycling	Appliance Recycling Program	0.614
Freezer Recycling	Appliance Recycling Program	0.706

Section 2. Calculation Methods

2.1 Energy Savings Estimation Methodologies

Energy savings for this measure are equal to the full annual energy consumption (UEC) for recycled refrigerators and freezers adjusted for “partial use” of some of the appliances. Extending the 2004-05 EM&V gross savings analysis, Athens Research applied the 2004-2005 UEC regression model to hypothetical distributions on appliances in 2009-11 ARP. Inputs included distributions based on available 2006-2007 tracking data with respect to appliance type, configuration, age, amperage, etc., but adjusted to reflect the vintage changes naturally occurring in moving from 2006-2007 to 2009-2011. The extended analysis is able to provide expected UECs by size range and by the tracking-data-age scenario.

Table 2 Calculation of Recycled Appliances Prevented UECs Adjusted for Partial Use

Recycled Refrigerator Size range	Annual Lab UEC estimate using age distribution adjustment (kWh)	Partial Use Adjusted Annual Lab UEC (kWh) UEC * 0.924
10-14 CuFt	997.37	921.57
15-19 CuFt	1389.60	1283.99
20-24 CuFt	1802.88	1665.86
25-27 CuFt	2152.31	1988.73
28-32 CuFt	2284.53	2110.91
Overall UEC	1581.28	1461.10

Recycled Freezer Size range	Annual Lab UEC estimate using age distribution adjustment	Partial Use Adjusted Annual Lab UEC (kWh) UEC * 0.878
10-14 CuFt	1278.21	1123.53
15-19 CuFt	1519.95	1336.02
20-24 CuFt	1763.18	1549.82
25-27 CuFt	1990.90	1749.98
28-32 CuFt	2230.97	1961.00
Overall	1533.46	1347.90

2.2 Demand Reduction Estimation Methodologies

The peak demand reduction is based on the DEER 2005 coincident peak adjustment factor (lines 129164, 129165 of the DEER measure table) and was used to calculate the unit demand savings (UDS), as in the following table:

Table 3. Calculation of Recycled Appliances Prevented Demand Savings Adjusted for Partial Use

REFRIGERATORS		
Recycled Refrigerator Size	Peak Watt Reduction based on Annual Lab UEC* estimate using age distribution adjustment	Partial Use Adjusted Peak Watt Reduction

		Watts*0.924
10-14 CuFt	153.69	142.01
15-19 CuFt	214.14	197.87
20-24 CuFt	277.82	256.71
25-27 CuFt	331.67	306.46
28-32 CuFt	352.05	325.29
Overall	243.68	225.16

FREEZERS		
Recycled Freezer Size range	Peak W reduction* based on Annual Lab UEC* estimate using age distribution adjustment	Partial Use Adjusted Peak Watt Reduction Peak Watts*0.8789
10-14 CuFt	196.97	173.13
15-19 CuFt	234.22	205.88
20-24 CuFt	271.71	238.83
25-27 CuFt	306.80	269.67
28-32 CuFt	343.79	302.19
Overall	236.31	207.71

* Per DEER 2005 estimates for refrigerator and freezer recycling measures: peak W reduction = UEC * 0.1541

Section 3. Load Shapes

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure's load shape. The measure's load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure's Total Resource Cost (TRC) benefit.[v]

3.1 Base Cases Load Shapes

The base case refrigerator or freezer's demand would be expected to follow a refrigeration end use load shape for each market sector as shown in the E3 Calculator.

3.2 Measure Load Shapes

For purposes of the net benefits estimates in the E3 calculator, what is required is the demand load shape that ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is what is called the Measure Load Shape and would be the preferred load shape for use in the net benefits calculations.

The Load Shape Update Initiative Study determined that for load-following measures, the end-use load shape can be substituted for the measure shape:

> "It can be argued that for measures that are roughly load-following (have a similar pattern to the end-use itself), substituting the end-use load shape for the measure shape is a reasonable simplification. Errors introduced by this substitution may be minor compared to other uncertainties in the savings valuation process. Distinguishing measure shape from end-use shape may be an unnecessary complication except for measures that are not load-following. This perspective was suggested by some workshop participants and interviewees."

The E3 Calculator contains a fixed set of load shapes selections that are the combination of the hourly avoided costs and whatever load shape data were available at the time of the tool's creation. In the case of SCE's E3 Calculator[vi], the majority of the load shape data at the time were TOU End Use load shapes and not Hourly Measure load shapes. **Figure 1** and **Figure 2** represent the TOU End Use Energy and Peak Demand factors for residential refrigeration measures that are embedded within the SCE E3 Calculator, and **Figure 3** and **Figure 4** represent the case for non-residential (Misc._Commercial) measures.

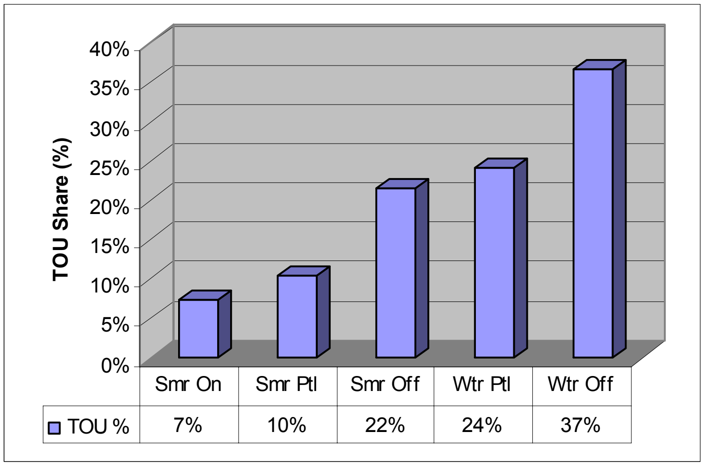

Figure 1. Residential Time of Use Energy Factors for the Refrigeration End Use

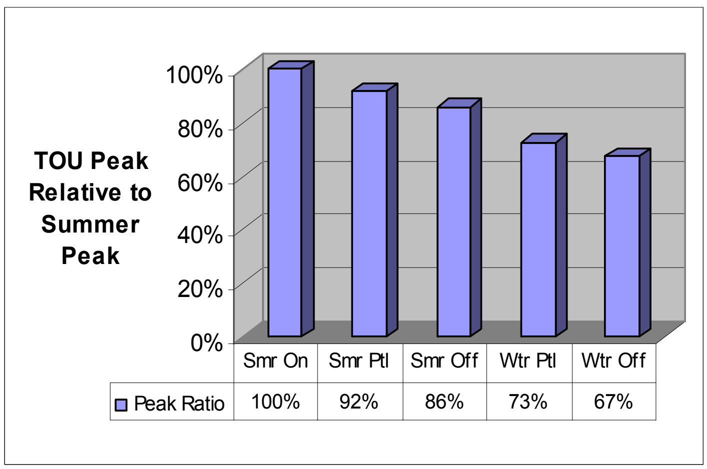

Figure 2. Residential Time of Use Demand Factors for the Refrigeration End Use

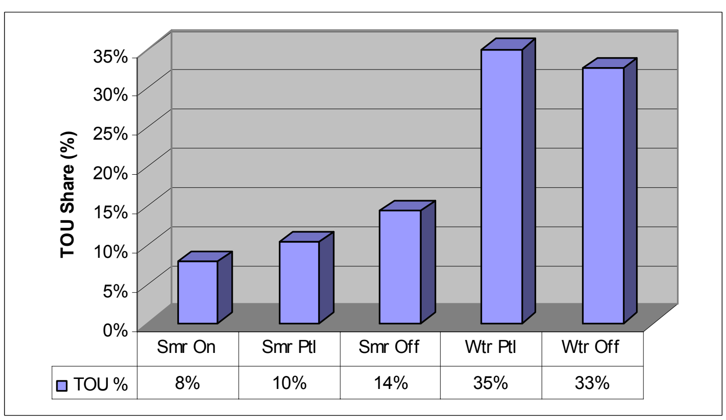

Figure 3. Misc._Commercial Time of Use Energy Factors for the Refrigeration End Use

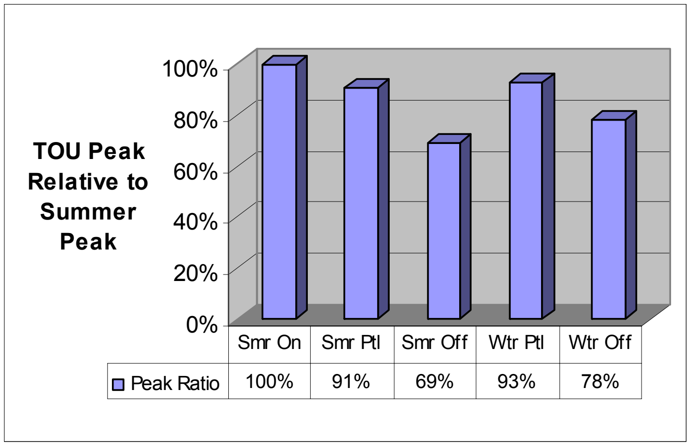

Figure 4. Misc._Commercial Time of Use Demand Factors for the Refrigeration End Use

In the E3 Calculator, for the “Measure Electric End Use Shape” selection, the “Refrigeration” load shape is the only appropriate selection for the Residential refrigerator/freezer measure category. The “Refrigeration” load shape is the only appropriate selection for the non-residential refrigerator/freezer measure category. The “Refrigeration” selection is enabled for only the Misc._Commercial Target Sector in Version 3c3-2000 of the E3 Calculator.

Section 4. Base Case and Measure Costs

4.1 Base Cases Costs

For this measure category, the base case cost is assumed to be zero because recycling the old, inefficient appliance is a discretionary action. The alternative is to make no change.

4.2 Measure Costs

SCE utilizes multiple vendors to pick-up and recycle the appliances as part of the program. The actual cost for each pick-up and recycling varies by contractor, the date of the pickup, and by the number of appliances picked-up at a given site. Vendor costs are confidential information and based upon contractually agreed upon pricing as established in their purchase order with SCE; therefore, the SCE program tracking system is the source for this data.

4.3 Incremental and Full Measure Costs

The total measure costs is used to represent both the incremental and full costs for this measure category since the base case costs are assumed equal to zero.

Attachments

KEMA EUL 2002 ARP Report.pdf RARP0911_PROJECTION.a.doc

References

[i] 2008 Database for Energy Efficient Resources (DEER) Version 2008.2.05, December 2008, (www.deeresources.com).

[ii] Evaluation Study of the 2004-05 Statewide Residential Appliance Recycling Program Final Report April 2008 ADM Associates www.calmac.org.

[iii] ibid.

[iv] EUL Estimate for the 2002 Appliance Recycling Program, KEMA memorandum dated March 1, 2005

[v] Final Report Load Shape Update Initiative, KEMA Inc. with the assistance of JJ Hirsch and Associates and Itron Inc., prepared for the California Public Utilities Commission under contract to Pacific Gas and Electric Company, November 15, 2006, Revised November 17, 2006, page 2-1.

[vi] Southern California Edison E3 Calculator Tool, Version 3c3-2000, [http://www.ethree.com/cpuc_cee_tools.html].

Energy Star Room Air Conditioners

Introduction

This section discusses changes made to the following HVAC Measures:
• Residential Room Air Conditioners Incremental Measure Costs.

Summary Issues

• **Energy Star Qualified Residential Room Air Conditioners**
The DEER 2008 measure equipment cost update lists a price of $537.39 for Energy Star qualified room air conditioners. This measure equipment cost is significantly higher than the utilities market experience and anticipated retail pricing for the 2009-2011 program time period. The DEER 2008 May 30 update[5] lists only the measure's equipment material cost, provides no incremental measure cost, does not indicate the size of the unit priced, and does not indicate what normalizing units apply to the cited costs.

Recommendations

• **Energy Star Qualified Residential Room Air Conditioners**
The installation and incremental measure costs for Energy Star qualified room air conditioners were obtained from SCE's work paper for Energy Star qualified room air conditioners See the referenced workpaper in the supporting documentation.

Installation Cost = $376.00 per Room AC
Incremental Measure Cost = $81.00 per Room AC

5 Cost Case ID "RAC-RoomAC-ES," Excel Workbook "Revised DE

The workpaper below is from SCE's 2006-2008 program cycle. Note that this workpaper will be updated as needed for the latest assumptions indicated above and for code and EM&V study updates.

- WPSCREHC0001- Energy Star Room Air Conditioner

Work Paper WPSCREHC0001 (Energy Star Room Air Conditioners) follows.

Work Paper WPSCREHC0001
Revision 2

Southern California Edison Company
Design & Engineering Services

Energy Star Room Air Conditioners

At a Glance Summary

Measure Name:	**Energy Star Room Air Conditioners**
Savings Impacts Common Units:	Unit (12,906 Btu Weighted Mean Room Air Conditioner)
Customer Base Case Description:	9.4 Weighted Mean EER (Current Code)
Code Case Description:	Same as Customer Base Case
Costs Common Units:	Same as Savings Impacts.
Measure Equipment Cost ($/unit):	$376.00 per room air conditioner
Measure Incremental Cost ($/unit):	$81.00 per room air conditioner
Measure Cost ($/unit):	$376.00 per room air conditioner
Measure Load Shape:	AC_Cooling-RC
Effective Useful Life (years):	15 years
Program Type:	Replace On Burnout (ROB) or New
TOU AC Adjustment:	100%
Net-to-Gross Ratios:	For Residential Contractor Program: 0.89 For all other residential programs: 0.80
Building Type:	All Residential
Building Vintage:	All
Important Comments:	This work paper assumes the customer is either replacing a failed room air conditioner (RAC) or adding a RAC by purchasing a new high efficiency RAC instead of a code minimum efficiency RAC. (This work paper also includes calculations and results for the Residential RAC Recycling to delineate efficiencies estimated for the Residential RAC Recycling work paper and for this work paper.)

Work Paper RunID WPSCREHC 0001.2-	Climate Zone	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)
001	6	197.7	0.132	197.7	0.132
002	8	247.0	0.132	247.0	0.132
003	9	232.3	0.132	232.3	0.132
004	10	219.8	0.132	219.8	0.132
005	13	217.9	0.132	217.9	0.132
006	14	201.3	0.132	201.3	0.132
007	15	293.5	0.132	293.5	0.132
008	16	158.2	0.132	158.2	0.132

Document Revision History

Rev #	MM/DD/YY	Author/Affiliation	Revisions
0	2/22/07	Unknown/DES	Original short form work paper.
1	10/16/07	Unknown/DES	Revision 0 (Rev 0) of this work paper was based on SCE engineering estimates of energy savings and demand reduction using Database for Energy Efficiency Resources (DEER) Annual Energy Consumption (kWh) per Multi-Family Apartment (RASS Weight Averaged) for a 14,000 Btu room air conditioner (RAC). Revision 1 (Rev 1) replaces the Rev 0 energy savings methodology with DEER database measure for Packaged Terminal Air Conditioners (PTAC) units for motel rooms as a basis. The PTAC measure is the only DEER measure using Energy Efficiency Ratios (EER) to measure performance for cooling of any kind: all other measures use the significantly different Seasonal EER. PTAC units are nearly identical to RACs in cooling performance but also provide heat. Establishing an equation for energy savings performance for PTAC EERs, Rev 1 uses a 12,906 Btu RAC and previous & current code and Energy Star room air conditioner EERs to establish energy savings. For demand reduction, Rev 1 retains the Rev 0 methodology. The DEER motel room PTAC measure's 24 hour profile for power demand varies significantly from residential room air conditioner power demand profile. The table below lists values for Rev 0, Rev 1 and the change between the revisions.

E3 Input	Rev 0	Rev 1	Change
Measure Incremental Cost	$106.00 per RAC	$81.00 per RAC	-$25.00 per RAC
Effective Useful Life	15	15	Unchanged

The table below lists the energy savings and demand reductions for Rev 0, Rev 1 and the change between the revisions. Rev 0 14,000 Btu RAC numbers were modified to 12,906 Btu RAC to match the RAC size of Rev 1.

Energy Star RAC Summary: Rev 0 to Rev 1 Comparison					
For One 12,906 Btu Room Air Conditioner					
Climate Zone	Rev 0	Rev 1	Climate Zone	Rev 0	Rev 1
Energy Savings (kWh/square foot)			Demand Reduction (kW/square foot)		
6	52	198	6	0.258	0.132
8	101	247	8	0.258	0.132
9	148	232	9	0.258	0.132
10	182	220	10	0.258	0.132
13	361	218	13	0.258	0.132
14	220	201	14	0.258	0.132
15	594	293	15	0.258	0.132
16	56	158	16	0.258	0.132

2	J1/12/09	Scott Hutton/DES	Deleted Index and index references.

Table of Contents

List of Tables

List of Figures

Section 1. General Measure & Baseline Data

1.1 Measure Description & Background

This work paper details the E3 Calculator inputs for purchase and installation of residential room air conditioners (RAC) that meet Energy Star requirements or Energy Star RACs (ES-RAC) instead of minimum Code efficiency RACs (C-RAC) requirement. Thus, purchase of a C-RAC is the base case and purchase of an ES-RAC is the measure case for this work paper. Installation costs are presumed to be identical.

1.2 DEER Differences Analysis

This paper covers residential RAC applications. There are no residential RAC application calculations available in the Database for Energy Efficiency Resources (DEER). Residential DEER applications evaluate more efficient split systems and central air conditioning systems with higher Seasonal EER (SEER) requirements.

To determine energy savings, this work paper uses DEER Measure D03-099 which provides an analysis of Packaged Terminal Air Conditioners (PTAC or Packaged Terminal Heat Pumps (PTHP) (collectively: PT units) installed in Motel Lodging Guest Rooms. PT units use similar equipment to RACs for cooling, but also feature heating functions which RACs do not have. PT unit EERs are similar to RAC EER requirements. PT unit vintage, code and 20% above code EERs and their related energy savings are used as points for Least Square Linear Regression (LSLR) Method to establish a function to calculate equivalent RAC energy savings figures.

This work paper does not use DEER to determine demand reduction. The twenty four hour Time-Of-Use (TOU) profile for DEER measure D03-099 differs significantly from residential RAC TOU. Also, as the PT units include provisions for heating and RACs do not, the DEER Measure D03-099 cost data is not used as that would include capital costs for the PT unit heating elements.

In DEER Section 6 for Motel Lodging Guest Rooms, Table 1 and Table 2 list the following information:

Table 1: DEER Table 6-1 (Partial): Nonresidential Space Characteristics1

Activity Area Type	Occupant Density (ft^2/person)	Sensible Occupant Load (Btuh/person)	Latent Occupant Load (Btuh/person)	Ventilation Rate (cfm/person)
Motel Guest Room	300.0	245	155	30.00

1. "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study", Prepared for SCE by Itron, Inc., Dec 2005, Section 6: Page 6-4.

Table 2: DEER Table 6-2 (Partial): Nonresidential Prototype Descriptions[2]

Prototype	Source	Activity Area Type	Area	% Area	Simulation Model Notes
10. Lodging - Motel	DEER	Corridor	3,333	11.1	Thermal Zoning: One zone per activity area. Model Configuration: Matches 1994 DEER configuration. Guestrooms are divided among: 12 hour occupied (12,794 ft^2/ 42.6%), 24-hour occupied (6,397 ft^2/ 21.3%) and unoccupied rooms (6,397 ft^2/ 21.3%). HVAC Systems: The oldest vintage uses PTAC systems with electric resistance heating. All other vintages use PTHP systems.
		Motel Guest Room (incl. toilets)	25,587	85.3	
		Laundry	480	1.6	
		Office (General)	600	2.0	
		Total	30,000		

Table 1 lists DEER loads and ventilation rates for Motel Lodging Guest Rooms. The Lodging – Motel section from DEER Table 6-2 identifies PTAC and PTHP (Table 2 above) as being used in the simulation of Motel Lodging Guest Rooms. The Motel Lodging Guest Room applications appear to be best available DEER simulation for residential RAC applications which are most likely used for cooling one room with both interior and exterior walls and ceilings. DEER Measure D03-099 Run IDs differ from Table 2 as all vintages in the Measure use PTACs.

Motels on average are cooled at 1 ton of cooling (12,000 Btu) per 300 square feet (ft^2)[3]. Based on the DEER occupant density of 300 ft^2 this paper sets PT units at 12,000 Btu cooling for 300 ft^2. The DEER Lodging – Motel total floor area is 30,000 ft^2 so dividing total floor area by 300 ft^2 results in 100 total PT units installed in the DEER Lodging – Motel.

DEER uses the PTAC EER values listed in Table 3 below:

Table 3: DEER PTAC EER Values for Lodging - Motel4

DEER: PTAC (7-15 kBtu/unit or 0.583 to 1.25 cooling tons/unit)			
Buildings Vintages	Measure Case Description (EER)	Base Case Description (EER)	Code Base Description (T24 minimum EER)
Built before 1978	10.27	6.80	8.56
Built between 1978 and 1992	10.27	7.80	8.56
Built between 1993 and 2001	10.27	8.50	8.56
Built between 2002 and 2005	10.27	8.50	8.56

2. Ibid: Note **Error! Bookmark not defined.**, Section 6: Page 6-10.
3. Table: "Cooling Load Check Figures", ASHRAE Pocket Guide for Air Conditioning Heating Ventilation Refrigeration (Inch-Pound Edition), ASHRAE, 1993, Page 128
4. Ibid: Note **Error! Bookmark not defined.**: Data from Page 6-19 DEER HVAC System Properties workbook (DEER HVAC System Properties-051212.xls) Tab: DX HVAC System Baseline: Msr: 99.

Built 2006 and later (measures as retrofit for nonresidential)	12.19	10.16	10.16

1.3 Codes & Standards Requirements Analysis

In 1987, the U.S. federal government created the National Appliance Energy Conservation Act establishing energy efficiency standards for residential appliances including RACs (RAC Standards)[5]. The U.S. Department of Energy (DoE) website lists several laws and acts establishing minimum appliance energy efficiecny standards[6]. The RAC Standards took effect January 1, 1990 and were later modified October 1, 2000. These RAC Standards are summarized in the State of California Code Of Regulations, Title 20: Division 2, Chapter 4, Article 4, Appliance Efficiency Regulations (Title 20) which are herein referenced. The RAC Standards of October 1, 2000 set the requirements for C-RACs.

1.3.1 Definitions

Title 20 establishes the following selected definitions in Section 1602(c) Air Conditioners[7]:

> "Air conditioner" means an appliance that supplies cooled air to a space for the purpose of cooling objects within the space.
> "Air-source heat pump" means an appliance that consists of one or more factory-made assemblies, that includes an indoor conditioning coil, a compressor, and a refrigerant-to-air heat exchanger, and that provides heating and cooling functions.
> "Btu" means British thermal unit.
> "Casement-only room air conditioner" means a room air conditioner with an encased assembly designed for mounting in a casement window with a width of 14.8 inches or less and a height of 11.2 inches or less.

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5 Technical Support Document For Energy Conservation Standards For Room Air Conditioners (Docket Numbers EE-RM-90-201 & EE-RM-93-801-RAC), September 1997, Lawrence Berkeley National Laboratory-Energy & Environment Division; Technology and Market Assessment Group; Prepared for U.S. Department of Energy - Office of Codes and Standards, Page ES-1.

6 U.S. Department of Energy - Energy Efficiency and Renewable Energy: A Consumer's Guide to Energy Efficiency and Renewable Energy: Energy Efficiency Standards for Residential Appliances (http://www.eere.energy.gov/consumer/your_home/appliances/index.cfm/mytopic=10050?print)

US DoE Energy Eff 4
Residential Appliance:

7. Appliance Efficiency Regulations CEC-400-2005-012, California Energy Commission, April 2005, State of California Code Of Regulations, Title 20: Division 2, Chapter 4, Article 4, pages 11 thru 13.

"Casement-slider room air conditioner" means a room air conditioner with an encased assembly designed for mounting in a sliding or casement window with a width of 15.5 inches or less.
"Casement window" means a window that opens on hinges at the side.
"Coefficient of Performance (COP)" of a heat pump means the ratio of the rate of useful heat output delivered by the complete heat pump unit (exclusive of supplementary heating) to the corresponding rate of energy input, in consistent units and as determined using the applicable test method in Section 1604(b) or 1604(c).
"Cooling capacity" means a measure of the ability of an air conditioner to remove heat from an enclosed space, as determined using the applicable test method in Section 1604(b) or 1604(c).
"Energy efficiency ratio (EER)" means the cooling capacity of an air conditioner in Btu per hour divided by the total electrical input in watts, as determined using the applicable test method in Section 1604(b) or 1604(c).
"Heat pump" means an appliance, other than a packaged terminal heat pump, that consists of one or more assemblies; that uses an indoor conditioning coil, a compressor, and a refrigerant-to-outdoor air heat exchanger to provide air heating; and that may also provide air cooling, dehumidifying, humidifying, circulating, or air cleaning.
"Packaged Terminal Air Conditioner" (PTAC) means a wall sleeve and a separate un-encased combination of heating and cooling assemblies that:

(1) is intended for mounting through the wall and
(2) includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability by hot water, steam, or electric resistance heat.

"Packaged Terminal Heat Pump" (PTHP) means a packaged terminal air conditioner that uses reverse cycle refrigeration as its prime heat source and that has a supplementary heat source of hot water, steam, or electric resistance heat.
"Room Air Conditioner" (RAC) means a factory-encased air conditioner that is designed:

(1) as a unit for mounting in a window, through a wall, or as a console, and
(2) for delivery without ducts of conditioned air to an enclosed space.

"Room air-conditioning heat pump" means a room air conditioner that is capable of heating by refrigeration.
"Seasonal energy efficiency ratio (SEER)" means the total cooling output of an air-cooled central air conditioner during its normal annual usage period for cooling, divided by the total electrical energy input in watt-hours during the same period, as determined using the applicable test method in Section 1604(c).

1.3.2 RAC Requirements

As stated in Section 1605.1 (b), code took effect as of Jan 1, 1990, several years before the advent of Energy Star. Code was revised as of Oct 2000 to the higher current standard. This enactment date was after the calendar year 2000 air conditioning season so energy savings and demand reduction due to this code change would not take effect until calendar year 2001[8].

Section 1605.1 (b) **Room Air Conditioners, Room Air-Conditioning Heat Pumps, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps.**
(1) **Room Air Conditioners and Room Air-Conditioning Heat Pumps.** The EER of room air conditioners and room air-conditioning heat pumps that are manufactured on or after the effective dates shown shall be not less than the applicable values shown in Table B-2. The EER of room air conditioners and room air-conditioning heat pumps that are labeled for use at more than one voltage shall be not less than the applicable values shown in Table B-2 at each of the labeled voltages.

Table 4: 1605.1 (b) Table B-2 Standards for Room Air Conditioners and Room Air-Conditioning Heat Pumps

Appliance	Louvered Sides	Cooling Capacity (Btu/hr)	Minimum EER or COP	
			Effective January 1, 1990	Effective October 1, 2000
Room Air Conditioner	Yes	< 6,000	8.0	9.7
Room Air Conditioner	Yes	≥ 6,000 - 7,999	8.5	9.7
Room Air Conditioner	Yes	≥ 8,000 - 13,999	9.0	9.8
Room Air Conditioner	Yes	≥ 14,000 - 19,999	8.8	9.7
Room Air Conditioner	Yes	≥ 20,000	8.2	8.5
Room Air Conditioner	No	< 6,000	8.0	9.0
Room Air Conditioner	No	≥ 6,000 - 7,999	8.5	9.0
Room Air Conditioner	No	≥ 8,000 - 19,999	8.5	8.5
Room Air Conditioner	No	≥ 20,000	8.2	8.5
Room Air Conditioning Heat Pump	Yes	< 20,000	8.5	9.0
Room Air Conditioning Heat Pump	Yes	≥ 20,000	8.5	8.5
Room Air Conditioning Heat Pump	No	< 14,000	8.0	8.5
Room Air Conditioning Heat Pump	No	≥ 14,000	8.0	8.0
Casement-Only Room Air Conditioner	Either	Any	*	8.7
Casement-Slider Room Air Conditioner	Either	Any	*	9.5
*Casement-only room air conditioners and casement-slider room air conditioners are not separate product classes under standards effective January 1, 1990. Such appliances, if manufactured before October 1, 2000, are subject to the applicable standards in Table B-2 for the other room air conditioners and room air-conditioning heat pumps based on capacity and the presence or absence of louvered sides.				

The Minimum EER or COP Effective October 1, 2000 column lists the current code requirements for C-RAC units. In Section 2.1, this work paper combines these various design and capacity EERs into a weighted mean EER for energy savings evaluation.

[8]. Ibid: Note **Error! Bookmark not defined.**, pages 73 & 74.

1.3.3 PTAC Requirements

Section 1605.1.2 defines Code requirements for the PT Units. For this work paper, these figures are only applicable to the determination of the LSLR Method for EER to Energy Savings. The equations used to determine energy savings for RACs[9] are in Section 2.1.

> **Section 1605.1** (2) **Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps.** The EER and COP, as applicable, of packaged terminal air conditioners and packaged terminal heat pumps shall be not less than the applicable values shown in Table B-3.

Table 5: 1605.1 (2) Table B-3 (Partial) Standards for Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps

Appliance	Mode	Cooling Capacity (Btu/hr)	Minimum EER or COP
Packaged terminal air conditioners and packaged terminal heat pumps	Cooling	=< 7,000	8.88 EER
		> 7,000 and < 15,000	10.0 - (0.00016 x Cap.) EER
		>=15,000	7.6 EER

1.3.4 Energy Star Standards

In 1992 the U.S. Environmental Protection Agency (EPA) introduced Energy Star as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Through 1995, EPA expanded the label to additional office equipment products and residential heating and cooling equipment. In 1996, EPA partnered with the DoE for particular product categories[10]. Energy Star announced labels for RACs in October 1996[11]. Energy Star RACs (ES-RAC) are defined as having a minimum of 10% energy efficiency improvement over minimum DoE requirements[12].

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9. Ibid: Note **Error! Bookmark not defined.**, pages 74 & 75.
10. "History", Energy Star website (http://www.energystar.gov/index.cfm?c=about.ab_history)

    Energy Star History.pdf
11. "Major Milestones", Energy Star website (http://www.energystar.gov/index.cfm?c=about.ab_milestones)

    Energy Star Major Milestones.pdf
12. "Room Air Conditioners", Energy Star website (http://www.energystar.gov/index.cfm?c=roomac.pr_room_ac)

    Energy Star Room Air Conditioners.pdf

Federal Standard (effective as of October 1, 2000) and Energy Star Energy Efficiency Ratio (EER) requirements are detailed in

Table 6.[13] As Title 20 has adopted these Federal Standard EERs, this paper refers to the Federal Standards as Title 20 code.

Table 6: ENERGY STAR Qualified Room Air Conditioner (RAC) Eligibility

<table>
<tr><th>Capacity (Btu/Hr)</th><th>Federal Standard EER, with louvered sides</th><th>ENERGY STAR EER, with louvered sides</th><th>Federal Standard EER, without louvered sides</th><th>ENERGY STAR EER, without louvered sides</th></tr>
<tr><td>< 6,000</td><td rowspan="2">≥ 9.7</td><td rowspan="2">≥ 10.7</td><td rowspan="2">≥ 9.0</td><td rowspan="2">≥ 9.9</td></tr>
<tr><td>6,000 to 7,999</td></tr>
<tr><td>8,000 to 13,999</td><td>≥ 9.8</td><td>≥ 10.8</td><td rowspan="3">≥ 8.5</td><td rowspan="3">≥ 9.4</td></tr>
<tr><td>14,000 to 19,999</td><td>≥ 9.7</td><td>≥ 10.7</td></tr>
<tr><td>≥ 20,000</td><td>≥ 8.5</td><td>≥ 9.4</td></tr>
<tr><td>Casement</td><td colspan="2">Federal Standard EER</td><td colspan="2">ENERGY STAR EER</td></tr>
<tr><td>Casement-only</td><td colspan="2">≥ 8.7</td><td colspan="2">≥ 9.6</td></tr>
<tr><td>Casement-slider</td><td colspan="2">≥ 9.5</td><td colspan="2">≥ 10.5</td></tr>
<tr><td colspan="5">REVERSE CYCLE</td></tr>
<tr><td>Capacity (Btu/Hr)</td><td>Federal Standard EER, with louvered sides</td><td>ENERGY STAR EER, with louvered sides</td><td>Federal Standard EER, without louvered sides</td><td>ENERGY STAR EER, without louvered sides</td></tr>
<tr><td>< 14,000</td><td rowspan="2">n/a</td><td rowspan="2">n/a</td><td>≥ 8.5</td><td>≥ 9.4</td></tr>
<tr><td>≥ 14,000</td><td>≥ 8.0</td><td>≥ 8.8</td></tr>
<tr><td>< 20,000</td><td>≥ 9.0</td><td>≥ 9.9</td><td>n/a</td><td>n/a</td></tr>
<tr><td>≥ 20,000</td><td>≥ 8.5</td><td>≥ 9.4</td><td>n/a</td><td>n/a</td></tr>
</table>

1.4 EM&V, Market Potential, and Other Studies

The Residential Appliance Saturation Survey (RASS) 2003 indicates an annual Unit Energy Consumption (UEC) of 240 kWh for RACs in the Southern California Edison (SCE) service area[14] and 214 kWh for statewide average:

13. "Room Air Conditioners", Energy Star website (http://www.energystar.gov/index.cfm?c=roomac.pr_crit_room_ac)

Energy Star RAC Key Product Data.pdf

14. California Statewide Residential Appliance Saturation Study Update to Air Conditioning Unit Energy Consumption Estimates Using 2004 Billing data – June

"Room air conditioning has a UEC of 214 kWh and evaporative systems 684 kWh. These values are somewhat lower than previous studies and forecasting values used at the Energy Commission. One possible reason for the lower than average use is attributed to the Statewide 20/20 Program. Billing data for the Conditional Demand Analysis is from the second half of 2001, all of 2002, as well as 2003 and 2004 to include years when the 20/20 program was not available. UEC results have all been annualized and calibrated to 2002 service territory total usage. It is likely that the UECs reflect the 20/20 program impact and thus these air conditioning values should be considered conservative estimates."[15]

The RASS states:

"A similar (to central air conditioning) albeit more parsimonious specification will be used for room air conditioning (RACUSEht), except that a term will be used to reflect the number of room air conditioning units (RACCNTh). This stems from the assumption that total usage depends on the number of room air conditioners."[16]

The RASS states RAC:

"Unit Energy Consumptions are also fairly low relative to prior estimates, varying from 105 kWh for multi-family units in buildings with 5+ units to 227 kWh for single family homes and mobile homes."[17]

The RASS does not state:

1) Size, design or capacity of RACs analyzed,
2) EERs of RACs or
3) Square footage cooled.

Without this information it is difficult to compare the RASS information to other sources in this work paper. There appears to be some questions in the RASS verbiage as to the accuracy of the UEC RAC figures.

The RASS estimates about 20 percent of SCE homes have room air conditioners. The SCE Residential Room Air-Conditioner Recycling Scoping Study (Scoping Study)[18] estimates 50% of those homes with room ACs have units ten years old or more, similar to

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2006 CEC-400-2006-009, Table 9 & 10 page 21

EN 06-RASS Update-AC 2004.pdf

[15]. Ibid: Note **Error! Bookmark not defined.**, page 17.
[16]. Ibid: Note **Error! Bookmark not defined.**, page 132.
[17]. Ibid: Note **Error! Bookmark not defined.**, page 7.
[18]. SCE Residential Room Air-Conditioner Recycling Scoping Study, page 2.

A2 final-report_RAC.doc

the RASS estimate of 47% of homes that have units more than nine years old. The average age of room air conditioners in RASS data is calculated to be 7.71 years[19].

For a Weighted Mean RAC (WM-RAC) that provides 12,906 Btu of cooling and averaging estimated energy savings for all climate zones, replacing a Jan 1990 code RAC with an Energy Star RAC produces a total annual 397.7 kWh/WM-RAC unit savings (From **Error! Reference source not found.**). This number compares with the 372.2 kWh/ room air conditioner unit annual savings reported for multifamily housing in the Low-Income Energy Efficiency (LIEE) program[20].

1.5 Base and Measure Cases for Savings Estimates

The base case is a C-RAC meeting the Federal Standard EER requirements as listed in Table 4. For this work paper, Customer Savings and Above Code Savings estimates are the same and are based on the Energy Star EERs as defined in
Table 6: Energy Star Qualified RAC Eligibility. Customer Savings from early retirement of existing RACs (vintage code to current code) are only counted in the separate Room Air Conditioner Recycling Work Paper.

1.6 Effective Useful Life

A table in the ASHRAE HVAC Equipment Handbook indicates the Effective Useful Life (EUL) for window unit RACs is ten years and fifteen years for all other air conditioning units and heat pumps. However, a footnote to that same table also indicates this data from Akalin (1978) “may be outdated and not statistically relevant. Use this data with caution until enough updated data are accumulated in Abramson et. al.”[21].

The Association of Home Appliance Manufacturers (AHAM) web site includes a 1996 survey by National Family Opinion, Inc. (NFO) stating the EUL for RACs is 12 years. The NFO’s basis for EUL is: “age of an appliance when it is replaced because it cannot

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[19]. “Effective Useful Life: Early Retirement and Replacement Room AC Measure”, Tabulated from the California Statewide Residential Appliance Saturation Study Database.

Room AC RULs.doc

[20]. “Table 3-8 SCE LIEE Program Impact Estimates for PY-2001”, Impact Evaluation Of The 2001 Statewide Low-Income Energy Efficiency (LIEE) Program - Final Report Volume 2 Study ID Number 577, Prepared for SCE, SC Gas Co., SDG&E and PG&E, Prepared by KEMA-XENERGY Inc.; Oakland, California and Business Economic Analysis & Research; Lemon Grove, California, April 8, 2003, Page E-6 (http://www.calmac.org/publications/2001_LIEE_Impact_Evaluation.pdf)

[21]. “Table 6 : Comparison of Service Life Estimates”, 2007 ASHRAE Handbook-HVAC Applications (Inch-Pound Edition), ASHRAE, 2007, Page A36.3

be repaired or costs too much to repair. (This does not infer the appliance will be without repair during its lifetime.)"[22].

The Table of Discarded Window/Wall (RAC) AGE (DWWAGE) by Window/Wall (RAC) ADDed (WWADD)[23] from the RASS 2003 data of homes that replaced their old wall/window RAC with a new unit, 20.59% of replaced units were up to ten years old, 38.71% were 11 to 20 years old and the remaining 40.70% units were more than 20 years old. Based on the RASS 2003 study, this paper uses a new RAC EUL for the SCE region of the half life of these units: 15 years.

1.7 Net-to-Gross Ratios for Different Program Strategies

This work paper covers customer driven appliance Replace on Burnout (ROB) and New residential installation. Per the CPUC Energy Efficiency Policy Manual and on the DEER web site the Net-to-Gross (NTG) ratio is 0.80 for all programs except the Residential Contractor program. For Residential Contractor replaced units, the NTG ratio is 0.89.[24]

Table 7: Net-to-Gross Ratios

Residential Construction	Program Approach	NTG
Multifamily unit	Residential Contractor Program	0.89
All unit	All other residential programs	0.80

[22]. "Average Useful Life of Major Home Appliances", National Family Opinion, Inc. (NFO), 1996 Survey (http://www.aham.org/industry/ht/action/GetDocumentAction/id/5271)

AHAM RAC EULs.pdf

[23]. Ibid: Note **Error! Bookmark not defined.**: Source data for Table of DWWAGE by WWADD

RMACAGE_2007-08-22.HTM

[24]. 2004-05 Database for Energy Efficiency Resources (DEER), Version 2.01 October 26, 2005. Net-to-Gross Ratios Table, at (http://eega.cpuc.ca.gov/deer/Ntg.asp)

EN17 DEER Database Net-To-Gro

Section 2. Calculation Methods

No study was available to quantify what type of residence one or more RACs may be located in or how many people may be in what size of how much conditioned space.

DEER Measure ID D03-099 Run IDs (DEER Calcs)[25] is the only DEER measure evaluating similar equipment cooling performance in EER. This measure evaluates PT units installed in the DEER two story building model Lodging-Motel. The construction elements used in the Lodging-Motel model are similar to residential construction elements. The measure also randomly loads PTAC units with mixed interior and exterior floors, walls and ceilings and mixes operating hours between none, 12 hour and 24 hour operation. While PTAC units can also provide heat thru either in-unit or externally supplied sources, this paper does not evaluate efficiency of PTAC heating.

The randomness of PTAC unit installation and operation provides something of a reasonable basis for estimating RAC energy savings. But, the DEER PTAC unit 24 hour usage distribution (percentage of the motel that is actively being cooled as shown in **Error! Reference source not found.**) which resembles thermal energy storage demand profile does not appear to match expected SCE system demand due to air conditioning. Therefore, RAC power demand is estimated at full RAC power demand during a three day heat wave in the SCE service area.

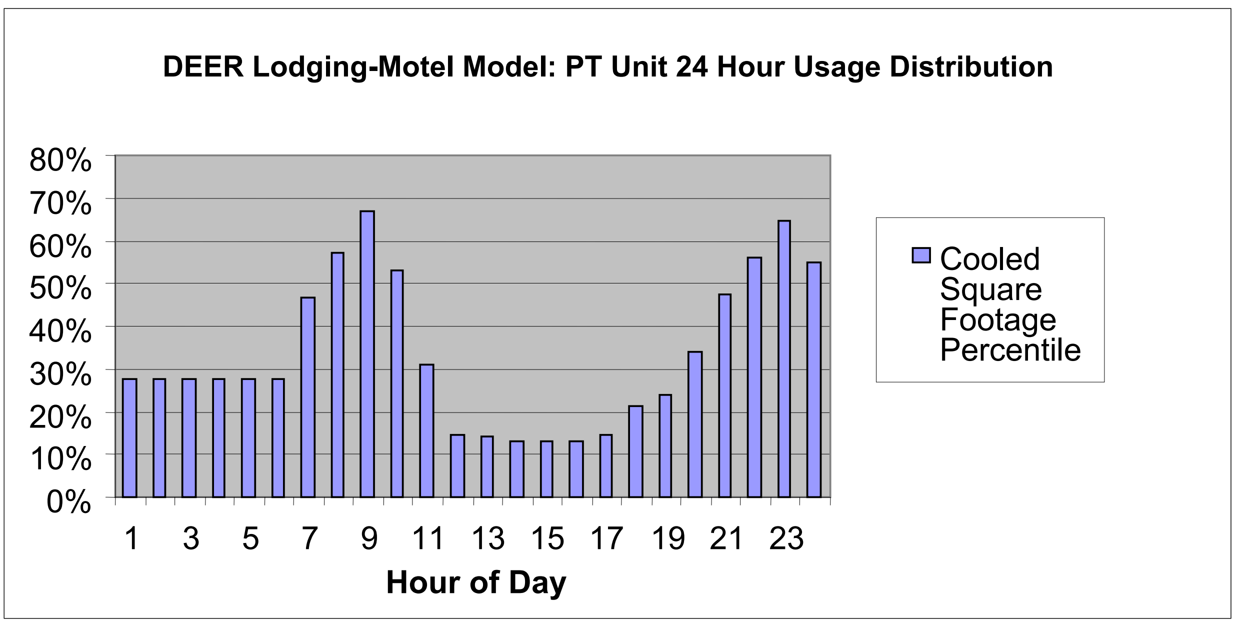

Figure 5: DEER Lodging-Motel Model: PT Unit 24 Hour Usage Distributions

25. RAC Calcs.zip: DEER Measure D03-099 Lodging-Motels.xls: Sheet "DEER Cals" (RAC Calcs.zip)

2.1 Energy Savings Estimation Methodologies

This work paper takes DEER data for PT units and uses the LSLR Method to establish an EER to energy savings equation for each motel building vintage in each SCE climate zone. By weighing the equation slope and Y intercept by motel building population data for each vintage in a climate zone a vintage weighted mean EER to energy savings equation is established for each climate zone.

To determine a single RAC cooling capacity with C-RAC and ES RAC EERs, this work paper establishes the following. For each cooling capacity range in British thermal units (Btu) all unique RAC units listed in the Energy Star web site are counted for each design type with that number divided by the total RACs of the same capacity. Using the percentage of units SCE rebated (SCE Rebate Scale) for each Btu range and translating the SCE ranges to match the Title 20 code Btu ranges, this work paper establishes a cooling capacity weighted mean RAC for evaluation in each climate zone. Using the same SCE Rebate Scale, this approach further weights the design weighted mean EERs to establish EERs for the WM-RAC. Using the energy savings equation, this paper estimates energy savings for both codes and Energy Star RAC in each climate zone.

2.1.1 LSLR Method for Equations

The DEER Calcs provide estimated energy savings for replacing vintage PT units with PT units that meet T24 minimum EER code requirements and 20% above code EER PT units. Using the LSLR Method as shown in Equation (1), these figures for each vintage within each climate zone produce equations expressing energy savings for various EERs.

$$y = K + Sx \qquad (1)$$

Where,

x = EER
y = annual energy savings

$$K = [(\sum y_i)(\sum x_i^2) - (\sum x_i)(\sum x_i y_i)] / [n(\sum x_i^2) - (\sum x_i)^2] \qquad (2)$$

$$S = [n(\sum x_i y_i) - (\sum x_i)(\sum y_i)] / [n(\sum x_i^2) - (\sum x_i)^2] \qquad (3)$$

"n" is the total number of data sets in the form (x_i,y_i). In these calculations, n equals three representing the Base Case, the 2000 Title 20 and 20% above 2000 Title 20 data sets.

The first set of data points represent the X-axis intercept (no energy savings) DEER base case EER found in the DEER Calcs: Base Case Description. This set characterizes the existing PT units in each DEER model which meet each building vintage's Nonresidential Compliance Manual For California's 2005 Energy Efficiency Standards (Title 24)[26] code requirements in different climate zones within SCE service territory.

[26]. Current requirements only: Nonresidential Compliance Manual For California's 2005 Energy Efficiency Standards (Title 24), California Energy

1) DEER building vintage with associated Title 24 EER:
   X_1 = vintage EER,
   Y_1 = zero energy savings

The second set of data points represent the fact the Title 24 code requires the building vintage PT units be upgraded on replacement to at least the current Title 20 EER figure. This upgrade produces the code energy savings (ECImpact).

2) DEER 2000 Title 20 EER:
   X_2 = EER required by 2000 Title 20,
   Y_2 = Code Energy Savings (ECImpact)

The third set of data points are the DEER measure energy savings (EImpact).

3) DEER measure EER:
   X_3 = 20% above EER required by 2000 Title 20,
   Y_3 = Measure Energy Savings (EImpact)

Data and calculations for all forty of the S and K values are detailed in DEER Measure D03-099 Lodging-Motels.xls: Sheet: LSLR Method & Vintage Weighing[27].

2.1.2 Example 1 - LSLR Method for Equations

Determine the Slope (S) and Y intercept (K) for the EER to energy savings equation for a 12,000 Btu PTAC unit installed in a motel built before 1978 in the City of Long Beach.

DEER Measure ID D03-099 Run ID CMtl0675PTAC2 provides estimated energy savings for replacing a vintage PT unit with a PT unit that meets T24 current minimum EER code requirements and 20% above code EER PT unit installed in a motel built before 1978 in the City of Long Beach. The DEER common units are Cooling Tons (CTon) or 12,000 Btu. DEER energy savings are in kilowatt-hour (kWh) per CTon.

The first point is set at the X-axis intercept (no energy savings) DEER base case EER found in the DEER Calcs: Base Case Description. This point represents the existing PT units in each DEER model which meet each building vintage's Title 24 code requirements.

1) DEER building vintage Title 24 construction code EER:
   X_1 = 6.80;
   Y_1 = 0.0 kWh/CTon,

The second point represents the fact the Title 24 code requires the building vintage PT units be upgraded on replacement to at least the current Title 20 EER figure. This upgrade produces the code energy savings ECImpact.

Commission, Publication Number: CEC-400-2005-006-CMF, Dated Published: April 2005, Effective Date: October 1, 2005.

27. Ibid: Note **Error! Bookmark not defined.**, Sheet "LSLR Method & Vintage Weighing"

2) DEER 2000 Title 20 code:
   X_2; = 8.56;
   Y_2 = 277.691 kWh/CTon (ECImpact)

The third point is the DEER measure energy savings (EImpact).

3) DEER measure EER:
   X_3; = 10.27;
   Y_3 = 709.349 kWh/CTon (EImpact)

Using these figures and LSLR Method Equation (1), an equation expressing energy savings for various EERs is established. The following variables are used in the LSLR Method:

Variables for Equation (2) are:

$\Sigma(X_i) = X_1 + X_2 + X_3 = 6.80 + 8.56 + 10.27 = \mathbf{25.63}$

$\Sigma(X_i^2) = (X_1 * X_1) + (X_2 * X_2) + (X_3 * X_3)$
$= (6.80 * 6.80) + (8.56 * 8.56) + (10.27 * 10.27) = \mathbf{224.987}$

$\Sigma(Y_i) = YE_1 + YE_2 + YE_3 = 0 + 277.691 + 709.349 = \mathbf{987.040}$

$\Sigma(X_i*Y_i) = X_1 * YE_1 + X_2 * YE_2 + X_3 * YE_3$
$= 6.8 * 0 + 8.56 * 277.691 + 10.27 * 709.349 = \mathbf{9{,}662.049}$

Equation (2) is used to determine the Y intercept (K) where EER equals zero:

$K = [(\sum y_i)(\sum x_i^2) - (\sum x_i)(\sum x_i y_i)] / [n(\sum x_i^2) - (\sum x_i)^2]$

$= [(987.040)(224.987) - (25.63)(9{,}662.049)] / [3(224.987) - (25.63)^2]$

$\mathbf{= -1415.502}$

Equation (3) is used to determine the linear slope (S):

$S = [n(\sum x_i y_i) - (\sum x_i)(\sum y_i)] / [n(\sum x_i^2) - (\sum x_i)^2]$

$= [3(9{,}662.049) - (25.63)(987.040)] / [3(224.987) - (25.63)^2]$

$\mathbf{= 204.196}$

By determining S and K, the EER to energy savings equation (Equation (1)) is:

$y = K + Sx = \mathbf{-1415.502 + 204.196x}$

Data and calculations for the S and K values and a graph of the resulting equation are detailed in DEER Measure D03-099 Lodging-Motels.xls: Sheet: LSLR Method Example+Graph[28].

[28]. Ibid: Note **Error! Bookmark not defined.**, Sheet "LSLR Method Example+Graph"

2.1.3 Vintage Weighted Mean Equations

For each climate zone, vintage weighted mean equations are determined by weighting the various slopes (S_i) and Y-Intercepts (K_i) by the total number of buildings per type and vintage.

DEER Measure D03-099 evaluates building type MTL (Motel). The Commercial End Use Saturation[29] surveys (CEUS) provides a relative basis for a total number of motel buildings per each vintage within the same climate zone (W_i). W_1 thru W_5 are the total number of basis motels for each vintage oldest to newest.

Weighting and combining the Y intercept values for each building vintage (K_1 thru K_5) produces the vintage weighted mean Y intercept (K_{vwm}) for all vintages in a climate zone. Equation (4) calculates K_{vwm} for all vintages of the building type per climate zone:

$$K_{vwm} = (\Sigma(W_i * K_i)) / \Sigma(W_i) \qquad (4)$$

In a similar way, the slope S for each building vintage of a climate zone (S_1 thru S_5) is used to determine the vintage weighted mean slope (S_{vwm}) (in equation (4): K becomes S).

Determining K_{vwm} and S_{vwm} establishes Equation (5), an EER to energy savings equation for each climate zone:

$$Y = K_{vwm} + S_{vwm} * X \qquad (5)$$

Data and calculations for all K_{vwm} and S_{vwm} values are detailed in DEER Measure D03-099 Lodging-Motels.xls: Sheet: LSLR Method & Vintage Weighing[30]. The resulting values are listed in**Error! Reference source not found.**.

Table 8: Energy Savings Vintage Weighted Mean Slopes & Y Intercepts

DEER Values		Energy Savings:	
Climate Zone City	**CA T24 CZ:**	**Slope** S_{vwm}	**Y-Intercept** K_{vwm}
Long Beach	6	183.835	-1,297.400
El Toro	8	229.651	-1,624.025
Burbank	9	216.026	-1,537.142
Riverside	10	204.380	-1,458.538
Fresno	13	202.615	-1,423.334
China Lake	14	187.204	-1,323.838
El Centro	15	272.872	-1,912.036

29. CEUS (SCE CEUS based Nonres Vintage & CZ Distributions.xls)
30. Ibid: Note **Error! Bookmark not defined.**, Sheet "LSLR Method & Vintage Weighing"

DEER Values		Energy Savings:	
Climate Zone City	CA T24 CZ:	Slope	Y-Intercept
		S_{vwm}	K_{vwm}
Mt. Shasta	16	147.093	-1,033.533

2.1.4 Example 2 – Energy Savings Vintage Weighted Mean Equation

Given the slopes (S_i) and Y intercepts (K_i) for each DEER vintage of motel built in Long Beach, find the vintage weighted mean linear slope (S_{vwm}), Y-Intercept (K_{vwm}) and the EER to energy savings equation on a cooling ton basis.

For the slope calculation, the required data from the "LSLR Method & Vintage Weighing" sheet of "DEER Measure D03-099 Lodging-Motels.xls"[31] are the CEUS Weight Factors W_i and the LSLR Method Slopes S_i for each building vintage. Multiplying the S_i by the respective W_i produces the Vintage Weighting Factor (S_i * W_i) for each vintage. Values for these variables are shown in **Error! Reference source not found.**.

Table 9: Example 2 - Climate Zone 6 Vintage Weighted Mean Linear Slope Calculations

For Motels in Long Beach Climate Zone 6:				
Buildings Vintages	Vintage Order	CEUS Weight Factors	LSLR Method Slopes	Vintage Weighting Factors
		W_i	S_i	(S_i * Wi)
Built before 1978	1	254	204.196	51,866
Built between 1978 and 1992	2	107	164.463	17,598
Built between 1993 and 2001	3	14	77.640	1,087
Built between 2002 and 2005	4	10	76.968	770
Built 2006 and later (measures as retrofit for nonresidential)	5	4	47.907	192
Totals (Σ):		389		71,512

Equation (4) modified to calculate the vintage weighted mean slope (S_{vwm}) for all vintages of the building type per climate zone is:

$S_{vwm} = (\Sigma(W_i * S_i)) / \Sigma(W_i) = 71{,}512 / 389 = \mathbf{183.835}$

For the Y intercept calculation, the data from the "LSLR Method & Vintage Weighing" sheet of "DEER Measure D03-099 Lodging-Motels.xls"**Error! Bookmark not defined.** are the CEUS Weight Factors W_i and the LSLR Method Y intercepts K_i for each building vintage. Multiplying K_i by the respective W_i produces the

31. Ibid: Note **Error! Bookmark not defined.**, Sheet "DEER Measure D03-099 Lodging-Motels.xls".

Vintage Weighting Factor (K_i * W_i) for each vintage. Values for these variables are shown in **Error! Reference source not found.**.

Table 10: Example 2 - Climate Zone 6 Vintage Weighted Mean Y Intercept Calculations

For Motels in Long Beach Climate Zone 6:				
Buildings Vintages	**Vintage Order**	**CEUS Weight Factors**	**LSLR Method Y intercepts**	**Vintage Weighting Factors**
		W_i	K_i	(K_i * W_i)
Built before 1978	1	254	-1,415.502	-359,537
Built between 1978 and 1992	2	107	-1,220.122	-130,553
Built between 1993 and 2001	3	14	-545.310	-7,634
Built between 2002 and 2005	4	10	-540.586	-5,406
Built 2006 and later (measures as retrofit for nonresidential)	5	4	-389.487	-1,558
	Totals (Σ):	389		-504,689

Equation (4) calculates the vintage weighted mean Y intercept (K_{vwm}) for all vintages of the building type per climate zone:

$K_{vwm} = (\Sigma(W_{i*} K_i)) / \Sigma(W_i) = -504{,}689 / 389 = \mathbf{-1{,}297.400}$

For Motels in Long Beach Climate Zone 6, the EER to energy savings Equation (4) is:

$Y = K_{vwm} + S_{vwm} * X = \mathbf{-1{,}297.400} + \mathbf{183.835} * X$

MS Excel versions of **Error! Reference source not found.** and **Error! Reference source not found.** are shown in the "Vintage Weighted Mean Example" sheet of "DEER Measure D03-099 Lodging-Motels.xls"**Error! Bookmark not defined.**.

2.1.5 RAC EER Design Variance Weighted Mean Values

The Energy Star Web site[32] provides a list of available Energy Star RACs from 5,000 to 28,000 Btu/hr cooling capacity. This list includes various design details like which RACs have reverse cycles (Heat Pumps), side louvers and or casement-only or slider style units. Title 20 Table B-2 lists code EERs based on those design details for various cooling capacity ranges. Counting the available unique units with each of these design characteristics and cooling capacities provides a design weighing factor to determine a design weighted mean RAC EER for the Title 20 Table B-2 cooling capacity ranges.

32. "Find ENERGY STAR Qualified Room Air Conditioners", Energy Star website (http://www.energystar.gov/index.cfm?fuseaction=roomac.search_room_air_conditioners)

Energy Star RACs-20070802.xls

This work paper adds together the counts of unique units with similar RAC EER & cooling capacities and then finds a design variance weighted mean EER for each Title 20 Table B-2 cooling capacity range. The resulting EERs are shown in **Error! Reference source not found.**.

Table 11: EER Weighted Mean by Unit Design for Cooling Capacity

EER Weighted Mean by Unit Design for Cooling Capacity		
Cooling Capacity (Btu/hr)	**Effective January 1, 1990**	**Effective October 1, 2000**
< 6,000	8.00	9.69
≥ 6,000 - 7,999	8.50	9.64
≥ 8,000 - 13,999	8.77	9.27
≥ 14,000 - 19,999	8.78	9.65
≥ 20,000	8.22	8.50

Complete tables of Energy Star Product Listings and calculations for Unique Unit Design Weighted Mean EERs are listed in Appendix A: RAC EER Design Variance Weighted Mean and in the "EER Weighting by Unique Units" sheet of MS Excel Workbook "Energy Star RACs-20070802.xls"[33].

2.1.6 Example 3 - RAC EER Design Variance Weighted Mean Values

Count the RACs with capacities equal to or greater than 8,000 and less than 13,999 Btu by unique design features listed in the Energy Star web site to determine the number of Unique Unit (UUs) RACs. Find the EER Weighted Mean Factor for each type of these UU designs and the weighted mean EER for all of these UU RAC units.

Example 3 column & row references can be found in **Error! Reference source not found.** below. The Energy Star web site lists four unique designs for RACs with capacities equal to or greater than 8,000 and less than 13,999 Btu: standard RACs with & without louvered sides and heat pumps with & without louvered sides (columns (A) & (B) in T-X). Also listed are the Jan 1990 and Oct 2000 minimum EERs for each of these designs (columns (C) & (D)).

Counting the number of unique RACs listed in the Energy Star Product Listing[34] results in the numbers in column (E). Column (F) shows the addition of ten 8,000 Btu casement units from Row 27 to Row 11 which have identical EERs with the results of the addition in column (G) and subtotal of all the 8,000 and less than 13,999 Btu manufacturer RACs.

For Row 11: (G) = (E) + (F) = 310 + 10 = **320**

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33. RAC Calcs.zip: Energy Star RACs-20070802.xls: Sheet "EER Weighting by Unique Units". (RAC Calcs.zip)

34. Ibid: Note **Error! Bookmark not defined.**: Sheet "Energy Star Product Listing".

Column (H) is the column (G) number divided by the column (G) subtotal resulting in the percentile of each unique design relative to the total number of unique designs:

Row 15 Column (G) Subtotal: Σ(G) = 320 + 193 + 20 + 19 = **552**

For Row 11: (H) = (G) / Σ(G) = 320 / 552 = **0.58 or 58.0%**

Columns (I) & (J) are the Minimum EERs (columns (C) & (D)) multiplied by the percentile.

For Row 11: (I) = (C) * (H) = 9.0 * 0.58 = **5.22**
(J) = (D) * (H) = 9.8 * 0.58 = **5.68**

Summing column (I) results in the design weighted EER of 8.77 for the Jan 1990 Code.

Row 15 Column (I) Subtotal: Σ(I) = 5.22 + 2.97 + 0.31 + 0.28 = **8.77**

Summing column (J) results in the design weighted EER of 9.27 for the Oct 2000 Code.

Row 15 Column (J) Subtotal: Σ(J) = 5.68 + 2.97 + 0.33 + 0.29 = **9.27**

Table 12: Example 3 - RAC Design Weighted Mean Values

Row	Cells in Blue Arial font are from Title 20 Table B-2				Energy Star Product Search Unique Units (UU)				EER Weighted Mean Factors by Unit Design for Capacity	
	Appliance	Louvered Sides	Minimum EER							
			Effective Jan 1990	Effective Oct 2000	No. of UUs	Adjust-ments to equiv. EERs	Adjust-ed No. of UUs	% of UUs per Cap	Effective Jan 1990	Effective Oct 2000
	Column (A)	(B)	(C)	(D)	(E)	(F)	(G) = (E)+(F)	(H) = (G) / Subtotal	(I) = (C)*(H)	(J) = (D)*(H)
	For Capacities ≥ 8,000 - 13,999 Btu/hr									
11	RAC	Yes	9.0	9.8	310	10 from Row 27	320	58.0%	5.22	5.68
12	RAC	No	8.5	8.5	193	None	193	35.0%	2.97	2.97
13	RAC Heat Pump	Yes	8.5	9.0	20	None	20	3.6%	0.31	0.33
14	RAC Heat Pump	No	8.0	8.5	19	None	19	3.4%	0.28	0.29
15						**Subtotal:**	**552**	**Weighted EERs:**	**8.77**	**9.27**
	For Casement RACs the only available capacity is 8,000 Btu/hr									
26	Casement-Only RAC	Either	(1)	8.7	0	None	0			
27	Casement-Slider RAC	Either	(1)	9.5	10	Add 10 to Row 11	0			
				Totals:	1032		1032			
Notes:	(1) Not a separate class until Oct 2000.									

▶ 2.1.7 RAC Population Weighted Mean Values

An SCE study[35] establishes a distribution of RAC unit cooling capacity for the SCE service area as listed in **Error! Reference source not found.**.

Table 13: SCE Service Area: RAC Cooling Capacity Distribution

Cooling Tons	BTU/hr	Percentage of Total RAC Units in SCE Service Area
0.5 to < 1.0	6,000 to <12,000	47%
1.0 to < 1.5	12,000 to <18,000	41%
1.5 to < 2.0	18,000 to 24,000	6%
> 2.0	> 24,000	6%

These unit cooling capacity ranges do not match Table 4 ranges so this work paper weighted the SCE area RAC distribution evenly over the Table 4 ranges as follows to establish a population Weighted Mean RAC (WM-RAC)[36].

Table 14: Basis for determining the Population Weight Mean RAC for SCE Service Area

Population Weighted Mean RAC Capacity			**Title 20**					
BTU/hr	**SCE Cooling Capacity Range BTU/ hr**	**% of Total RAC Units in SCE Service Area**	**Title 20 Cooling Capacity Range BTU/ hr**	**Title 20 Average Cooling Capacity BTU/ hr**	**Title 20: % of SCE Dist**	**SCE Count/ 100 RAC Units**	**Title 20 % Dist**	**Weighted Mean Factor BTU/hr**
	Column (A): From Error! Reference source not found.	**(B): From** Error! Reference source not found.	**(C): From Table 4**	**(D): Average of (C)**	**(E) = % of (B)**	**(F) = (B) * (E) *100**	**(G) = (F) / 100**	**(H) = (D) * (G)**
5000	6,000 to <12,000	47%	> 6,000	5000	14.3%	7	6.7%	336
6000			≥ 6,000 - 7,999	6500	28.6%	13	13.4%	873
7000								
8000			= 8,000 - 13,999	11000	57.1%	27	40.5%	4458
9000								
10000								
11000								
12000	12,000 to <18,000	41%			33.3%	14		
13000								
14000			≥ 14,000 - 19,999	16500	66.7%	27	29.3%	4840
15000								
16000								
17000								

35. Ibid: Note 18: "Figure 1: RAC Cooling Capacity in Tons"
36. Ibid: Note **Error! Bookmark not defined.**: E3 WM-RAC Weighting Calcs.xls Sheet: "Weighted Mean RAC and EERs".

18000	18,000 to 24,000	6%			33.3%	2		
19000								
20000			≥ 20,000	24000	66.7%	4	10.0%	2400
21000								
22000								
23000								
24000	> 24,000	6%			100.0%	6		
25000								
26000								
27000								
28000								
Weighted Mean RAC BTU/hr:								**12,906**

For the SCE service area, the WM-RAC BTU/hr is 12,906. The following **Error! Reference source not found.** takes the EER Weighted Mean by Unit Design for Cooling Capacities figures from **Error! Reference source not found.** and further weights the EERs by the Title 20 % distribution from Table 14 **Error! Bookmark not defined.**.

Table 15: Basis for determining the Weight Mean RAC EERs for SCE Service Area

EER Weighted Mean by Unit Design for Cooling Capacity (from Error! Reference source not found.**)**			**Energy Star EER**	**Title 20 % Dist (from**Error! Reference source not found.**)**	**Weighted Mean EER Factors**		
Cooling Capacity (Btu/hr)	**Effective 1-Jan-90**	**Effective 1-Oct-00**			**Jan-90**	**Oct-00**	**Energy Star**
	Column (A)	**(B)**	**(C) = (B) * 1.1**	**(D) = Table 14: Col (G)**	**(E) = (A) * (D)**	**(F) = (B) * (D)**	**(G) = (C) * (D)**
< 6,000	8.0	9.7	10.7	6.7%	0.537	0.651	0.718
≥ 6,000 - 7,999	8.5	9.6	10.6	13.4%	1.141	1.289	1.423
≥ 8,000 - 13,999	8.8	9.3	10.2	40.5%	3.566	3.769	4.133
≥ 14,000 - 19,999	8.8	9.7	10.7	29.3%	2.581	2.845	3.139
≥ 20,000	8.2	8.5	9.4	10.0%	0.820	0.850	0.940
Weighted Mean EERs:					**8.6**	**9.4**	**10.4**

For the SCE service area, WM-RACs are 12,906 BTU/hr units that would meet EERs of 8.6 after Jan 1990, 9.4 as of Oct 2000 or an Energy Star rating of at least 10.4.

2.1.8 Energy Savings for WM-RAC

Error! Reference source not found. below lists the SCE climate zones and repeats the S_{vwm} Weighted Slope and K_{vwm} Weighted Y Intercept from**Error! Reference source not found.**. Using Equation (5), Columns (C), (D) and (E) show the resulting energy savings calculations for WM-RACs for Jan 1990 code, Oct 2000 code and Energy Star (10% above Oct 2000 code) for the SCE climate zones. Column (F) numbers are the total energy savings of upgrading from a Jan 1990 Code to Energy Star WM-RAC. Column (G) numbers are the energy savings for buying an Energy Star WM-RAC instead of a current (Oct 2000) C-RAC: the energy savings for this work paper. Column (H) is the energy savings for replacing an existing Jan 1990 code RAC with a C-RAC: the energy savings for the RAC Recycling work paper[37].

[37]. Ibid: Note **Error! Bookmark not defined.**: Sheet: “WM-RAC Energy Savings”.

Table 16: WM-RAC Annual Energy Savings (AES)

For Weighted Mean RAC:		BTU/ hr:	12,906	Weighted Mean EERs			WM-RAC Energy Star AES less: (kWh/Unit)		Code Differential AES: Oct 2000 less Jan 1990 (kWh/Unit) (Note 2)
				8.6	9.4	10.4			
DEER Values		Annual Energy Savings (AES): (From Table X)		WM-RAC Total AES: (kWh/WM RAC)					
Climate Zone City	CA T24 CZ:	S_{vwm} Weighted Slope	K_{vwm} Weighted Y Intercept	Code: Jan 1990	Code: Oct 2000	Energy Star	Code: Jan 1990	Code: Oct 2000 (Note 1)	
		Column (A)	(B)	(C) (Note 3)	(D) (Note 4)	(E) (Note 5)	(F) = (E) - (C)	(G) = (E) - (D)	(H) = (F) - (G)
Long Beach	6	183.835	-1,297.400	305.0	463.2	660.9	355.9	197.7	158.2
El Toro	8	229.651	-1,624.025	377.5	575.1	822.1	444.6	247.0	197.6
Burbank	9	216.026	-1,537.142	344.9	530.8	763.1	418.2	232.3	185.9
Riverside	10	204.380	-1,458.538	321.7	497.6	717.4	395.7	219.8	175.8
Fresno	13	202.615	-1,423.334	343.3	517.6	735.5	392.2	217.9	174.3
China Lake	14	187.204	-1,323.838	307.7	468.8	670.1	362.4	201.3	161.1
El Centro	15	272.872	-1,912.036	467.5	702.3	995.7	528.3	293.5	234.8
Mt. Shasta	16	147.093	-1,033.533	248.9	375.5	533.7	284.8	158.2	126.6
Notes:	(1)	Energy Star RAC energy savings: Purchase an Energy Star Unit instead of an Oct 2000 Code Unit.							
	(2)	Residential RAC Recycling energy savings: Recycle a Jan 1990 Code Unit and replace with an Oct 2000 Code Unit.							
	(3)	(C) = ((B) + (A) * 8.6) / (12,000 / 12,906)							
	(4)	(D) = ((B) + (A) * 9.4) / (12,000 / 12,906)							
	(5)	(E) = ((B) + (A) * 10.4) / (12,000 / 12,906)							

2.1.9 Example 4 - WM-RAC Annual Energy Savings (AES) Calculations

As an example, the equation to determine the total annual energy savings for an RAC with a BTU/hr capacity of 12,906 and EER of 8.6 in the Long Beach climate zone is:

$Y = (K_{vwm} + S_{vwm} * X) * (\text{WM-RAC Capacity (BTU/hr)} / 12{,}000 \; \text{((BTU/hr)/Cooling Ton)}$

$= (-1{,}297.400 \; \text{(kWh / Cooling Ton year)} + 183.835(\text{(year-kWh/Cooling Ton year) / (BTU/W)})*8.6(\text{BTU/W})) * 12906(\text{BTU/hr})/(\text{WM-RAC Unit})) / (12000((\text{BTU/hr})/(\text{Cooling Ton}))$

$= 305.0 \; \text{kWh / year WM-RAC Unit}$

Averaging the last three columns of **Error! Reference source not found.** produces average annual energy savings for the Residential RAC Recycling and Energy Star RAC work papers and a combined total savings as shown in **Error! Reference source not found.** [37]. The total savings is comparable to the RAC energy savings from the LIEE program of PY 2001 [20].

Table 17: Average Annual Energy Savings for a WM-RAC

For a WM-RAC rated at 12,906 Btu:	Average Annual Energy Savings (kWh/WM-RAC):
Residential RAC Recycling: Replace a Jan 1990 Code Unit with an Oct 2000 Code Unit	176.8
Energy Star RAC: Purchase an Energy Star Unit instead of an Oct 2000 Code Unit	221.0
Total Savings: Replace a Jan 1990 Code Unit with an Energy Star Unit	397.7

2.2. Demand Reduction Estimation Methodologies

To derive the demand reduction, this work paper uses the Weighted Mean RAC of 12,906 Btu. The equation for EER is:

EER = Cooling Capacity (Btu/hr) / Power (Watts)

To determine Power in kW:

Power (kW) = [Cooling Capacity (Btu/hr) / EER] * [1 (kW) / 1000 (Watts)]

Power and Demand Reduction for the Weighted Mean EERs are shown in the following table:

Table 18: Weighted Mean RAC Demand Reduction

For Weighted Mean RAC 12,906 Btu / hr			
	Code: Jan 1990	**Code: Oct 2000**	**Energy Star**
EER	8.6	9.4	10.4
Power (kW)	1.501	1.373	1.241
Demand Reduction (kW)			
		Energy Star - Code: Oct 2000 (1):	0.132
		Code: Oct 2000 - Code: Jan 1990 (2):	0.128
Notes:	(1) Energy Star RAC Demand Reduction: Purchase an Energy Star Unit instead of an Oct 2000 Code Unit.		
	(2) Residential RAC Recycling Demand Reduction: Recycle a Jan 1990 Code Unit and replace with an Oct 2000 Code Unit.		

The Energy Star demand reduction is 0.132 kW for all climate zones in SCE's service area. This is based on the assumption that for a typical summer three day heat wave peak demand period RACs will operate at or above the test condition of 95°F[38]. As a result, the peak demand would be close to the same value for all units across different climate zones. This assumption simplifies the demand estimation process and also reduces any discrepancies due to under estimation of the potential demand reduction.

Section 3. Load Shapes

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the

38 U.S. Office of the Federal Register. 2002. Code of Federal Regulations, Title 10, Energy. Part 430, Subpart B, Appendix F: Uniform Test Method for Measuring the Energy Consumption of Room Air Conditioners.

avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure's load shape.

The measure's load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A TOU load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure's Total Resource Cost (TRC) benefit[39].

3.1 Base Case Load Shapes

The existing base case RAC energy use and peak demand load shapes would follow typical air conditioner hourly demand profile. Seasonal variations should follow the typical seasonal outdoor dry-bulb temperature variation for each climatic zone over a course of a year. The Load Shapes for this work paper are AC_Cooling-RC which is inclusive of both building type and climate zone.

3.2 Measure Case Load Shapes

The RAC measure would move the typical RAC hourly demand profile lower in all times except when load is zero when compared to the base system. Figure 6 and Figure 7 represent the TOU End Use Energy and Peak Demand factors for air conditioning: cooling RC measures that are embedded within the SCE E3 Calculator[40].

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[39]. Final Report Load Shape Update Initiative, KEMA Inc. with the assistance of JJ Hirsch and Associates and Itron Inc., prepared for the California Public Utilities Commission under contract to PG&E, November 15, 2006, Revised November 17, 2006, page 2-1.

[40]. SCE Demand Side Management Unit Energy Savings, Energy Efficiency & Market Services, Engineering Analysis & Development, Revision 1, October 1, 1992, page 184.

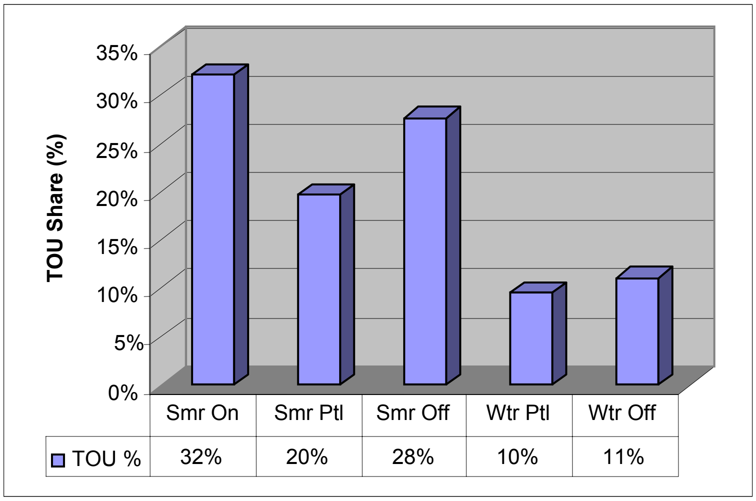

Figure 6: TOU AC Cooling-RC Energy Share

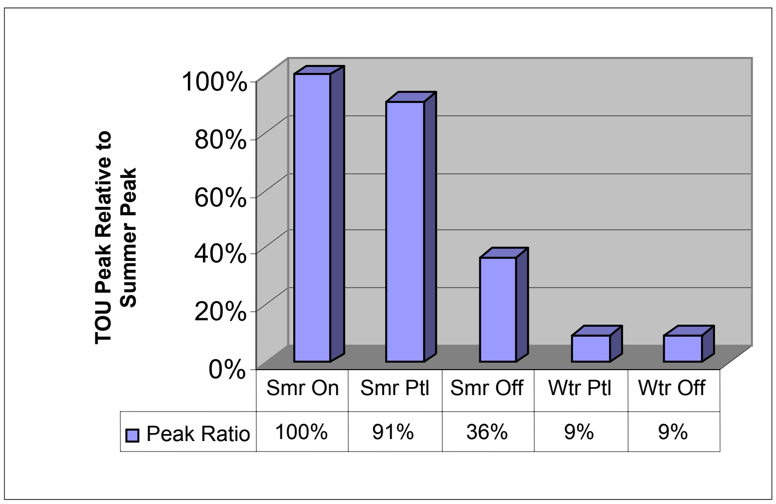

Figure 7: TOU Peak kW Factors

Section 4. Base and Measure Case Costs

This work paper uses WM-RAC of 12,906 BTU/hr and provides average costs sourced from Consumer Reports Magazine for 9,800 to 12,500 BTU/hr units which may under price an actual WM-RAC unit.[41] Since the measures are assumed to be installed in either as ROB or New installation, the installation cost differential between the base case and measure case is zero for the customer.

[41]. Table "Ratings Air Conditioners", Consumer Reports Magazine, July 2007, page 51.

4.1 Base Case Costs

The base case equipment cost is the purchase price of C-RAC unit that meets minimum Federal and State of California appliance standards. Base costs are estimated at $295.00[42].

4.2 Measure Costs

The measure case equipment cost is greater for ES-RAC units that exceed the Federal EER appliance standards by at least 10%. Measure costs are estimated at $376.00**Error! Bookmark not defined.**.

4.3 Incremental Measure Costs

The only cost differences are the extra capital costs of purchasing an Energy Star unit over a non-energy star unit. Thus the incremental cost is estimated at $81.00.

[42]. RAC Calcs.zip: Consumer Reports Mag-Jul 2007-pg 51 Partial Table.xls.

Appendices

Appendix A: RAC EER Design Variance Weighted Mean

RAC Design Variance EER Merge										
	Cells in Blue Arial font are from Title 20 Table B-2				Energy Star Product Search Unique Units (UU)				EER Weighted Mean Factors by Unit Design for Capacity	
			Minimum EER							
Row:	Appliance	Louvered Sides	Effective Jan 1990	Effective Oct 2000	No. of UUs	Adjust-ments to equiv. EERs	Adjust-ed No. of UUs	% of UUs per Cap	Effective Jan 1990	Effective Oct 2000
	Column (A)	(B)	(C)	(D)	(E)	(F)	(G) = (E)+(F)	(H) = (G)/ Subtotal	(I) = (C)*(H)	(J) = (D)*(H)
	For Capacities < 6,000 Btu/hr									
1	RAC	Yes	8.0	9.7	123	None	123	99.2%	7.9	9.6
2	RAC	No	8.0	9.0	1	None	1	0.8%	0.1	0.1
3	RAC Heat Pump	Yes	8.5	9.0	0	None	0	0.0%	0.0	0.0
4	RAC Heat Pump	No	8.0	8.5	0	None	0	0.0%	0.0	0.0
5						**Subtotal:**	**124**	**Weighted EERs:**	**8.0**	**9.7**
	For Capacities ≥ 6,000 - 7,999 Btu/hr									
6	RAC	Yes	8.5	9.7	98	None	98	90.7%	7.7	8.8
7	RAC	No	8.5	9.0	8	2 from Row 10	10	9.3%	0.8	0.8
8	RAC Heat Pump	Yes	8.5	9.0	2	Add 2 to Row 9	0	0.0%	0.0	0.0
9	RAC Heat Pump	No	8.0	8.5	0	None	0	0.0%	0.0	0.0
10						**Subtotal:**	**108**	**Weighted EERs:**	**8.5**	**9.6**
	For Capacities ≥ 8,000 - 13,999 Btu/hr									
11	RAC	Yes	9.0	9.8	310	10 from Row 27	320	58.0%	5.2	5.7
12	RAC	No	8.5	8.5	193	None	193	35.0%	3.0	3.0
13	RAC Heat Pump	Yes	8.5	9.0	20	None	20	3.6%	0.3	0.3
14	RAC Heat Pump	No	8.0	8.5	19	None	19	3.4%	0.3	0.3
15						**Subtotal:**	**552**	**Weighted EERs:**	**8.8**	**9.3**
	For Capacities ≥ 14,000 - 19,999 Btu/hr									
16	RAC	Yes	8.8	9.7	143	None	143	94.7%	8.3	9.2
17	RAC	No	8.5	8.5	3	None	3	2.0%	0.2	0.2
18	RAC Heat Pump	Yes	8.5	9.0	5	None	5	3.3%	0.3	0.3
19	RAC Heat Pump	No	8.0	8.0	0	None	0	0.0%	0.0	0.0

RAC Design Variance EER Merge

Row:	Cells in Blue Arial font are from Title 20 Table B-2		Minimum EER		Energy Star Product Search Unique Units (UU)				EER Weighted Mean Factors by Unit Design for Capacity	
	Appliance	Louvered Sides	Effective Jan 1990	Effective Oct 2000	No. of UUs	Adjust-ments to equiv. EERs	Adjust-ed No. of UUs	% of UUs per Cap	Effective Jan 1990	Effective Oct 2000
	Column (A)	(B)	(C)	(D)	(E)	(F)	(G) = (E)+(F)	(H) = (G)/ Subtotal	(I) = (C)*(H)	(J) = (D)*(H)
20						**Subtotal:**	**151**	**Weighted EERs:**	**8.8**	**9.7**
	For Capacities ≥ 20,000 Btu/hr									
21	RAC	Yes	8.2	8.5	92	None	92	94.8%	7.8	8.1
22	RAC	No	8.2	8.5	0	None	0	0.0%	0.0	0.0
23	RAC Heat Pump	Yes	8.5	8.5	5	None	5	5.2%	0.4	0.4
24	RAC Heat Pump	No	8.0	8.0	0	None	0	0.0%	0.0	0.0
25						**Subtotal:**	**97**	**Weighted EERs:**	**8.2**	**8.5**
	For Casement RACs the only available capacity is 8,000 Btu/hr									
26	Casement-Only RAC	Either	(1)	8.7	0	None	0			
27	Casement-Slider RAC	Either	(1)	9.5	10	Add 10 to Row 11	0			
	Total for all Capacities:				**1032**		**1032**			
Notes:										
(1)	Not a separate class until Oct 2000.									

Upstream CFLs

Introduction

The following Supporting Documentation summarizes the issues encountered with the following CFL savings parameters:

• EUL
• NTG
• Base Wattage
• IMC
• Gross Savings
• Hours of Operation

Summary Issues

• EUL: DEER 2008 uses inappropriate methods to arrive at a proxy estimate, when actual EUL estimates are available.
• NTG: DEER 2008 uses a conjectured value that does not agree with various ex-post evaluations.
• Base Wattage: DEER 2008 uses an invalid comparison to arrive at a proxy estimate, disregards lumen equivalencies. Better comparisons that agree with ex-post evaluation exist.
• IMC: DEER 2008 uses participant cost in place of incremental measure cost.
• Gross Savings: DEER 2008 does not utilize load profiles from ex-post evaluation.
• Hours of Operation: DEER 2008 uses results based on subsets of data to make statistically insignificant changes.

Recommendations

- ### EUL

  DEER 2008 recommends an effective useful life (EUL) estimate that is based on a non-compliant methodology not conforming to standards on approach and precision level as established for EUL studies in the CPUC Protocols. SCE does not recommend the use of this estimate. Instead, SCE recommends the adoption of results from the CPUC-approved retention studies that were designed to achieve CPUC-required precision levels. The DEER 2008 value is of indeterminate (and unknowable) but extremely large standard error and is based on laboratory testing of a small number of bulbs, using only a subset of the bulbs. That is, it is a highly uncertain estimate of one of the factors that affects the effective useful life of CFLs, not the EUL itself. The retention studies, on the other hand, have known and modestly sized standard errors and are designed to estimate the EUL itself in accordance with CPUC Protocols.

  The effective useful life of a measure is the estimated duration at which exactly of the end user. This is exactly what is measured by a retention study. Therefore, SCE proposes to use retention study results for the EUL of CFLs. This is in accordance with CPUC Protocols. SCE recommends the use of 6.25 years for residential CFLs[10] and 2.8 years for non-residential CFLs.[11]

- **NTG**

  DEER 2008 recommends a net-to-gross ratio that tries to forecast the future free-ridership in upstream lighting programs based on unproven assumptions about program and market characteristics. SCE does not recommend the use of this estimate. Instead, SCE recommends the adoption of results from CPUC-approved impact evaluations. The CPUC has defined Net-to-Gross Ratio (NTG) as "a factor representing net program load impacts divided by gross program load impacts that is applied to gross program load impacts to convert them into net program load impacts." That is, it is the portion of program activity that is due to the program, rather than due to other factors; it is not an arbitrary factor in a savings calculation meant to achieve certain policy objectives. Therefore, SCE uses a net-to-gross ratio based on CPUC-approved impact evaluations, rather than conjectures about the effects of market and program factors that do not have ex-post data to support them.

  The draft DEER recommends a value of 0.60 for the net-of-free-ridership (NOFR) of residential CFLs distributed through upstream programs. SCE believes that the draft NOFR values for CFLs lack a substantive basis and are overly conservative. We recommend a market channel weighted value at this time of 0.74 for 2009-11, with individual NOFR numbers to assist in the development of portfolios that maximize cost effective energy savings for California. The current recommended NOFR estimate of 0.74 is net of any free-ridership, ignoring any spillover effects, and hence already making the final savings estimates conservative for the 2009-2011 program cycle.

  Recent studies from other states corroborate the higher NTG estimates. A Connecticut study found a NTG of 1.09, with .06 free ridership and .15 spillover; that is, a NOFR of .94.[12] NMR mentioned that sales in Massachusetts "more than tripled" during program promotion, i.e. net of free-riders of at least 2/3.[13] In New Hampshire, NMR finds a NTG of 0.847 with 0.191 free-ridership; that is, 0.801 NOFR and 0.046 spillover.[14] Focus on Energy found NTGs in Wisconsin by retail channel, including 0.98 for hardware 0.61 for home improvement and 1.18 for grocery and other. The program-wide value is .81 with the NOFR indeterminate from the chosen methodology.[15] The SFEER residential customer survey documents multiple barriers to customers' purchase of additional CFLs, suggesting that a continuing program is needed to reduce these obstacles.[16] The Utility estimate of 0.74 is based upon the latest information with regard to free-ridership for these measures. The SFEER study found distinct free-ridership rates for different retail channels, and then calculated a weighted average of these based on rebated sales volume.[17] This is still a conservative estimate when consumer price is taken into consideration. We recommend DEER provide NOFR values for the market delivery channels for the Upstream Lighting program. As noted above, the documentation supporting the Draft DEER value for 2009-2011 indicates that the recommended NOFR values are by target market, delivery method and measure. Such values should be utilized to provide data that can assist the IOUs in portfolio planning. Regarding Multifamily CFLs, the NTG should be maintained at the value of 0.78 determined by the MFEER study.[18]

o Base Wattage

The 2008 DEER Update Measure Revisions for Residential Interior Lighting uses RLW's 2005 CLASS[6] study results for the average wattage of existing screw-in incandescent bulbs and average wattage of existing CFLs to calculate a ratio of the average wattages and a wattage reduction factor (the ratio minus one). The DEER approach calculates the base case screw-in incandescent wattage by multiplying the CFL wattage by the ratio between the average wattages and the change in wattage by multiplying the CFL wattage by the wattage reduction factor. That is, DEER 2008 recommends a change in wattage based on the ratio between all existing installed CFL wattages and all existing incandescent wattages. Because the SCE programs have the effect of replacing incremental incandescents with new CFLs, rather than changing all incandescents with existing CFLs, SCE recommends instead, methodology that is in agreement with results of the CPUC-approved impact evaluation's assessment of the change in wattage as the incremental incandescent is replaced with a new CFL. The problem with the DEER methodology is that, first, it does not measure what it is supposed to measure, that is, the expected baseline for CFL, and second, it does not make a valid comparison in its use of the CLASS data. By including all non-CFL wattages in the baseline the approach ignores consumer behavior as regards the probability of installing a CFL in any given socket. Fundamentally, the issue is that this approach implicitly assumes a uniform probability distribution of CFL installation across all remaining incandescents, and assumes an equivalent wattage distribution between previous and future CFLs and base cases. With regard to replacement probability distribution, the RLW study showed conclusively that certain room types and fixture types are more likely than others to contain CFLs.[7] With regard to past versus future bulbs, it is entirely possible that many higher-wattage incandescents have already been replaced with CFLs, depressing the average incandescent wattage and inflating the average CFL wattage. In addition, the approach does not factor in lumen equivalency, which adds to the significant weakness in the DEER 2008 approach for wattage assumptions.

The SFEER study looked at the wattage of CFLs and the base they replaced.[19] The study found that incandescent bulbs averaging 64.9 W (800-1099 lumens) were replaced by CFLs with an average wattage of 13.6 W. This is compared to the 64.14 W incandescent replaced by 18.15 W CFL assumed by the DEER team, which is a 33.5% difference, well outside the confidence interval for a "90/10" estimate. That is, the DEER value, which uses a proxy to measure their desired parameter, disagrees with the ex-post evidence of the exact parameter DEER is trying to estimate. The SFEER number is based on making comparisons about actual bulbs that were exchanged. There is some question about the methodology used for the SFEER number regarding bulbs for which the owner did not remember the base wattage, but is surely better than a blind comparison between all incandescents and all CFLs.

Currently, California's Title 20 Appliance Efficiency Regulation uses a lumen equivalency mapping approach. Table K3 of the Title 20 report exhibits the standards for state regulated general service incandescent lamps. Effective January 1st, 2008, the maximum power draw for clear, frost, and soft white incandescent bulbs must comply with Title 20's lumen equivalency requirements as shown in Table K-3. SCE recommends the adoption of these standards as the base incandescent case for 2009-11. This mapping agrees well with the SFEER results: a 950 lumen CFL (at the midpoint between 800 and 1099) would be projected to replace a 66 W incandescent, a 1.7% difference, well within the confidence interval. Furthermore, it is mandated by the State Regulated Code and is thus a legally recognized equivalence.

Table K-3
Standards for State-Regulated General Service Incandescent Lamps

Frost or Clear		
	Maximum Power Use (watts)	
Lumens (L)	**January 1, 2006**	**January 1, 2008**
$L < 340$	(0.0500 * Lumens) + 21	(0.0500 * Lumens) + 21
$340 \leq L < 562$	(0.0500 * Lumens) + 21	38
$562 \leq L < 610$	(0.0500 * Lumens) + 21	(0.2400 * Lumens) – 97
$610 \leq L < 760$	(0.0500 * Lumens) + 21	(0.0500 * Lumens) + 19
$760 \leq L < 950$	(0.0500 * Lumens) + 21	57
$950 \leq L < 1013$	(0.0500 * Lumens) + 21	(0.2000 * Lumens) – 133
$1013 \leq L < 1040$	(0.0500 * Lumens) + 21	(0.0500 * Lumens) + 19
$1040 \leq L < 1300$	(0.0500 * Lumens) + 21	71
$1300 \leq L < 1359$	(0.0500 * Lumens) + 21	(0.2700 * Lumens) – 280
$1359 \leq L < 1520$	(0.0500 * Lumens) + 21	(0.0500 * Lumens) + 19
$1520 \leq L < 1850$	(0.0500 * Lumens) + 21	95
$1850 \leq L < 1900$	(0.0500 * Lumens) + 21	(0.4200 * Lumens) - 682
$L \geq 1900$	(0.0500 * Lumens) + 21	(0.0500 * Lumens) + 21

Table K-3 (Continued)
Standards for State-Regulated General Service Incandescent Lamps

Soft White		
	Maximum Power Use (watts)	
Lumens (L)	January 1, 2006	January 1, 2008
L < 310	(0.0500 * Lumens) + 22.5	(0.0500 * Lumens) + 22.5
310 ≤ L < 514	(0.0500 * Lumens) + 22.5	38
514 ≤ L < 562	(0.0500 * Lumens) + 22.5	(0.2200 * Lumens) – 75
562 ≤ L < 730	(0.0500 * Lumens) + 22.5	(0.0500 * Lumens) + 20.5
730 ≤ L < 909	(0.0500 * Lumens) + 22.5	57
909 ≤ L < 963	(0.0500 * Lumens) + 22.5	(0.2200 * Lumens) – 143
963 ≤ L < 1010	(0.0500 * Lumens) + 22.5	(0.0500 * Lumens) + 20.5
1010 ≤ L < 1250	(0.0500 * Lumens) + 22.5	71
1250 ≤ L < 1310	(0.0500 * Lumens) + 22.5	(0.2500 * Lumens) – 241.5
1310 ≤ L < 1490	(0.0500 * Lumens) + 22.5	(0.0500 * Lumens) + 20.5
1490 ≤ L < 1800	(0.0500 * Lumens) + 22.5	95
1800 ≤ L < 1850	(0.0500 * Lumens) + 22.5	(0.4000 * Lumens) – 625
L ≥ 1850	(0.0500 * Lumens) + 22.5	(0.0500 * Lumens) + 22.5

- **IMC**

  DEER 2008 recommends using participant costs as the incremental measure costs. SCE instead recommends using incremental measure costs as the incremental measure costs.

  The DEER 2008 measure costs update has deviated from past Measure Cost Update studies and used CFL "shelf" pricing to establish measure equipment and incremental measure costs for the upstream program approach; that is, it has supplied a list of upstream participant costs. This approach to measure costs requires that any upstream incentive already reflected in the shelf price be removed to properly reflect the actual measure equipment and incremental measure costs that are used as inputs to the cost-effectiveness analysis in the E3 Calculators. Hence, the utilities have added the specific, upstream measure incentives to the upstream DEER 2008 CFL incremental measure costs to create the proper inputs for the E3 Calculators. The resulting participant costs in the E3 calculators thus match the DEER 2008 Update values for upstream CFLs for the cases that match the utilities programs.

- ## Gross Savings
  While DEER 2008 does not include an explicit load factor, the data do reflect an implicit one. This implicit load factor is significantly higher than the value found in the CFL Metering Study, a CPUC-approved study.[8] This large disagreement with empirical results leads SCE to be suspicious of the Gross Savings values found in DEER. Additionally, SCE does not consider HVAC interactive effects when calculating the demand and energy savings of CFLs installed in residential applications because of lack of ex-post evidence.

- ## Hours of Operation
  DEER 2008 recommends a value for the daily hours of operation that is a recalculation of data from the CFL Metering Study,[9] a CPUC-approved study. The difference is not statistically significant. SCE recommends using the value found in the study, rather than other values that are not statistically different and make selective use of the data. DEER 2008 does not estimate hours of operation for the portion of the bulbs that are purchased for non-residential use.

  The *CFL Metering Study* used light loggers to monitor CFL use in the homes of 375 people in the territories of the California IOUs for six months to one year.[20] The study found an average of 2.34 hours of use for CFLs (Section 4). The study found different hours of use for different rooms. The SFEER study used the results of the study and the specific mix of room locations found in the on-site inspections and determined an average of 2.6 hours of operation per day[21]. DEER 2008 used some of the data from the CFL Metering Study to recalculate the value. The result was not statistically different from the value in the original report. That is, the exercise was not statistically valid and will not be used by SCE. We recommend retaining the 2.34 hours found in the Metering Study. SCE also recommends retaining the hours of operation for non-residential bulbs purchased through the Upstream Lighting Program at 8.8 hours, an average value based on the types of buildings where these bulbs tend to be installed.

- ## In-Service Rate
  Based on the telephone survey, the SFEER study estimates a 76% in-service rate for CFLs purchased during 2004-2005.[22] Adopting this estimate is not recommended. This estimate also does not reflect the necessary time dependency of the in-service rate, but rather assumes that 24% of bulbs do not yield any savings at all. Currently, there are no ex-post studies that provide an accurate estimate (or appropriate proxy estimate) of the in-service rate. Thus, we recommend retaining the default 90% in-service rate found in DEER 2005 in order to account for any bulbs that might be broken or otherwise not yield savings. For non-residential, the 92% installation rate would continue to be used.

6 RLW Analytics. *2005 California Statewide Residential Lighting and Appliance Efficiency Saturation Study.* August 2005.
7 RLW Analytics. *2005 California Statewide Residential Lighting and Appliance Efficiency Saturation Study.* August 2005.

[8] KEMA Inc. *CFL Metering Study*. February 2005.
[9] KEMA Inc. *CFL Metering Study*. February 2005.
[10] Athens Research. *Southern California Edison 1994 Residential CFB Manufacturers' Incentive Program: 2004 Retention Study*. July 2004.
[11] DSRA. *1994 Commercial CFL Manufacturers' Rebate Ninth Year Retention Study*.
[12] United Illuminating. *UI and CL&P Program Savings Documentation for 2006 Program Year.* 2005.
[13] NMR. *Market Progress and Evaluation Report (MPER)For the 2005 Massachusetts ENERGY STAR® Lighting Program. 2003.*
[14] NMR. *Process and Impact Evaluation of the New Hampshire Residential Lighting Program. 2003.*
[15] Focus on Energy. *Comprehensive CFL Market Effects Study— Final Report.* 2007.
[16] Itron, Inc. *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation*. June 29, 2007.
[17] Itron, Inc. *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation*. June 29, 2007.
[18] KEMA, Inc. *Evaluation of the 2004-2005 Statewide Multifamily Rebate Program*. 2007.
[19] Itron, Inc. *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation*. June 29, 2007.
[20] KEMA Inc. *CFL Metering Study*. February 2005.
[21] Itron, Inc. *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation*. June 29, 2007.
[22] Itron, Inc. *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation*. June 29, 2007.

The workpapers below are SCE's major CFL workpapers from the 2006-2008 program cycle. Note that they will be updated as needed for the latest assumptions indicated above and for code and EM&V study updates.

- WPSCRELG0017- Integral (Screw-In) CFLs-Residential
- WPSCRELG0022- Integral (Screw-In) CFLs-Nonresidential

Work Paper WPSCRELG0017 (Integral (Screw-In) CFLs- Residential) follows.

Work Paper WPSCRELG0017
Revision 2

Southern California Edison Company
Design & Engineering Services

Integral (Screw-in) CFLs
Residential

At a Glance Summary

Measure Description	**Integral (Screw-in) CFLs Residential**
Savings Impacts Common Units	Lamp
Customer Base Case Description	Incandescent Lamp
Code Base Case Description	Screw-in Compact Fluorescent Lamp
Costs Common Units	Lamp
Building Type	Residential
Building Vintage	All
Climate Zone	All
Measure Load Shape	CFL-RC
Effective Useful Life (years)	9.4 years
Program Type	Replace on Burnout (ROB)
TOU AC Adjustment	0%
Net-to-Gross Ratio	75% (Subject to completion of the study referenced in this work paper and in accordance with any direction provided by the Commission in the final decision on energy efficiency incentives)
Important Comments	Values in the "At a Glance Summary" section below are rounded representations of full decimal values. The full values will be used when calculating program results for reporting purposes.

Work Paper RunID: WPSCRELG0017.2-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
001	Screw-in CFL 5 Watt <450 Lumens	15.4	0.001	15.4	0.001	$4.98	$4.40	$4.40
002	Screw-in CFL 7 Watt 450 to 799 Lumens	25.4	0.002	25.4	0.002	$4.98	$4.40	$4.40
003	Screw-in CFL 9 Watt 450 to 799 Lumens	23.8	0.002	23.8	0.002	$4.98	$4.40	$4.40
004	Screw-in CFL 10 Watt <450 Lumens	11.5	0.001	11.5	0.001	$4.98	$4.40	$4.40
005	Screw-in CFL 10 Watt 450 to 799 Lumens	23.1	0.002	23.1	0.002	$4.98	$4.40	$4.40
006	Screw-in CFL 10 Watt 800 to 1,099 Lumens	38.4	0.003	38.4	0.003	$4.98	$4.40	$4.40
007	Screw-in CFL 11 Watt <450 Lumens	10.8	0.001	10.8	0.001	$4.98	$4.40	$4.40
008	Screw-in CFL 11 Watt 450 to 799 Lumens	22.3	0.002	22.3	0.002	$4.98	$4.40	$4.40
009	Screw-in CFL 11 Watt 800 to 1,099 Lumens	37.7	0.003	37.7	0.003	$4.98	$4.40	$4.40
010	Screw-in CFL 12 Watt <450 Lumens	10.0	0.001	10.0	0.001	$4.98	$4.40	$4.40
011	Screw-in CFL 12 Watt 450 to 799 Lumens	21.5	0.002	21.5	0.002	$4.98	$4.40	$4.40
012	Screw-in CFL 12 Watt 800 to 1,099 Lumens	36.9	0.003	36.9	0.003	$4.98	$4.40	$4.40
013	Screw-in CFL 13 Watt <450 Lumens	9.2	0.001	9.2	0.001	$4.98	$4.40	$4.40
014	Screw-in CFL 13 Watt 450 to 799 Lumens	20.8	0.002	20.8	0.002	$4.98	$4.40	$4.40
015	Screw-in CFL 13 Watt 800 to 1,099 Lumens	36.1	0.003	36.1	0.003	$4.81	$4.26	$4.26
016	Screw-in CFL 14 Watt 450 to 799 Lumens	20.0	0.002	20.0	0.002	$5.25	$4.64	$4.64

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017	Screw-in CFL 14 Watt 800 to 1,099 Lumens	35.4	0.003	35.4	0.003	$5.25	$4.64	$4.64
018	Screw-in CFL 15 Watt 450 to 799 Lumens	19.2	0.002	19.2	0.002	$5.62	$5.01	$5.01
019	Screw-in CFL 15 Watt 800 to 1,099 Lumens	34.6	0.003	34.6	0.003	$5.62	$5.01	$5.01
020	Screw-in CFL 15 Watt 1,100 to 1,399 Lumens	46.1	0.004	46.1	0.004	$5.62	$5.01	$5.01
021	Screw-in CFL 16 Watt 800 to 1,099 Lumens	33.8	0.003	33.8	0.003	$6.00	$5.39	$5.39
022	Screw-in CFL 16 Watt 1,100 to 1,399 Lumens	45.4	0.004	45.4	0.004	$6.00	$5.39	$5.39
023	Screw-in CFL 17 Watt 450 to 799 Lumens	17.7	0.002	17.7	0.002	$6.74	$6.14	$6.14
024	Screw-in CFL 17 Watt 800 to 1,099 Lumens	33.1	0.003	33.1	0.003	$6.74	$6.14	$6.14
025	Screw-in CFL 17 Watt 1,100 to 1,399 Lumens	44.6	0.004	44.6	0.004	$6.74	$6.14	$6.14
026	Screw-in CFL 18 Watt 450 to 799 Lumens	16.9	0.001	16.9	0.001	$6.74	$6.14	$6.14
027	Screw-in CFL 18 Watt 800 to 1,099 Lumens	32.3	0.003	32.3	0.003	$6.74	$6.14	$6.14
028	Screw-in CFL 18 Watt 1,100 to 1,399 Lumens	43.8	0.004	43.8	0.004	$6.37	$5.77	$5.77
029	Screw-in CFL 19 Watt 450 to 799 Lumens	16.1	0.001	16.1	0.001	$6.73	$6.12	$6.12
030	Screw-in CFL 19 Watt 800 to 1,099 Lumens	31.5	0.003	31.5	0.003	$6.73	$6.12	$6.12
031	Screw-in CFL 19 Watt 1,100 to 1,399 Lumens	43.0	0.004	43.0	0.004	$6.73	$6.12	$6.12
032	Screw-in CFL 20 Watt 800 to 1,099 Lumens	30.7	0.003	30.7	0.003	$7.08	$6.47	$6.47

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033	Screw-in CFL 20 Watt 1,100 to 1,399 Lumens	42.3	0.004	42.3	0.004	$7.08	$6.47	$6.47
034	Screw-in CFL 21 Watt 800 to 1,099 Lumens	30.0	0.003	30.0	0.003	$6.66	$6.05	$6.05
035	Screw-in CFL 21 Watt 1,100 to 1,399 Lumens	41.5	0.004	41.5	0.004	$6.66	$6.05	$6.05
036	Screw-in CFL 22 Watt 800 to 1,099 Lumens	29.2	0.003	29.2	0.003	$6.66	$6.05	$6.05
037	Screw-in CFL 22 Watt 1,100 to 1,399 Lumens	40.7	0.004	40.7	0.004	$6.66	$6.05	$6.05
038	Screw-in CFL 23 Watt 800 to 1,099 Lumens	28.4	0.002	28.4	0.002	$6.66	$6.05	$6.05
039	Screw-in CFL 23 Watt 1,100 to 1,399 Lumens	40.0	0.004	40.0	0.004	$6.66	$6.05	$6.05
040	Screw-in CFL 23 Watt 1,400 to 1,599 Lumens	51.5	0.005	51.5	0.005	$6.66	$6.05	$6.05
041	Screw-in CFL 23 Watt 1,600 to 1,999 Lumens	59.2	0.005	59.2	0.005	$6.66	$6.05	$6.05
042	Screw-in CFL 24 Watt 800 to 1,099 Lumens	27.7	0.002	27.7	0.002	$8.85	$8.24	$8.24
043	Screw-in CFL 24 Watt 1,100 to 1,399 Lumens	39.2	0.003	39.2	0.003	$8.85	$8.24	$8.24
044	Screw-in CFL 24 Watt 1,400 to 1,599 Lumens	50.7	0.004	50.7	0.004	$8.85	$8.24	$8.24
045	Screw-in CFL 24 Watt 1,600 to 1,999 Lumens	58.4	0.005	58.4	0.005	$7.24	$6.63	$6.63
046	Screw-in CFL 25 Watt 800 to 1,099 Lumens	26.9	0.002	26.9	0.002	$8.85	$8.24	$8.24
047	Screw-in CFL 25 Watt 1,100 to 1,399 Lumens	38.4	0.003	38.4	0.003	$8.85	$8.24	$8.24
048	Screw-in CFL 25 Watt 1,400 to 1,599 Lumens	50.0	0.004	50.0	0.004	$8.85	$8.24	$8.24

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049	Screw-in CFL 25 Watt 1,600 to 1,999 Lumens	57.7	0.005	57.7	0.005	$7.24	$6.63	$6.63
050	Screw-in CFL 26 Watt 800 to 1,099 Lumens	26.1	0.002	26.1	0.002	$7.52	$6.92	$6.92
051	Screw-in CFL 26 Watt 1,100 to 1,399 Lumens	37.7	0.003	37.7	0.003	$7.52	$6.92	$6.92
052	Screw-in CFL 26 Watt 1,400 to 1,599 Lumens	49.2	0.004	49.2	0.004	$7.52	$6.92	$6.92
053	Screw-in CFL 26 Watt 1,600 to 1,999 Lumens	56.9	0.005	56.9	0.005	$7.52	$6.92	$6.92
054	Screw-in CFL 27 Watt 800 to 1,099 Lumens	25.4	0.002	25.4	0.002	$8.10	$7.50	$7.50
055	Screw-in CFL 27 Watt 1,100 to 1,399 Lumens	36.9	0.003	36.9	0.003	$8.10	$7.50	$7.50
056	Screw-in CFL 27 Watt 1,400 to 1,599 Lumens	48.4	0.004	48.4	0.004	$8.10	$7.50	$7.50
057	Screw-in CFL 27 Watt 1,600 to 1,999 Lumens	56.1	0.005	56.1	0.005	$8.10	$7.50	$7.50
058	Screw-in CFL 28 Watt 1,100 to 1,399 Lumens	36.1	0.003	36.1	0.003	$8.10	$7.50	$7.50
059	Screw-in CFL 28 Watt 1,400 to 1,599 Lumens	47.7	0.004	47.7	0.004	$8.10	$7.50	$7.50
060	Screw-in CFL 28 Watt 1,600 to 1,999 Lumens	55.3	0.005	55.3	0.005	$8.10	$7.50	$7.50
061	Screw-in CFL 29 Watt 1,100 to 1,399 Lumens	35.4	0.003	35.4	0.003	$9.26	$8.65	$8.65
062	Screw-in CFL 29 Watt 1,400 to 1,599 Lumens	46.9	0.004	46.9	0.004	$9.26	$8.65	$8.65
063	Screw-in CFL 29 Watt 1,600 to 1,999 Lumens	54.6	0.005	54.6	0.005	$9.26	$8.65	$8.65
064	Screw-in CFL 30 Watt 1,100 to 1,399 Lumens	34.6	0.003	34.6	0.003	$9.26	$8.65	$8.65

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065	Screw-in CFL 30 Watt 1,400 to 1,599 Lumens	46.1	0.004	46.1	0.004	$9.26	$8.65	$8.65
066	Screw-in CFL 30 Watt 1,600 to 1,999 Lumens	53.8	0.005	53.8	0.005	$9.26	$8.65	$8.65
067	Screw-in CFL 30 Watt 2,000 to 2,599 Lumens	69.2	0.006	69.2	0.006	$9.26	$8.65	$8.65
068	Screw-in CFL 31 Watt 1,100 to 1,399 Lumens	33.8	0.003	33.8	0.003	$9.19	$6.97	$6.97
069	Screw-in CFL 31 Watt 1,400 to 1,599 Lumens	45.4	0.004	45.4	0.004	$9.19	$6.97	$6.97
070	Screw-in CFL 31 Watt 1,600 to 1,999 Lumens	53.0	0.005	53.0	0.005	$9.19	$6.97	$6.97
071	Screw-in CFL 32 Watt 1,100 to 1,399 Lumens	33.1	0.003	33.1	0.003	$9.19	$6.97	$6.97
072	Screw-in CFL 32 Watt 1,400 to 1,599 Lumens	44.6	0.004	44.6	0.004	$9.19	$6.97	$6.97
073	Screw-in CFL 32 Watt 1,600 to 1,999 Lumens	52.3	0.005	52.3	0.005	$9.19	$6.97	$6.97
074	Screw-in CFL 33 Watt 1,100 to 1,399 Lumens	32.3	0.003	32.3	0.003	$9.19	$6.97	$6.97
075	Screw-in CFL 33 Watt 1,400 to 1,599 Lumens	43.8	0.004	43.8	0.004	$9.19	$6.97	$6.97
076	Screw-in CFL 33 Watt 1,600 to 1,999 Lumens	51.5	0.005	51.5	0.005	$9.19	$6.97	$6.97
077	Screw-in CFL 34 Watt 1,100 to 1,399 Lumens	31.5	0.003	31.5	0.003	$9.19	$6.97	$6.97
078	Screw-in CFL 34 Watt 1,400 to 1,599 Lumens	43.0	0.004	43.0	0.004	$9.19	$6.97	$6.97
079	Screw-in CFL 34 Watt 1,600 to 1,999 Lumens	50.7	0.004	50.7	0.004	$9.19	$6.97	$6.97
080	Screw-in CFL 35 Watt 1,400 to 1,599 Lumens	42.3	0.004	42.3	0.004	$9.19	$6.97	$6.97

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081	Screw-in CFL 35 Watt 1,600 to 1,999 Lumens	50.0	0.004	50.0	0.004	$9.19	$6.97	$6.97
082	Screw-in CFL 35 Watt 2,000 to 2,599 Lumens	65.3	0.006	65.3	0.006	$9.19	$6.97	$6.97
083	Screw-in CFL 36 Watt 1,400 to 1,599 Lumens	41.5	0.004	41.5	0.004	$9.19	$6.97	$6.97
084	Screw-in CFL 36 Watt 1,600 to 1,999 Lumens	49.2	0.004	49.2	0.004	$9.19	$6.97	$6.97
085	Screw-in CFL 36 Watt 2,000 to 2,599 Lumens	64.6	0.006	64.6	0.006	$9.19	$6.97	$6.97
086	Screw-in CFL 37 Watt 1,400 to 1,599 Lumens	40.7	0.004	40.7	0.004	$12.77	$10.55	$10.55
087	Screw-in CFL 37 Watt 1,600 to 1,999 Lumens	48.4	0.004	48.4	0.004	$12.77	$10.55	$10.55
088	Screw-in CFL 37 Watt 2,000 to 2,599 Lumens	63.8	0.006	63.8	0.006	$12.77	$10.55	$10.55
089	Screw-in CFL 38 Watt 1,400 to 1,599 Lumens	40.0	0.004	40.0	0.004	$12.77	$10.55	$10.55
090	Screw-in CFL 38 Watt 1,600 to 1,999 Lumens	47.7	0.004	47.7	0.004	$12.77	$10.55	$10.55
091	Screw-in CFL 38 Watt 2,000 to 2,599 Lumens	63.0	0.006	63.0	0.006	$12.77	$10.55	$10.55
092	Screw-in CFL 38 Watt 2,600 to 3,599 Lumens	86.1	0.008	86.1	0.008	$12.77	$10.55	$10.55
093	Screw-in CFL 39 Watt 1,400 to 1,599 Lumens	39.2	0.003	39.2	0.003	$12.77	$10.55	$10.55
094	Screw-in CFL 39 Watt 1,600 to 1,999 Lumens	46.9	0.004	46.9	0.004	$12.77	$10.55	$10.55
095	Screw-in CFL 39 Watt 2,000 to 2,599 Lumens	62.3	0.005	62.3	0.005	$12.77	$10.55	$10.55
096	Screw-in CFL 39 Watt 2,600 to 3,599 Lumens	85.3	0.007	85.3	0.007	$12.77	$10.55	$10.55

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097	Screw-in CFL 40 Watt 1,600 to 1,999 Lumens	46.1	0.004	46.1	0.004	$12.77	$10.55	$10.55
098	Screw-in CFL 40 Watt 2,000 to 2,599 Lumens	61.5	0.005	61.5	0.005	$12.77	$10.55	$10.55
099	Screw-in CFL 40 Watt 2,600 to 3,599 Lumens	84.6	0.007	84.6	0.007	$12.77	$10.55	$10.55
100	Screw-in CFL 41 Watt 1,600 to 1,999 Lumens	45.4	0.004	45.4	0.004	$12.77	$10.55	$10.55
101	Screw-in CFL 41 Watt 2,000 to 2,599 Lumens	60.7	0.005	60.7	0.005	$12.77	$10.55	$10.55
102	Screw-in CFL 41 Watt 2,600 to 3,599 Lumens	83.8	0.007	83.8	0.007	$12.77	$10.55	$10.55
103	Screw-in CFL 42 Watt 1,600 to 1,999 Lumens	44.6	0.004	44.6	0.004	$12.77	$10.55	$10.55
104	Screw-in CFL 42 Watt 2,000 to 2,599 Lumens	60.0	0.005	60.0	0.005	$12.77	$10.55	$10.55
105	Screw-in CFL 42 Watt 2,600 to 3,599 Lumens	83.0	0.007	83.0	0.007	$12.77	$10.55	$10.55
106	Screw-in CFL 43 Watt 1,600 to 1,999 Lumens	43.8	0.004	43.8	0.004	$12.77	$10.55	$10.55
107	Screw-in CFL 43 Watt 2,000 to 2,599 Lumens	59.2	0.005	59.2	0.005	$12.77	$10.55	$10.55
108	Screw-in CFL 43 Watt 2,600 to 3,599 Lumens	82.2	0.007	82.2	0.007	$12.77	$10.55	$10.55
109	Screw-in CFL 44 Watt 1,600 to 1,999 Lumens	43.0	0.004	43.0	0.004	$12.77	$10.55	$10.55
110	Screw-in CFL 44 Watt 2,000 to 2,599 Lumens	58.4	0.005	58.4	0.005	$12.77	$10.55	$10.55
111	Screw-in CFL 44 Watt 2,600 to 3,599 Lumens	81.5	0.007	81.5	0.007	$12.77	$10.55	$10.55
112	Screw-in CFL 45 Watt 1,600 to 1,999 Lumens	42.3	0.004	42.3	0.004	$12.77	$10.55	$10.55

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113	Screw-in CFL 45 Watt 2,000 to 2,599 Lumens	57.7	0.005	57.7	0.005	$12.77	$10.55	$10.55
114	Screw-in CFL 45 Watt 2,600 to 3,599 Lumens	80.7	0.007	80.7	0.007	$12.77	$10.55	$10.55
115	Screw-in CFL 46 Watt 1,600 to 1,999 Lumens	41.5	0.004	41.5	0.004	$12.77	$10.55	$10.55
116	Screw-in CFL 46 Watt 2,000 to 2,599 Lumens	56.9	0.005	56.9	0.005	$12.77	$10.55	$10.55
117	Screw-in CFL 46 Watt 2,600 to 3,599 Lumens	79.9	0.007	79.9	0.007	$12.77	$10.55	$10.55
118	Screw-in CFL 47 Watt 1,600 to 1,999 Lumens	40.7	0.004	40.7	0.004	$12.77	$10.55	$10.55
119	Screw-in CFL 47 Watt 2,000 to 2,599 Lumens	56.1	0.005	56.1	0.005	$12.77	$10.55	$10.55
120	Screw-in CFL 47 Watt 2,600 to 3,599 Lumens	79.2	0.007	79.2	0.007	$12.77	$10.55	$10.55
121	Screw-in CFL 48 Watt 1,600 to 1,999 Lumens	40.0	0.004	40.0	0.004	$12.77	$10.55	$10.55
122	Screw-in CFL 48 Watt 2,000 to 2,599 Lumens	55.3	0.005	55.3	0.005	$12.77	$10.55	$10.55
123	Screw-in CFL 48 Watt 2,600 to 3,599 Lumens	78.4	0.007	78.4	0.007	$12.77	$10.55	$10.55
124	Screw-in CFL 49 Watt 1,600 to 1,999 Lumens	39.2	0.003	39.2	0.003	$12.77	$10.55	$10.55
125	Screw-in CFL 49 Watt 2,000 to 2,599 Lumens	54.6	0.005	54.6	0.005	$12.77	$10.55	$10.55
126	Screw-in CFL 49 Watt 2,600 to 3,599 Lumens	77.6	0.007	77.6	0.007	$12.77	$10.55	$10.55
127	Screw-in CFL 50 Watt 2,000 to 2,599 Lumens	53.8	0.005	53.8	0.005	$12.77	$10.55	$10.55
128	Screw-in CFL 50 Watt 2,600 to 3,599 Lumens	76.9	0.007	76.9	0.007	$12.77	$10.55	$10.55

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129	Screw-in CFL 50 Watt 3,600 to 4,599 Lumens	115.3	0.010	115.3	0.010	$12.77	$10.55	$10.55
130	Screw-in CFL 51 Watt 2,000 to 2,599 Lumens	53.0	0.005	53.0	0.005	$12.77	$10.55	$10.55
131	Screw-in CFL 51 Watt 2,600 to 3,599 Lumens	76.1	0.007	76.1	0.007	$12.77	$10.55	$10.55
132	Screw-in CFL 51 Watt 3,600 to 4,599 Lumens	114.5	0.010	114.5	0.010	$12.77	$10.55	$10.55
133	Screw-in CFL 52 Watt 2,000 to 2,599 Lumens	52.3	0.005	52.3	0.005	$12.77	$10.55	$10.55
134	Screw-in CFL 52 Watt 2,600 to 3,599 Lumens	75.3	0.007	75.3	0.007	$12.77	$10.55	$10.55
135	Screw-in CFL 52 Watt 3,600 to 4,599 Lumens	113.8	0.010	113.8	0.010	$12.77	$10.55	$10.55
136	Screw-in CFL 53 Watt 2,000 to 2,599 Lumens	51.5	0.005	51.5	0.005	$12.77	$10.55	$10.55
137	Screw-in CFL 53 Watt 2,600 to 3,599 Lumens	74.6	0.007	74.6	0.007	$12.77	$10.55	$10.55
138	Screw-in CFL 53 Watt 3,600 to 4,599 Lumens	113.0	0.010	113.0	0.010	$12.77	$10.55	$10.55
139	Screw-in CFL 54 Watt 2,000 to 2,599 Lumens	50.7	0.004	50.7	0.004	$12.77	$10.55	$10.55
140	Screw-in CFL 54 Watt 2,600 to 3,599 Lumens	73.8	0.006	73.8	0.006	$12.77	$10.55	$10.55
141	Screw-in CFL 54 Watt 3,600 to 4,599 Lumens	112.2	0.010	112.2	0.010	$12.77	$10.55	$10.55
142	Screw-in CFL 55 Watt 2,000 to 2,599 Lumens	50.0	0.004	50.0	0.004	$12.77	$10.55	$10.55
143	Screw-in CFL 55 Watt 2,600 to 3,599 Lumens	73.0	0.006	73.0	0.006	$12.77	$10.55	$10.55
144	Screw-in CFL 55 Watt 3,600 to 4,599 Lumens	111.5	0.010	111.5	0.010	$12.77	$10.55	$10.55

Work Paper RunID: WPSCRELG0017.2-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
145	Screw-in UL Rated CFL 7 Watt <450 Lumens	13.8	0.001	13.8	0.001	$4.98	$4.40	$4.40

Document Revision History

Revision #	Date	Author/Affiliation	Description of Changes
Revision 0	March 2007		Original work paper short form WPSCRELG0017.0.
Revision 1	September 2007		• Split original work paper into compact fluorescent lamps (CFL) groups • Expanded to final work paper template format • Measure equipment costs added • Net-to-gross ratio (NGR) reduced from 80% to 75% (Subject to completion of the study referenced in this work paper and in accordance with any direction provided by the Commission in the final decision on energy efficiency incentives)
Revision 2	February 2009	Selya J. Arce/SP&TS	• Added new measure (WP Run ID 145) • The 13 watt UL Rated CFL, 800 to 1099 lumens measure is mapped to WPSCRELG0017.2-015 • Revision 2 documents the UL Rated CFLs to be the same as the spiral CFLs.

Note: The information provided in this work paper was developed using the best available technical resources at the time this document was prepared.

Table of Contents

List of Tables

List of Figures

Section 1. General Measure and Baseline Data

1.1 Measure Description and Background

Screw-in compact fluorescent lamps (CFL) consist of two main parts: A gas-filled tube and an electronic ballast. Electric current flows from the ballast through the gas, causing it to emit ultraviolet light. The ultraviolet light then excites a white phosphor coating on the inside of the tube, making it emit visible light. This measure replaces incandescent lamps. An incandescent lamp is also a source of artificial light that works through a different process known as incandescence. In the incandescent process, an electrical current passes through a thin filament heating it and causing it to become excited and release photons. Incandescent lamps are less efficient than CFLs because incandescent lamps convert approximately 90% of the energy they consume into heat compared to approximately 30% for a CFL. Modern CFLs typically have a life span of between 6,000 and 15,000 hours. CFL wattages covered by this work paper range in values from 5 watts through 55 watts with lumen rages from under 450 lumens through 4,599 lumens replacing incandescent lamps with wattages that range from under 24 watts through 500 watts with matching lumen ranges. The measures discussed in this work paper are integral (screw in) compact fluorescent lamps and the UL Rated CFLs are considered the same as the spiral CFLs.

1.2 DEER Differences Analysis

The 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report (Itron 2005)[43], December 2005 contains energy savings for screw-in compact fluorescent lamps (CFL) measures that range from 13 watts through 40 watts identified as measures D03-801 through D03-837. These measures are contained in Table 2-1: 20004-05 DEER Residential CFL Lamp Measures and Table 2-2: 2004-05 DEER Residential CFL Measure IDs and Savings Estimates on pages 2-4 and 2-5. As explained on page 2-2 of the DEER report*,* the measure savings in these tables are based on several factors that include the calculation of demand savings based on a matching of base technologies with CFL measures, calculating the delta watts, and then multiplying the result by an In-Service Rate and Peak Hour Load Share. The calculation of energy savings is accomplished in a similar manner, calculating the delta watts and multiplying the results by an In Service Rate and hours of daily use or annual operating hours, however a Peak Hour Load Share is not applied to the energy savings calculation.

As explained in Section 3 on Load Shapes, SCE has determined that the Peak Demand Saving used in calculating demand savings in the current version of DEER is no longer appropriate. Due to this change and the fact that the wattages and lumen ranges of many of the measures in the upstream program are not contained in the DEER tables a simplified mapping system was

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[43] Itron, Inc., JJ Hirsch & Associates, Synergy Consulting, and Quantum, Inc., "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report," December 2005, p. 2-4.

developed patterned after the DEER methodology and a mapping system developed by Energy Star® which is explained further in Section 1.5. SCE then recalculated each of the measure energy impacts with a Peak Hour Load Share of 7.5% [0.075]

DEER measure costs were used whenever possible. As explained further below in Section 4, there are several measures covered by this work paper that could not be matched to measures in DEER. In those instances, the closest available costs were used.

1.3 Codes and Standards Requirements Analysis

There are no current code requirements applicable to this measure through 2007. However, starting in January 2008, changes to California's Title 20 requirements become effective and will affect the Above Code baselines, but no studies are available to substantiate the timing of the market penetration of the new lamps. Therefore, no code related adjustments were made.

1.4 EM&V, Market Potential, and Other Studies

The most directly applicable study for residential upstream lighting is the *2004/2005 Statewide Residential Retrofit Single-Family Energy Efficiency Rebate Evaluation* (Itron 2007)[44]. Sections 5 and 6 of this study provide an updated analysis of the upstream CFL program covered by this work paper. Itron gathered general energy efficiency data from a telephone survey (n=4,718), with a portion being asked in-depth questions about residential lighting (n=1000), an on-site inspection (n=100) and surveys of manufacturers and retailers.

Delta Wattage Assumption (ΔW): The Itron 2007 study developed ΔkW assumptions based on lumens using data from the on-site inspections[45]. Rather than determining a base wattage from which to calculate the ΔkW for each bulb, they calculated an average ΔkW for various lumen ranges. That is, a 13W and a 14W CFL of the same luminosity would be assumed to have the same average ΔkW. Unfortunately, lamps with output of 1,100 to 2,599 lumens were considered as one category, even though that range includes the lumen output of 75W, 100W, and 150W incandescent bulbs replacements. The study results were used, together with the number of non specialty CFLs from each lumen category sold under the 2006 SCE Residential Upstream Lighting Program, to determine a base-wattage assumption. The ΔW assumptions were drawn from the study. Using program data, the wattages of all the bulbs in each lumen category were summed to find the average wattage of CFLs in that category. The average wattage was added to the ΔW to find a base wattage for each lumen category as shown in [Equation 1]:

[Equation 1] $$\overline{\Delta W} = \frac{\Sigma(W_{base} - W_{new})}{n} \rightarrow \overline{W_{base}} = \frac{\Sigma W_{new}}{n} + \overline{\Delta W} = \overline{W_{new}} + \overline{\Delta W}$$

[44] Itron, Inc., 2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation, June 29, 2007, Sections 5 and 6.

[45] Ibid., 6-6.

In addition, the same calculations were done for all of the bulbs in the 1100-2599 lumen range, using weighted averages based on the number of bulbs that were sold under the 2006 program in each category. The results are contained in

Table 19.

Table 19. Base Wattage Assumptions

Lumen Range	SCE Base Wattage (Energy Star)	Average CFL Wattage (SCE 2006 Program)	SCE Average Delta W	SFEER Delta W	Inferred Base Wattage
0-799	40	9.0	31.0	46.8	55.8
800-1099	60	13.8	46.2	51.3	65.1
1100-1599	75	19.2	55.8	68.5	87.7
1600-2000	100	23.9	76.1	68.5	92.4
2000-2599	150	30.0	120.0	68.5	98.5
1100-2599	96.6	23.2	73.4	68.5	91.7

*This category is based on weighted averages for the three smaller categories

In each case the ENERGY STAR® wattage equivalence used in the DEER report and the program assumptions is more conservative, except for the 1600-1999 and 2000-2599 lumen range. This is most likely due to the fact that such a large lumen range was used. For the grouped 1100-2599 lumen category, the difference between the effective SCE base wattage and the inferred base wattage based on SFEER is 5.3%, well within an expected 10% error bound on the SFEER estimate. This exercise was only meant to demonstrate that the program assumptions, based on ENERGY STAR®, are reasonable and somewhat conservative. The survey relied on self-reported data about what light bulb had preceded an existing light bulb, which may not be highly reliable data. This exercise is not meant to support an increase in the base wattage assumption. We recommend maintaining the DEER equivalence over the Itron finding because it is more conservative and more specific to the lumen range of a bulb.

Net-to-Gross Assumption: To determine the net-to-gross ratio (NTG) the study relied on surveys of retailers and manufacturers. This was due to the fact that in the telephone survey only 24% of respondents who had purchased CFLs during the program were aware they had received a discount, and so direct self-reporting data were scarce. This is characteristic of upstream programs where it is difficult to adopt standard end-use-based survey methodologies for determining a net-to-gross ratio. Hence, in the surveys of retailers and manufacturers, the study asked respondents to estimate free ridership based on their sales data for various retail channels. Although the number of respondents was very small in many cases, we accept this because the respondents represented a large portion of the sales volume in that retail channel. The study found distinct free-ridership rates for different retail channels, and then calculated a weighted average of these based on rebated sales volume during 2004-05. The overall free-ridership for Southern California Edison (SCE) was calculated to be 33%, yielding a 0.67 NTG for 2004-05. Of the 24% of those surveyed who remembered receiving a discount, 63% were somewhat likely, not very likely, or very unlikely to purchase a CFL in the absence of the discount, and thus demonstrated some influence by the program[46]. The 0.67 NTG value is close to the value determined by the retailer and manufacturer survey data so the two different methodologies corroborate one another.

[46] Ibid., 5-23.

Because the study NTG results are retail channel specific and the Upstream Lighting program retail channel distribution of CFLs has shifted, the NTG was calculated using weights developed from 2006 program data. Weights were calculated using proportions of sales volume, dollar amount paid by the utility and energy savings for the utility. The results are contained in Table 20.

Table 20. Net-to-Gross Values by Distribution Channel

Channel	Units	Dollars	kWh	SFEER 04/05	Channel Free-ridership
Big Box	8.5%	6.6%	6.2%	18.0%	75%
Discount	19.2%	20.2%	20.4%	12.0%	3%
Drug	5.5%	5.6%	5.4%	4.0%	41%
Grocery	56.4%	57.4%	57.6%	51.0%	16%
Home Improvement	8.1%	7.8%	8.1%	12.0%	66%
Small Hardware	1.4%	1.3%	1.3%	2.0%	52%
Other	0.9%	0.9%	1.0%	1.0%	38%
Total	100.0%	100.0%	100.0%	100.0%	
Parameter Free-ridership	24.8%	23.4%	23.2%	33.4%	
NTG	0.75	0.77	0.77	0.67	

Weighting by dollars or energy saved yields a slightly higher NTG, but the figures are quite similar and SCE recommends using the 0.75 NTG determined using the methodology used in the study.

In-service factor/first year installation rate: Based on the telephone survey, the Itron 2007 study estimates a 76% in-service rate for CFLs purchased during 2004-2005[47]. Adopting this estimate is not recommended. The estimate was based on 100 on-site inspections of the homes of telephone survey respondents who volunteered to partake in the on-site portion. This was not a representative sample (on-site participants on average had 63% more CFLs installed per home than phone survey participants). Additionally, the estimate disregards burned out CFLs, which should be included in the in-service rate as it is assumed they have been accounted for in the shortened EUL estimate. Although the phone survey estimated a small number of bulbs had burned out, this assertion was based on inference as no question directly asked all respondents about burn-outs. This estimate also does not reflect the necessary time dependency of the in-service rate. Thus, we recommend retaining the default 90% in-service rate found in DEER.

Hours of Operation: The *CFL Metering Study* (KEMA 2005). Light loggers monitored CFL use in the homes of 375 people in the territories of the California IOUs for six months to one year. The study found an average of 2.34 hours of use for CFLs (Section 4). The study found different hours of use for different rooms. The Itron 2007 study used the results of the study and

[47] Ibid., 6-6

the specific mix of room locations found in the on-site inspections and determined an average of 2.6 hours of operation per day[48]. We recommend retaining the 2.34 hours found in the Metering Study due to unknown location mix of the installed bulbs in the 2006 program.

Effective Useful Life: The program assumes DEER effective useful life (EUL) for screw-in CFLs that is 9.4 years and is based on 8,000 hours of manufactured rated bulb life given the average 2.34 hours of operation. In order to determine the average EUL for bulbs we used 2006 program data on manufacturer- rated bulb-life hours. The rated life was summed for the different bulb types used, weighting by the sales volume of the bulb type. In 2006, 0.50% of bulbs were rated for 5,000 hours, 3.5% for 6,000 hours, 19% for 8,000 hours and 77% for 10,000 hours. This yielded an average rated life of 9,530 hours. Using the operating hours assumption described above, this yields an EUL of 11.4 years. Southern California Edison recommends retaining the DEER assumption of 9.4 years due to decreased life caused by on-off stress, heat and other CFL savings retention issues that remain to be explored in a future study.

Residential/Non-Residential Split: Currently there are no studies available that directly measure the proportion of upstream rebated lighting products purchased for commercial use. This work paper assumes 10% of the measures purchased are for commercial applications. To validate this assumption, we used data gathered in a previous manufacture buy-down program. The 1994 Compact Fluorescent Lamp Manufacturers' Rebate Program provided financial incentives directly to CFL manufacturers to sell compact fluorescent equipment in Southern California Edison territory at discounted prices. As part of the program, consumer bounce–back cards collected basic information for the CFL product usage. The bounce back card included a question on use of the purchased product for business or home use. The responses to this question are provided in Table 3 as both unweighted and weighted proportions, where the weights are based on the number of CFLs purchased. Two questions were used to calculate the weighted proportions: weighted proportions based on responses to either question on "number of CFL bulbs purchased" (Q7) or "number of CFLs by location used(Q5 a-g)"; and weighted proportions based on "number of bulbs purchased (Q7) where information on location was unknown. Thus column X in Table 3 is based on an amalgam of weight proportions sensitive to location and records that could only be weighted with respect to bulb count.

[48] Ibid., 6-9

Table 21. 1994 CFL Manufacturers Bounce Back Card Survey

1994 CFL Manufacturer's Bounce Back Card Survey						
Is this Compact Fluorescent Bulb for your Home or Business?						
Source Question *	Column X: No. of bulbs and bulbs with location		Column Y: No. of bulbs		Column Z: No. of Cards	
	CFL(c)	Wtd.Percent	CFL(b)	Wtd.Percent	CFL(a)	Percent
Business	5,860	16%	122	11%	1,931	10%
Household	30,567	81%	934	86%	16,424	88%
Household/Business	1,350	4%	33	3%	272	1%
TOTAL	37,777		1,089		18,627	
Percent Business		19%		14%		12%

*Column X: Q7- How Many CFLs Purchased or Q5A-Q5G - No. of CFLs in a different location
Column Y: Q7- How Many CFLs Purchased
CFL(c) and CFL(b) are weighted counts by number of CFLs purchased. CFL(a) is unweighted count of cards.

As shown in Table 21 at least 12% or as high as 19% bulbs purchased through the Manufacturers' Rebate program were for commercial use, hence supporting the conservative program planning estimate of 10%. Future EM&V study needs to update this proportion for the Upstream lighting program measures assumed to be used in commercial application as well.

Incandescent Equivalency: The CFL to incandescent equivalency assumptions made in this work paper can be validated by creating a metric using available data from field observations. This metric is the CFL–to-incandescent ratio, which tells us the observed relationship between the wattages of CFLs and wattages of incandescent lamps they replaced. The equivalence need not be based on wattage alone but rather can be based on lumen output as is assumed in this work paper. SCE compared the CFL to incandescent ratio implied by the ENERGY STAR® Light Output Equivalency Table (Section 1.5 below) to the ratio calculated using the results of the KEMA CFL Metering Study (Table 22). For the ENERGY STAR® equivalence, the categories are based on lumen levels; for the CFL Metering Study they are based on incandescent base wattage. In each case, a range of CFL wattages fall into each category, and so minimum and maximum value were calculated for each category and the mean was chosen. The weighted average was then calculated based on 2006 program volume for the ENERGY STAR® equivalence and from KEMA's reported relative frequency. The aggregated CFL to incandescent ratio from the ENERGY STAR® chart is 0.267 and that for the CFL Metering Study was 0.254. This is a difference of 5%. This suggests that the lumen mapping method recommended by ENERGY STAR® roughly approximates the wattage matching that KEMA observed in the field.

Table 22. Incandescent Bulbs Replaced by CFLs from the KEMA CFL Metering Study

Original Incandescent Wattage	Number of Monitored Fixtures with Replacement CFLs	Percent of Monitored Fixtures	Typical CFL Replacement Wattage
60	250	57%	13-17
75	84	19%	18-22
40	55	12%	9-12
100	53	12%	23-26

Table 23. Summary of Market Parameters

Measure Parameter	Ex-Ante Value	Revised Ex-Ante Value
ΔkW	**ENERGY STAR® lumen equivalents**	No change
Hours of Operation	2.34 hrs/day	2.34 hrs/day
Net-to-Gross Ratio	0.80	0.75
Effective Useful Life	9.4 years	9.4 years
In-service Rate	90%	90%

1.5 Base Cases for Savings Estimates: Existing and Above Code

The existing equipment replaced by these measures are incandescent lamps in the range of 15 watts through 500 watts. Base measures are mapped to replacement CFLs as described in Table 24

Table 24. Mapping of Base Wattages to CFLs by Lumen Equivalency

BASE WATTS	LUMEN RANGE		SOURCE
	≤	≥	
≥24	0	249	extrapolated
25	250	449	extrapolated
40	450	799	Energy Star®
60	800	1,099	Energy Star®
75	1,100	1,399	Energy Star®
90	1,400	1,599	interpolated
100	1,600	1,999	Energy Star
120	2,000	2,599	interpolated
150	2,600	3,599	Energy Star®
200	3,600	4,599	extrapolated
500	4,600		extrapolated

Table 6 is an expansion of the Energy Star® CFL/Incandescent Equivalency Chart reproduced below in Table 25[49].

Table 25. Energy Star® Light Output Equivalent

LIGHT OUTPUT EQUIVALENCY

To determine which ENERGY STAR qualified light bulbs will provide the same amount of light as your current incandescent light bulbs, consult the following chart:

INCANDESCENT LIGHT BULBS WATTS	MINIMUM LIGHT OUTPUT LUMENS	COMMON ENERGY STAR QUALIFIED LIGHT BULBS WATTS
40	450	9-13
60	800	13-15
75	1,100	18-25
100	1,600	23-30
150	2,600	30-52

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[49] Energy Star® CFL/Incandescent Equivalency Chart which can be found at http://www.energystar.gov/index.cfm?c=cfls.pr_cfls

1.6 Base Cases and Measure Effective Useful Lives

A measure Effective Useful Life (EUL) of 9.4 years is used for these measures are based on EULs for DEER MeasureIDs D03-801 to D03-818 All Screw-in CFLs – Residential located in Table 11-4: Non-Weather Sensitive – Lighting EULs, in Section 11 of the *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report*[50]. See Section 1.4 EM&V, Market Potential, and Other Studies for discussion.

1.7 Net-to-Gross Ratios for Different Program Strategies

Table 26 summarizes all applicable net-to-gross ratios for programs that may be used by this measure.

Table 26. Net-to-Gross Ratios

Program Approach	NTG
Upstream Lighting	0.75

The net-to-gross (NTG) ratio used for these measures is based on Edison's evaluation of actual measure distributions in combination with the methodology outlined in the *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation,* June 29, 2007.

Section 2. Calculation Methods

2.1 Energy Savings Estimation Methodologies

The annual energy savings and demand reduction formulas follow the calculation methods used in Section 2 of the *2004–2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, December 2005*[51], specifically:

ΔWatts/unit:

The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit.

ΔWatts/unit = *Base Watts/unit - Energy Efficient Unit Watts*

Example: *ΔWatts/unit = 100 Watts/unit - 54 Watts / units = 46 Watts*

Annual Energy Savings:

[50] Itron 2005, 11-8

[51] Ibid., 2-2, 2-3

$$\text{Energy Savings [kWh/Unit]} = \frac{(\Delta\text{Watts/unit}) \times (\text{hours/day}) \times (\text{days/year}) \times (\text{In Service Rate})}{1{,}000 \text{ Watts / kW}}$$

$$\textit{Example: Energy Savings} = \frac{(46 \text{ Watts})(2.34/\text{hrs / day})(365 \text{ days / year}) \times .90}{1{,}000 \text{ Watt / kW}} = 35.4 \text{ kWh}$$

2.2 Demand Reduction Estimation Methodologies

The annual energy savings and demand reduction formulas follow the calculation methods used in Section 2 of the *2004–2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, December 2005*[52], specifically:

ΔWatts/unit:

The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit.

$\underline{\Delta \textit{Watts/unit}}$ = *Base Watts/unit - Energy Efficient Unit Watts*

Example: Δ*Watts/unit = 100 Watts/unit - 54 Watts / units = 46 Watts*

Demand Reduction:

$$\textit{Demand Reduction [kW/Unit]} = \frac{(\Delta\text{Watts/unit}) \times (\text{In Service Rate}) \text{ X } (\text{Peak Hour Load Share})}{1{,}000 \text{ Watts s/ kW}}$$

$$\textit{Example:} \quad \textit{Demand Reduction} = \frac{(46 \text{ Watts} \times (0.90) \times (0.075)}{1{,}000 \text{ Watt s /kW}} = 0.0031 \text{ kW}$$

Peak Hour Load Share: The Peak Hour Load Share represents the portion of energy demand produced by a lighting measure during an on peak period expressed as a percentage. The Peak Hour Load Share serves the same purpose for residential lighting as the Coincident Diversity Factor does for nonresidential lighting.

The load shape used for these measures is based on a simple average of the three usage periods between the hours of 2:00 pm and 5:00 pm summer weekdays as required by California Public Utilities Commission Interim Opinion 2006 Update of Avoided Costs and Related Issues Pertaining to Energy Efficiency Resources, Decision 06-06-063, June 29, 2006[53] which states "Until further notice of this Commission, the definition of peak kilowatt (kW) contained in the 2005 Database for Energy Efficient Resources (DEER) shall be used for the purpose of verifying energy efficiency program and portfolio performance. As discussed in this decision, DEER defines peak demand as the average grid level impact for a measure between 2 p.m. and 5 p.m. during the three consecutive weekday period containing the weekday temperature with the hottest temperature of the year." This results in a Peak Hour Load Share of 7.5%. This revision

[52] Ibid., 2-2, 2-3

[53] Ibid., 2-5

is based on the underlying data supporting the load shapes presented in Figure 4-13 Indoor CFL Load Shapes by Day Type, contained in Section 4 of the CFL Metering Study Final Report, KEMA, February 25, 2005. The information is reproduced here as Table 27. This is an update or revision to the 8.1% Peak Demand Savings factor embedded in the energy savings presented in Table 2-2: 2004-05 DEER Residential CFL Measure IDs and Savings Estimates, Section 2 of the *2004–2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, December 2005*[54].

[54] Decision 06-06-063, June 29, 2006, Interim Opinion: 2006 Update of Avoided Costs and Related Issues Pertaining to Energy Efficiency Resources.

Table 27. CFL Percent On by Day Type and Season

Percent On by Day Type and Season					
Average of 2:00 PM to 5:00 PM Summer Weekdays:					
From	**To**	**Winter***		**Summer****	
Hour	**Hour**	**Weekday**	**Weekend**	**Weekday**	**Weekend**
0	**1**	6.7%	7.9%	4.9%	5.7%
1	**2**	4.2%	5.1%	3.2%	3.8%
2	**3**	3.3%	4.2%	2.6%	2.8%
3	**4**	3.4%	3.8%	2.6%	2.6%
4	**5**	3.6%	3.3%	2.8%	2.3%
5	**6**	5.1%	4.1%	4.0%	2.8%
6	**7**	6.9%	5.6%	5.9%	4.1%
7	**8**	7.7%	7.2%	6.3%	5.6%
8	**9**	8.2%	8.8%	6.4%	6.6%
9	**10**	9.3%	10.9%	7.1%	7.9%
10	**11**	10.2%	12.0%	7.5%	8.5%
11	**12**	10.4%	12.6%	7.3%	8.4%
12	**13**	10.3%	12.1%	7.3%	8.2%
13	**14**	10.1%	12.0%	7.4%	8.1%
14	**15**	9.9%	12.2%	7.5%	8.2%
15	**16**	9.6%	11.8%	7.4%	8.3%
16	**17**	9.7%	11.9%	7.7%	8.4%
17	**18**	11.2%	13.0%	8.1%	8.7%
18	**19**	16.0%	17.2%	10.0%	10.1%
19	**20**	22.2%	22.3%	14.4%	12.9%
20	**21**	25.3%	25.3%	19.2%	17.8%
21	**22**	22.8%	23.3%	18.8%	17.1%
22	**23**	17.2%	18.5%	14.1%	13.4%
23	**24**	11.2%	12.5%	8.7%	8.7%

*Winter refers to the month with the highest usage, which is December.

**Summer refers to the lowest usage month, which is June.

Section 3 Load Shapes

Load shapes are a graphic representation of electrical load over time and are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure's load shape. The measure's load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A time-of-use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure's total resource cost (TRC) benefit.

3.1 Base Cases Load Shapes

The base case indoor lighting system's demand would be expected to follow a typical residential indoor lighting end use load shape as illustrated in Figures 1 and 2.

3.2 Measure Load Shapes

To estimate net benefits in the E3 calculator, a demand load shape is required. The demand load shape ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is what is called the Measure Load Shape and would be the preferred load shape for use in the net benefits calculations.

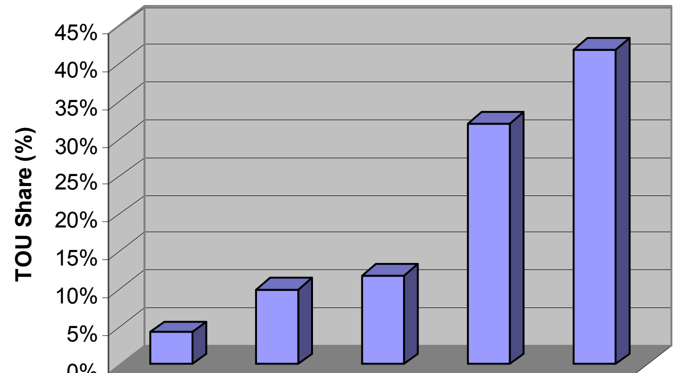
The Load Shape Update Initiative Study determined that for load-following measures, the end-use load shape can be substituted for the measure shape:

> "It can be argued that for measures that are roughly load-following (have a similar pattern to the end-use itself), substituting the end-use load shape for the measure shape is a reasonable simplification. Errors introduced by this substitution may be minor compared to other uncertainties in the savings valuation process. Distinguishing measure shape from end-use shape may be an unnecessary complication except for measures that are not load-following. This perspective was suggested by some workshop participants and interviewees."[55]

[55] KEMA Inc., Final Report Load Shape Initiative, November 17, 2006

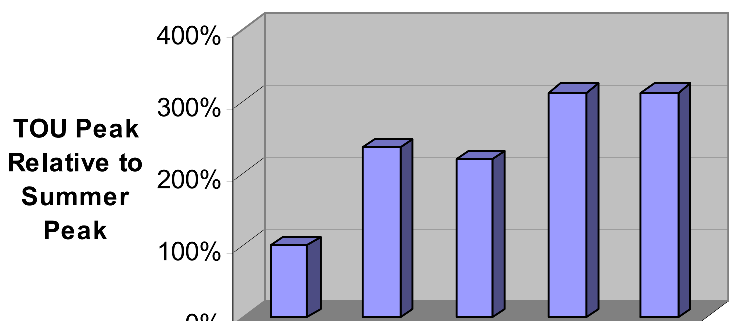
Since CFLs are direct replacements for incandescent lamps with no change in their operational characteristics, Southern California Edison (SCE) uses the lighting end use load shape in the E3 calculator for residential lighting. The E3 Calculator contains a fixed set of load shapes selections that are the combination of the hourly avoided costs and whatever load shape data were available at the time of the tool's creation. In the case of SCE's E3 Calculator, the majority of the load shape data at the time were TOU End Use load shapes and not Hourly Measure load shapes. Figure 8and Figure 9 represent the TOU End Use Energy and Peak Demand factors for indoor lighting measures that are embedded within the SCE E3 Calculator.

The “CFL-RC” load shape in the SCE E3 calculator was derived from the KEMA CFL metering study and compressed into the TOU factors shown in Figure 8 and Figure 9. The same end use load shape is used for both the measure and the base case.



	Smr On	Smr Ptl	Smr Off	Wtr Ptl	Wtr Off
TOU %	4%	10%	12%	32%	42%

Figure 8. Time of Use Energy Factors for Residential CFLs



	Smr On	Smr Ptl	Smr Off	Wtr Ptl	Wtr Off
Peak Ratio	100%	236%	219%	312%	312%

Figure 9. Time of Use Demand Factors for Residential CFLs

Section 4. Base Case and Measure Costs

Measure costs were obtained directly from *Table C-4: DEER Non-Weather Sensitive Measure List* in most instances. As explained in Section 4.3 below, for certain measures that were not represented in the DEER tables, bulb wattages were extrapolated to match available cost data.

4.1 Base Case Costs

Base equipment costs were obtained from the DEER for this work paper as listed in Table 28.

4.2 Measure Costs

For screw-in compact fluorescent lamps, measure costs were extracted from the *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, Appendix C, Table C-4 DEER Non – Weather Sensitive Measure List*[56]. Wattages of CFLs measures were matched to those in the DEER table and the incremental measure costs were used. In instances where direct mappings of wattages were not possible, costs from the closest available DEER wattages were used. For example, Table C-4 in DEER did not have costs for 9 Watt, 10 Watt, or 11 Watt CFLs. The first available costs in the DEER table were for a 13 Watt CFL. So the costs presented for the 13 Watt CFLs were used for the 9, 10, and 11 watt CFLs. Using the above example, 9 Watt, 10 Watt, 11 Watt, and 13 Watt CFLs would all be priced at the next available cost of $4.98/unit.

4.3 Incremental and Full Measure Costs

For screw-in compact fluorescent lamps, incremental costs were extracted from the *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, Appendix C, Table C-4 DEER Non – Weather Sensitive Measure List*[57] Wattages of CFLs measures were matched to those in the DEER table and the incremental measure costs were used as presented here as Table 28. Where direct mappings of wattages were not possible, costs from the closest available DEER wattages were used. For example, Table C-4 in the DEER update study did not have costs for a 9 Watt, 10 Watt, or 11 Watt CFLs. The first available costs in the DEER table were for a 13 Watt CFL. So the costs presented for the 13 Watt CFLs were used for the 9, 10, and 11 watt CFLs. Using the above example, 9 Watt, 10 Watt, 11 Watt, and 13 Watt CFLs would all be priced at the next available cost of $4.40/unit.

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[56] Itron 2005, 2-5

[57] Itron 2005, C-

The DEER measure installation costs were not used for these measures for the following reasons. The participants in this program are home owners or renters who would install these units as part of their normal maintenance routines and not incur any additional operating expense over and above the level of effort in replacing a standard incandescent lamp. An argument could be made that due to the longer life on CFLs those installations would occur less frequently and that an installation credit due to the reduced frequency of replacement could be easily calculated. However, SCE has decided not to calculate and claim an installation credit at this time.

Table 28. DEER Table C-4: Non-Weather Sensitive Measure List

MeasureID	Measure Name	Energy Common Units	Cost Common Units	Base Equipment Cost ($)	Measure Equipment Cost ($)	Incremental Equipment Cost ($)	Labor Cost ($)	Installed Cost ($)
D03-801	13 Watt CFL < 800 Lumens - screw-in	LAMP	Lamp	$0.57	$4.98	$4.40	$3.77	$8.18
D03-802	13 Watt CFL =800 Lumens - screw-in	LAMP	Lamp	$0.61	$4.87	$4.26	$3.77	$8.04
D03-803	14 Watt CFL - screw-in	LAMP	Lamp	$0.61	$5.25	$4.64	$3.77	$8.41
D03-804	15 Watt CFL - screw-in	LAMP	Lamp	$0.61	$5.62	$5.01	$3.77	$8.79
D03-805	16 Watt CFL - screw-in	LAMP	Lamp	$0.61	$6.00	$5.39	$3.77	$9.16
D03-806	18 Watt CFL < 1,100 Lumens - screw-in	LAMP	Lamp	$0.61	$6.74	$6.14	$3.77	$9.91
D03-807	18 Watt CFL =1,100 Lumens - screw-in	LAMP	Lamp	$0.61	$6.37	$5.77	$3.77	$9.54
D03-808	19 Watt CFL =1,100 Lumens - screw-in	LAMP	Lamp	$0.61	$6.73	$6.12	$3.77	$9.89
D03-809	20 Watt CFL - screw-in	LAMP	Lamp	$0.61	$7.08	$6.47	$3.77	$10.25
D03-810	23 Watt CFL - screw-in	LAMP	Lamp	$0.61	$6.66	$6.05	$3.77	$9.82
D03-811	25 Watt CFL <1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$8.85	$8.24	$3.77	$12.02
D03-812	25 Watt CFL =1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$7.24	$6.63	$3.77	$10.40
D03-813	26 Watt CFL <1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$9.21	$8.60	$3.77	$12.37
D03-814	26 Watt CFL =1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$7.52	$6.92	$3.77	$10.69
D03-815	28 Watt CFL - screw-in	LAMP	Lamp	$0.61	$8.10	$7.50	$3.77	$11.27
D03-816	30 Watt CFL - screw-in	LAMP	Lamp	$0.61	$9.26	$8.65	$3.77	$12.43
D03-817	36 Watt CFL - screw-in	LAMP	Lamp	$2.22	$9.19	$6.97	$3.77	$10.75
D03-818	40 Watt CFL - screw-in	LAMP	Lamp	$2.22	$12.77	$10.55	$3.77	$14.32
D03-819	13 Watt CFL < 800 Lumens - pin based	LAMP	Lamp	$0.00	$17.88	$0.00	$27.14	$45.02
D03-820	13 Watt CFL =800 Lumens - pin based	LAMP	Lamp	$0.00	$17.88	$0.00	$27.14	$45.02
D03-821	14 Watt CFL - pin based	LAMP	Lamp	$0.00	$18.38	$0.00	$27.14	$45.51
D03-822	15 Watt CFL - pin based	LAMP	Lamp	$0.00	$18.87	$0.00	$27.14	$46.01
D03-823	16 Watt CFL - pin based	LAMP	Lamp	$0.00	$19.36	$0.00	$27.14	$46.50
D03-824	18 Watt CFL < 1,100 Lumens - pin based	LAMP	Lamp	$0.00	$20.35	$0.00	$27.14	$47.49
D03-825	18 Watt CFL =1,100 Lumens - pin based	LAMP	Lamp	$0.00	$20.35	$0.00	$27.14	$47.49
D03-826	19 Watt CFL =1,100 Lumens - pin based	LAMP	Lamp	$0.00	$20.84	$0.00	$27.14	$47.98
D03-827	20 Watt CFL - pin based	LAMP	Lamp	$0.00	$21.34	$0.00	$27.14	$48.48
D03-828	23 Watt CFL - pin based	LAMP	Lamp	$0.00	$22.82	$0.00	$27.14	$49.96
D03-829	25 Watt CFL <1,600 Lumens - pin based	LAMP	Lamp	$0.00	$23.80	$0.00	$27.14	$50.94
D03-830	25 Watt CFL =1,600 Lumens - pin based	LAMP	Lamp	$0.00	$23.80	$0.00	$27.14	$50.94
D03-831	26 Watt CFL <1,600 Lumens - pin based	LAMP	Lamp	$0.00	$24.30	$0.00	$27.14	$51.44
D03-832	26 Watt CFL =1,600 Lumens - pin based	LAMP	Lamp	$0.00	$24.30	$0.00	$27.14	$51.44
D03-833	28 Watt CFL - pin based	LAMP	Lamp	$0.00	$25.28	$0.00	$27.14	$52.42
D03-834	30 Watt CFL - pin based	LAMP	Lamp	$0.00	$26.27	$0.00	$27.14	$53.41
D03-835	40 Watt CFL - pin based	LAMP	Lamp	$0.00	$31.20	$0.00	$27.14	$58.34
D03-836	55 Watt CFL - pin based	LAMP	Lamp	$0.00	$38.60	$0.00	$27.14	$65.74
D03-837	65 Watt CFL - pin based	LAMP	Lamp	$0.00	$43.54	$0.00	$27.14	$70.68
D03-838	20W CFL Table Lamp	Fixture	Fixture	$50.43	$50.43	$0.00	$0.00	$0.00
D03-839	25W CFL Table Lamp	Fixture	Fixture	$61.13	$61.13	$0.00	$0.00	$0.00
D03-840	32W CFL Table Lamp	Fixture	Fixture	$63.20	$63.20	$0.00	$0.00	$0.00
D03-841	50W CFL Table Lamp	Fixture	Fixture	$122.96	$122.96	$0.00	$0.00	$0.00
D03-842	55W CFL Torchiere	Fixture	Torchiere	$59.39	$59.39	$0.00	$0.00	$0.00
D03-843	70W CFL Torchiere (two LAMPs)	Fixture	Torchiere	$55.76	$55.76	$0.00	$0.00	$0.00
D03-844	50W Metal Halide	Fixture	Fixture	$0.00	$113.85	$0.00	$100.51	$214.36
D03-845	75W Metal Halide	Fixture	Fixture	$0.00	$120.09	$0.00	$100.51	$220.60
D03-846	100W Metal Halide	Fixture	Fixture	$0.00	$126.66	$0.00	$100.51	$227.17
D03-847	175W PS Metal Halide	Fixture	Fixture	$0.00	$129.01	$0.00	$67.84	$196.86
D03-848	175W PS Metal Halide	Fixture	Fixture	$0.00	$129.01	$0.00	$67.84	$196.86
D03-849	250W PS Metal Halide	Fixture	Fixture	$0.00	$152.08	$0.00	$67.84	$219.92
D03-850	200W HPS	Fixture	Fixture	$0.00	$91.05	$0.00	$67.84	$158.89
D03-851	180W LPS	Fixture	Fixture	$0.00	$74.62	$0.00	$67.84	$142.46
D03-852	Premium T8 El Ballast	Fixture	Fixture	$19.23	$23.42	$4.19	$0.00	$0.00
D03-853	T8 32W Dimming El Ballast	Fixture	Fixture	$16.54	$72.89	$56.34	$16.96	$89.85
D03-854	De-lamp from 4', 4 lamp/fixture	Fixture	Fixture	$0.00	$3.08	$0.00	$22.63	$25.71
D03-855	De-lamp from 8', 4 lamp/fixture	Fixture	Fixture	$0.00	$3.28	$0.00	$22.63	$25.91
D03-856	Occ-Sensor - Wall box	Sensor	Sensor	$0.00	$42.28	$0.00	$35.00	$77.28
D03-857	Occ-Sensor - Plug loads	Sensor	Sensor	$0.00	$82.25	$0.00	$35.00	$117.25
D03-858	Timeclock:	Timeclock	Timeclock	$0.00	$123.01	$0.00	$116.88	$239.89
D03-859	Photocell:	Photocell	Photocell	$0.00	$12.06	$0.00	$47.75	$59.81
D03-860	LED Exit Sign (New)	Exit Sign	Sign	$0.00	$31.52	$0.00	$33.92	$65.44
D03-861	LED Exit Sign Retrofit Kit	Exit Sign	Sign	$0.00	$16.66	$0.00	$33.92	$50.58
D03-862	Electroluminescent Exit Sign (New)	Exit Sign	Sign	$0.00	$73.42	$0.00	$33.92	$107.34
D03-863	Electroluminescent Exit Sign Retrofit Kit	Exit Sign	Sign	$0.00	$70.14	$0.00	$33.92	$104.06
D03-901	High Efficiency Copier	Copy Machine	copier	$1,616.38	$1,773.14	$156.76	$0.00	$0.00
D03-902	High Efficiency Copier	Copy Machine	copier	$4,686.00	$7,654.69	$2,968.69	$0.00	$0.00
D03-903	High Efficiency Copier	Copy Machine	copier	$0.00	$10,924.63	$0.00	$0.00	$0.00
D03-904	High Efficiency Gas Fryer	Fryer	Fryer	$1,520.61	$4,103.15	$2,582.54	$0.00	$0.00
D03-905	High Efficiency Gas Griddle	Griddle	Griddle	$1,758.36	$3,860.67	$2,102.31	$0.00	$0.00
D03-906	High Efficiency Electric Fryer	Fryer	Fryer	$3,326.73	$12,088.62	$8,761.89	$0.00	$0.00
D03-907	Hot Food Holding Cabinet	Cabinet	Cabinet	$1,545.67	$2,589.81	$1,044.13	$0.00	$0.00
D03-908	Connectionless Steamer	Steamer	Steamer	$5,128.24	$3,206.64	-$1,921.61	$0.00	$0.00
D03-909	Point of Use Water Heat	1000 sqft building	WtrHtr	$492.96	$863.60	$370.64	$250.90	$1,114.50

Attachments

Attachment 1. Integral Screw-In Residential Compact Fluorescent Worksheet.

WPSCRELG0017.1
Summary.xls

Work Paper WPSCRELG0022 (Integral (Screw-In) CFLs- Nonresidential) follows.

Work Paper WPSCRELG0022
Revision 1

Southern California Edison Company
Design & Engineering Services

Integral (Screw-In) CFLs NonResidential

At a Glance Summary

Measure Description	**Integral (Screw-in) CFL's NonResidential**
Savings Impacts Common Units	Lamp
Customer Base Case Description	Incandescent Lamp
Code Base Case Description	Screw-in Compact Fluorescent Lamp
Costs Common Units	Lamp
Building Type	Miscellaneous Commercial
Building Vintage	All
Climate Zone	All
Measure Load Shape	Indoor Lt
Effective Useful Life (years)	2.1 years
Program Type:	Replace on Burnout (ROB)
TOU AC Adjustment	0%
Net-to-Gross Ratio	75% (Subject to completion of the study referenced in this work paper and in accordance with any direction provided by the Commission in the final decision on energy efficiency incentives)
Important Comments	Values in the "At a Glance Summary" table below are rounded representations of full decimal values. The full values will be used when calculating program results for reporting purposes.

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
001	Screw-in CFL 5 Watt <450 Lumens (Nonres.)	59.2	0.015	59.2	0.015	$4.98	$4.40	$4.40
002	Screw-in CFL 7 Watt 450 to 799 Lumens (Nonres.)	97.8	0.024	97.8	0.024	$4.98	$4.40	$4.40
003	Screw-in CFL 9 Watt 450 to 799 Lumens (Nonres.)	91.8	0.023	91.8	0.023	$4.98	$4.40	$4.40
004	Screw-in CFL 10 Watt <450 Lumens (Nonres.)	44.4	0.011	44.4	0.011	$4.98	$4.40	$4.40
005	Screw-in CFL 10 Watt 450 to 799 Lumens (Nonres.)	88.9	0.022	88.9	0.022	$4.98	$4.40	$4.40
006	Screw-in CFL 10 Watt 800 to 1,099 Lumens (Nonres.)	148.1	0.036	148.1	0.036	$4.87	$4.26	$4.26
007	Screw-in CFL 11 Watt <450 Lumens (Nonres.)	41.5	0.010	41.5	0.010	$4.98	$4.40	$4.40
008	Screw-in CFL 11 Watt 450 to 799 Lumens (Nonres.)	85.9	0.021	85.9	0.021	$4.98	$4.40	$4.40
009	Screw-in CFL 11 Watt 800 to 1,099 Lumens (Nonres.)	145.2	0.036	145.2	0.036	$4.87	$4.26	$4.26
010	Screw-in CFL 12 Watt <450 Lumens (Nonres.)	38.5	0.009	38.5	0.009	$4.98	$4.40	$4.40
011	Screw-in CFL 12 Watt 450 to 799 Lumens (Nonres.)	82.9	0.020	82.9	0.020	$4.98	$4.40	$4.40
012	Screw-in CFL 12 Watt 800 to 1,099 Lumens (Nonres.)	142.2	0.035	142.2	0.035	$4.87	$4.26	$4.26
013	Screw-in CFL 13 Watt <450 Lumens (Nonres.)	35.5	0.009	35.5	0.009	$4.98	$4.40	$4.40
014	Screw-in CFL 13 Watt 450 to 799 Lumens (Nonres.)	80.0	0.020	80.0	0.020	$4.98	$4.40	$4.40
015	Screw-in CFL 13 Watt 800 to 1,099 Lumens (Nonres.)	139.2	0.034	139.2	0.034	$4.87	$4.26	$4.26
016	Screw-in CFL 14 Watt 450 to	77.0	0.019	77.0	0.019	$5.25	$4.64	$4.64

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
	799 Lumens (Nonres.)							
017	Screw-in CFL 14 Watt 800 to 1,099 Lumens (Nonres.)	136.3	0.033	136.3	0.033	$5.25	$4.64	$4.64
018	Screw-in CFL 15 Watt 450 to 799 Lumens (Nonres.)	74.1	0.018	74.1	0.018	$5.62	$5.01	$5.01
019	Screw-in CFL 15 Watt 800 to 1,099 Lumens (Nonres.)	133.3	0.033	133.3	0.033	$5.62	$5.01	$5.01
020	Screw-in CFL 15 Watt 1,100 to 1,399 Lumens (Nonres.)	177.7	0.044	177.7	0.044	$5.62	$5.01	$5.01
021	Screw-in CFL 16 Watt 800 to 1,099 Lumens (Nonres.)	130.3	0.032	130.3	0.032	$6.00	$5.39	$5.39
022	Screw-in CFL 16 Watt 1,100 to 1,399 Lumens (Nonres.)	174.8	0.043	174.8	0.043	$6.00	$5.39	$5.39
023	Screw-in CFL 17 Watt 450 to 799 Lumens (Nonres.)	68.1	0.017	68.1	0.017	$6.74	$6.14	$6.14
024	Screw-in CFL 17 Watt 800 to 1,099 Lumens (Nonres.)	127.4	0.031	127.4	0.031	$6.74	$6.14	$6.14
025	Screw-in CFL 17 Watt 1,100 to 1,399 Lumens (Nonres.)	171.8	0.042	171.8	0.042	$6.37	$6.14	$6.14
026	Screw-in CFL 18 Watt 450 to 799 Lumens (Nonres.)	65.2	0.016	65.2	0.016	$6.74	$6.14	$6.14
027	Screw-in CFL 18 Watt 800 to 1,099 Lumens (Nonres.)	124.4	0.031	124.4	0.031	$6.74	$6.14	$6.14
028	Screw-in CFL 18 Watt 1,100 to 1,399 Lumens (Nonres.)	168.9	0.041	168.9	0.041	$6.37	$5.77	$5.77
029	Screw-in CFL 19 Watt 450 to 799 Lumens (Nonres.)	62.2	0.015	62.2	0.015	$6.73	$6.12	$6.12
030	Screw-in CFL 19 Watt 800 to 1,099 Lumens (Nonres.)	121.5	0.030	121.5	0.030	$6.73	$6.12	$6.12
031	Screw-in CFL 19 Watt 1,100 to 1,399 Lumens (Nonres.)	165.9	0.041	165.9	0.041	$6.73	$6.12	$6.12

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
032	Screw-in CFL 20 Watt 800 to 1,099 Lumens (Nonres.)	118.5	0.029	118.5	0.029	$7.08	$6.47	$6.47
033	Screw-in CFL 20 Watt 1,100 to 1,399 Lumens (Nonres.)	162.9	0.040	162.9	0.040	$7.08	$6.47	$6.47
034	Screw-in CFL 21 Watt 800 to 1,099 Lumens (Nonres.)	115.5	0.028	115.5	0.028	$6.66	$6.05	$6.05
035	Screw-in CFL 21 Watt 1,100 to 1,399 Lumens (Nonres.)	160.0	0.039	160.0	0.039	$6.66	$6.05	$6.05
036	Screw-in CFL 22 Watt 800 to 1,099 Lumens (Nonres.)	112.6	0.028	112.6	0.028	$6.66	$6.05	$6.05
037	Screw-in CFL 22 Watt 1,100 to 1,399 Lumens (Nonres.)	157.0	0.039	157.0	0.039	$6.66	$6.05	$6.05
038	Screw-in CFL 23 Watt 800 to 1,099 Lumens (Nonres.)	109.6	0.027	109.6	0.027	$6.66	$6.05	$6.05
039	Screw-in CFL 23 Watt 1,100 to 1,399 Lumens (Nonres.)	154.0	0.038	154.0	0.038	$6.66	$6.05	$6.05
040	Screw-in CFL 23 Watt 1,400 to 1,599 Lumens (Nonres.)	198.5	0.049	198.5	0.049	$6.66	$6.05	$6.05
041	Screw-in CFL 23 Watt 1,600 to 1,999 Lumens (Nonres.)	228.1	0.056	228.1	0.056	$6.66	$6.05	$6.05
042	Screw-in CFL 24 Watt 800 to 1,099 Lumens (Nonres.)	106.6	0.026	106.6	0.026	$8.85	$6.63	$6.63
043	Screw-in CFL 24 Watt 1,100 to 1,399 Lumens (Nonres.)	151.1	0.037	151.1	0.037	$7.24	$6.63	$6.63
044	Screw-in CFL 24 Watt 1,400 to 1,599 Lumens (Nonres.)	195.5	0.048	195.5	0.048	$7.24	$6.63	$6.63
045	Screw-in CFL 24 Watt 1,600 to 1,999 Lumens (Nonres.)	225.1	0.055	225.1	0.055	$7.24	$6.63	$6.63
046	Screw-in CFL 25 Watt 800 to 1,099 Lumens (Nonres.)	103.7	0.025	103.7	0.025	$8.85	$6.63	$6.63

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
047	Screw-in CFL 25 Watt 1,100 to 1,399 Lumens (Nonres.)	148.1	0.036	148.1	0.036	$7.24	$6.63	$6.63
048	Screw-in CFL 25 Watt 1,400 to 1,599 Lumens (Nonres.)	192.6	0.047	192.6	0.047	$7.24	$6.63	$6.63
049	Screw-in CFL 25 Watt 1,600 to 1,999 Lumens (Nonres.)	222.2	0.055	222.2	0.055	$7.24	$6.63	$6.63
050	Screw-in CFL 26 Watt 800 to 1,099 Lumens (Nonres.)	100.7	0.025	100.7	0.025	$9.21	$6.92	$6.92
051	Screw-in CFL 26 Watt 1,100 to 1,399 Lumens (Nonres.)	145.2	0.036	145.2	0.036	$7.52	$6.92	$6.92
052	Screw-in CFL 26 Watt 1,400 to 1,599 Lumens (Nonres.)	189.6	0.047	189.6	0.047	$7.52	$6.92	$6.92
053	Screw-in CFL 26 Watt 1,600 to 1,999 Lumens (Nonres.)	219.2	0.054	219.2	0.054	$7.52	$6.92	$6.92
054	Screw-in CFL 27 Watt 800 to 1,099 Lumens (Nonres.)	97.8	0.024	97.8	0.024	$8.10	$7.50	$7.50
055	Screw-in CFL 27 Watt 1,100 to 1,399 Lumens (Nonres.)	142.2	0.035	142.2	0.035	$8.10	$7.50	$7.50
056	Screw-in CFL 27 Watt 1,400 to 1,599 Lumens (Nonres.)	186.6	0.046	186.6	0.046	$8.10	$7.50	$7.50
057	Screw-in CFL 27 Watt 1,600 to 1,999 Lumens (Nonres.)	216.3	0.053	216.3	0.053	$8.10	$7.50	$7.50
058	Screw-in CFL 28 Watt 1,100 to 1,399 Lumens (Nonres.)	139.2	0.034	139.2	0.034	$8.10	$7.50	$7.50
059	Screw-in CFL 28 Watt 1,400 to 1,599 Lumens (Nonres.)	183.7	0.045	183.7	0.045	$8.10	$7.50	$7.50
060	Screw-in CFL 28 Watt 1,600 to 1,999 Lumens (Nonres.)	213.3	0.052	213.3	0.052	$8.10	$7.50	$7.50
061	Screw-in CFL 29 Watt 1,100 to 1,399 Lumens (Nonres.)	136.3	0.033	136.3	0.033	$9.26	$8.65	$8.65

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
062	Screw-in CFL 29 Watt 1,400 to 1,599 Lumens (Nonres.)	180.7	0.044	180.7	0.044	$9.26	$8.65	$8.65
063	Screw-in CFL 29 Watt 1,600 to 1,999 Lumens (Nonres.)	210.3	0.052	210.3	0.052	$9.26	$8.65	$8.65
064	Screw-in CFL 30 Watt 1,100 to 1,399 Lumens (Nonres.)	133.3	0.033	133.3	0.033	$9.26	$8.65	$8.65
065	Screw-in CFL 30 Watt 1,400 to 1,599 Lumens (Nonres.)	177.7	0.044	177.7	0.044	$9.26	$8.65	$8.65
066	Screw-in CFL 30 Watt 1,600 to 1,999 Lumens (Nonres.)	207.4	0.051	207.4	0.051	$9.26	$8.65	$8.65
067	Screw-in CFL 30 Watt 2,000 to 2,599 Lumens (Nonres.)	266.6	0.065	266.6	0.065	$9.26	$8.65	$8.65
068	Screw-in CFL 31 Watt 1,100 to 1,399 Lumens (Nonres.)	130.3	0.032	130.3	0.032	$9.19	$6.97	$6.97
069	Screw-in CFL 31 Watt 1,400 to 1,599 Lumens (Nonres.)	174.8	0.043	174.8	0.043	$9.19	$6.97	$6.97
070	Screw-in CFL 31 Watt 1,600 to 1,999 Lumens (Nonres.)	204.4	0.050	204.4	0.050	$9.19	$6.97	$6.97
071	Screw-in CFL 32 Watt 1,100 to 1,399 Lumens (Nonres.)	127.4	0.031	127.4	0.031	$9.19	$6.97	$6.97
072	Screw-in CFL 32 Watt 1,400 to 1,599 Lumens (Nonres.)	171.8	0.042	171.8	0.042	$9.19	$6.97	$6.97
073	Screw-in CFL 32 Watt 1,600 to 1,999 Lumens (Nonres.)	201.4	0.049	201.4	0.049	$9.19	$6.97	$6.97
074	Screw-in CFL 33 Watt 1,100 to 1,399 Lumens (Nonres.)	124.4	0.031	124.4	0.031	$9.19	$6.97	$6.97
075	Screw-in CFL 33 Watt 1,400 to 1,599 Lumens (Nonres.)	169.2	0.041	169.2	0.041	$9.19	$6.97	$6.97
076	Screw-in CFL 33 Watt 1,600 to 1,999 Lumens (Nonres.)	198.5	0.049	198.5	0.049	$9.19	$6.97	$6.97

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
077	Screw-in CFL 34 Watt 1,100 to 1,399 Lumens (Nonres.)	121.5	0.030	121.5	0.030	$9.19	$6.97	$6.97
078	Screw-in CFL 34 Watt 1,400 to 1,599 Lumens (Nonres.)	165.9	0.041	165.9	0.041	$9.19	$6.97	$6.97
079	Screw-in CFL 34 Watt 1,600 to 1,999 Lumens (Nonres.)	195.5	0.048	195.5	0.048	$9.19	$6.97	$6.97
080	Screw-in CFL 35 Watt 1,400 to 1,599 Lumens (Nonres.)	162.9	0.040	162.9	0.040	$9.19	$6.97	$6.97
081	Screw-in CFL 35 Watt 1,600 to 1,999 Lumens (Nonres.)	192.6	0.047	192.6	0.047	$9.19	$6.97	$6.97
082	Screw-in CFL 35 Watt 2,000 to 2,599 Lumens (Nonres.)	251.8	0.062	251.8	0.062	$9.19	$6.97	$6.97
083	Screw-in CFL 36 Watt 1,400 to 1,599 Lumens (Nonres.)	160.0	0.039	160.0	0.039	$9.19	$6.97	$6.97
084	Screw-in CFL 36 Watt 1,600 to 1,999 Lumens (Nonres.)	189.6	0.047	189.6	0.047	$9.19	$6.97	$6.97
085	Screw-in CFL 36 Watt 2,000 to 2,599 Lumens (Nonres.)	248.8	0.061	248.8	0.061	$9.19	$6.97	$6.97
086	Screw-in CFL 37 Watt 1,400 to 1,599 Lumens (Nonres.)	157.0	0.039	157.0	0.039	$12.77	$10.55	$10.55
087	Screw-in CFL 37 Watt 1,600 to 1,999 Lumens (Nonres.)	186.6	0.046	186.6	0.046	$12.77	$10.55	$10.55
088	Screw-in CFL 37 Watt 2,000 to 2,599 Lumens (Nonres.)	245.9	0.060	245.9	0.060	$12.77	$10.55	$10.55
089	Screw-in CFL 38 Watt 1,400 to 1,599 Lumens (Nonres.)	154.0	0.038	154.0	0.038	$12.77	$10.55	$10.55
090	Screw-in CFL 38 Watt 1,600 to 1,999 Lumens (Nonres.)	183.7	0.045	183.7	0.045	$12.77	$10.55	$10.55
091	Screw-in CFL 38 Watt 2,000 to 2,599 Lumens (Nonres.)	242.9	0.060	242.9	0.060	$12.77	$10.55	$10.55

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
092	Screw-in CFL 38 Watt 2,600 to 3,599 Lumens (Nonres.)	331.8	0.081	331.8	0.081	$12.77	$10.55	$10.55
093	Screw-in CFL 39 Watt 1,400 to 1,599 Lumens (Nonres.)	151.1	0.037	151.1	0.037	$12.77	$10.55	$10.55
094	Screw-in CFL 39 Watt 1,600 to 1,999 Lumens (Nonres.)	180.7	0.044	180.7	0.044	$12.77	$10.55	$10.55
095	Screw-in CFL 39 Watt 2,000 to 2,599 Lumens (Nonres.)	240.0	0.059	240.0	0.059	$12.77	$10.55	$10.55
096	Screw-in CFL 39 Watt 2,600 to 3,599 Lumens (Nonres.)	328.8	0.081	328.8	0.081	$12.77	$10.55	$10.55
097	Screw-in CFL 40 Watt 1,600 to 1,999 Lumens (Nonres.)	177.7	0.044	177.7	0.044	$12.77	$10.55	$10.55
098	Screw-in CFL 40 Watt 2,000 to 2,599 Lumens (Nonres.)	237.0	0.058	237.0	0.058	$12.77	$10.55	$10.55
099	Screw-in CFL 40 Watt 2,600 to 3,599 Lumens (Nonres.)	325.9	0.080	325.9	0.080	$12.77	$10.55	$10.55
100	Screw-in CFL 41 Watt 1,600 to 1,999 Lumens (Nonres.)	174.8	0.043	174.8	0.043	$12.77	$10.55	$10.55
101	Screw-in CFL 41 Watt 2,000 to 2,599 Lumens (Nonres.)	234.0	0.057	234.0	0.057	$12.77	$10.55	$10.55
102	Screw-in CFL 41 Watt 2,600 to 3,599 Lumens (Nonres.)	322.9	0.079	322.9	0.079	$12.77	$10.55	$10.55
103	Screw-in CFL 42 Watt 1,600 to 1,999 Lumens (Nonres.)	171.8	0.042	171.8	0.042	$12.77	$10.55	$10.55
104	Screw-in CFL 42 Watt 2,000 to 2,599 Lumens (Nonres.)	231.1	0.057	231.1	0.057	$12.77	$10.55	$10.55
105	Screw-in CFL 42 Watt 2,600 to 3,599 Lumens (Nonres.)	319.9	0.078	319.9	0.078	$12.77	$10.55	$10.55
106	Screw-in CFL 43 Watt 1,600 to 1,999 Lumens (Nonres.)	168.9	0.041	168.9	0.041	$12.77	$10.55	$10.55

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
107	Screw-in CFL 43 Watt 2,000 to 2,599 Lumens (Nonres.)	228.1	0.056	228.1	0.056	$12.77	$10.55	$10.55
108	Screw-in CFL 43 Watt 2,600 to 3,599 Lumens (Nonres.)	317.0	0.078	317.0	0.078	$12.77	$10.55	$10.55
109	Screw-in CFL 44 Watt 1,600 to 1,999 Lumens (Nonres.)	165.9	0.041	165.9	0.041	$12.77	$10.55	$10.55
110	Screw-in CFL 44 Watt 2,000 to 2,599 Lumens (Nonres.)	225.1	0.055	225.1	0.055	$12.77	$10.55	$10.55
111	Screw-in CFL 44 Watt 2,600 to 3,599 Lumens (Nonres.)	314.0	0.077	314.0	0.077	$12.77	$10.55	$10.55
112	Screw-in CFL 45 Watt 1,600 to 1,999 Lumens (Nonres.)	162.9	0.040	162.9	0.040	$12.77	$10.55	$10.55
113	Screw-in CFL 45 Watt 2,000 to 2,599 Lumens (Nonres.)	222.2	0.055	222.2	0.055	$12.77	$10.55	$10.55
114	Screw-in CFL 45 Watt 2,600 to 3,599 Lumens (Nonres.)	311.1	0.076	311.1	0.076	$12.77	$10.55	$10.55
115	Screw-in CFL 46 Watt 1,600 to 1,999 Lumens (Nonres.)	160.0	0.039	160.0	0.039	$12.77	$10.55	$10.55
116	Screw-in CFL 46 Watt 2,000 to 2,599 Lumens (Nonres.)	219.2	0.054	219.2	0.054	$12.77	$10.55	$10.55
117	Screw-in CFL 46 Watt 2,600 to 3,599 Lumens (Nonres.)	308.1	0.076	308.1	0.076	$12.77	$10.55	$10.55
118	Screw-in CFL 47 Watt 1,600 to 1,999 Lumens (Nonres.)	157.0	0.039	157.0	0.039	$12.77	$10.55	$10.55
119	Screw-in CFL 47 Watt 2,000 to 2,599 Lumens (Nonres.)	216.3	0.053	216.3	0.053	$12.77	$10.55	$10.55
120	Screw-in CFL 47 Watt 2,600 to 3,599 Lumens (Nonres.)	305.1	0.075	305.1	0.075	$12.77	$10.55	$10.55
121	Screw-in CFL 48 Watt 1,600 to 1,999 Lumens (Nonres.)	154.0	0.038	154.0	0.038	$12.77	$10.55	$10.55

Work Paper RunID: WPSCRELG0022.1-	Measure Name	Customer Annual Electric Savings (kWh/unit)	Customer Peak Electric Demand Reduction (kW/unit)	Above Code Annual Electric Savings (kWh/unit)	Above Code Peak Electric Demand Reduction (kW/unit)	Measure Equipment Cost ($/unit)	Measure Incremental Cost ($/unit)	Measure Installed Cost ($/unit)
122	Screw-in CFL 48 Watt 2,000 to 2,599 Lumens (Nonres.)	213.3	0.052	213.3	0.052	$12.77	$10.55	$10.55
123	Screw-in CFL 48 Watt 2,600 to 3,599 Lumens (Nonres.)	302.2	0.074	302.2	0.074	$12.77	$10.55	$10.55
124	Screw-in CFL 49 Watt 1,600 to 1,999 Lumens (Nonres.)	151.1	0.037	151.1	0.037	$12.77	$10.55	$10.55
125	Screw-in CFL 49 Watt 2,000 to 2,599 Lumens (Nonres.)	210.3	0.052	210.3	0.052	$12.77	$10.55	$10.55
126	Screw-in CFL 49 Watt 2,600 to 3,599 Lumens (Nonres.)	299.2	0.073	299.2	0.073	$12.77	$10.55	$10.55
127	Screw-in CFL 50 Watt 2,000 to 2,599 Lumens (Nonres.)	207.4	0.051	207.4	0.051	$12.77	$10.55	$10.55
128	Screw-in CFL 50 Watt 2,600 to 3,599 Lumens (Nonres.)	296.2	0.073	296.2	0.073	$12.77	$10.55	$10.55
129	Screw-in CFL 50 Watt 3,600 to 4,599 Lumens (Nonres.)	444.4	0.109	444.4	0.109	$12.77	$10.55	$10.55
130	Screw-in CFL 51 Watt 2,000 to 2,599 Lumens (Nonres.)	204.4	0.050	204.4	0.050	$12.77	$10.55	$10.55
131	Screw-in CFL 51 Watt 2,600 to 3,599 Lumens (Nonres.)	293.3	0.072	293.3	0.072	$12.77	$10.55	$10.55
132	Screw-in CFL 51 Watt 3,600 to 4,599 Lumens (Nonres.)	441.4	0.108	441.4	0.108	$12.77	$10.55	$10.55
133	Screw-in CFL 52 Watt 2,000 to 2,599 Lumens (Nonres.)	201.4	0.049	201.4	0.049	$12.77	$10.55	$10.55
134	Screw-in CFL 52 Watt 2,600 to 3,599 Lumens (Nonres.)	290.3	0.071	290.3	0.071	$12.77	$10.55	$10.55
135	Screw-in CFL 52 Watt 3,600 to 4,599 Lumens (Nonres.)	438.4	0.108	438.4	0.108	$12.77	$10.55	$10.55
136	Screw-in CFL 53 Watt 2,000 to 2,599 Lumens (Nonres.)	198.5	0.049	198.5	0.049	$12.77	$10.55	$10.55

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137	Screw-in CFL 53 Watt 2,600 to 3,599 Lumens (Nonres.)	287.4	0.070	287.4	0.070	$12.77	$10.55	$10.55
138	Screw-in CFL 53 Watt 3,600 to 4,599 Lumens (Nonres.)	435.5	0.107	435.5	0.107	$12.77	$10.55	$10.55
139	Screw-in CFL 54 Watt 2,000 to 2,599 Lumens (Nonres.)	195.5	0.048	195.5	0.048	$12.77	$10.55	$10.55
140	Screw-in CFL 54 Watt 2,600 to 3,599 Lumens (Nonres.)	284.4	0.070	284.4	0.070	$12.77	$10.55	$10.55
141	Screw-in CFL 54 Watt 3,600 to 4,599 Lumens (Nonres.)	432.5	0.106	432.5	0.106	$12.77	$10.55	$10.55
142	Screw-in CFL 55 Watt 2,000 to 2,599 Lumens (Nonres.)	192.6	0.047	192.6	0.047	$12.77	$10.55	$10.55
143	Screw-in CFL 55 Watt 2,600 to 3,599 Lumens (Nonres.)	281.4	0.069	281.4	0.069	$12.77	$10.55	$10.55
144	Screw-in CFL 55 Watt 3,600 to 4,599 Lumens (Nonres.)	429.5	0.105	429.5	0.105	$12.77	$10.55	$10.55
145	Screw-in UL Rated CFL 7 Watt <450 Lumens (Nonres.)	53.3	0.013	53.3	0.013	$4.98	$4.40	$4.40

Document Revision History

Revision #	Date	Author/Affiliation	Description of Changes
Revision 0	September 2007		• Split original work paper short form WPSCRELG0017.0 into CFL groups • Expanded to final WP template format • Measure equipment costs added • Net to Gross Ration Reduced from 80% to 75% (Subject to completion of the study referenced in this work paper and in accordance with any direction provided by the Commission in the final decision on energy efficiency incentives) • In Service Rate Changed from 90% to 92%
Revision 1	February 2009	Selya J. Arce/SP&TS	• Added new measure (WP Run ID 145) • The 13 watt UL Rated CFL, 800 to 1099 lumens measure is mapped to WPSCRELG0022.1-015 • Revision 1 documents the UL Rated CFLs to be the same as the spiral CFLs

Note: The information provided in this work paper was developed using the best available technical resources at the time this document was prepared.

Table of Contents

List of Tables

List of Figures

Section 1. General Measure and Baseline Data

1.1 Measure Description and Background

A compact fluorescent lamp (CFL) consists of two main parts: a gas-filled tube and an electronic ballast. Electric current flows from the ballast through the gas, causing it to emit ultraviolet light. The ultraviolet light then excites a white phosphor coating on the inside of the tube, making it emit visible light. This measure replaces incandescent lamps. An incandescent lamp is also a source of artificial light that works through a different process known as incandescence. In the incandescent process an electrical current passes through a thin filament, heating it and causing it to become excited and release photons.

The fluorescent process is approximately four times more efficient at converting electricity into light. Modern CFLs typically have a life span of between 6,000 and 15,000 hours. CFL wattages covered by this work paper range in values from 5 watts through 55 watts with lumen rages from under 450 lumens through 4,599 lumens replacing incandescent lamps with wattages that range from under 24 watts through 500 watts with matching lumen rages.

The measures discussed in this work paper are integral (screw-in) compact fluorescent lamps. The UL Rated CFLs are considered the same as the spiral CFLs.

1.2 DEER Differences Analysis

The Non-Residential Sector Non-Weather Sensitive section (Section 3) of the *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report*, *December 2005(Itron, 2005)*[58]contains the DEER methodology for calculating energy savings for screw-in compact fluorescent lamps (CFL) measures. A lumen equivalency table is also presented for compact fluorescent lamps (CFLs) that range from less than 13 watts through 40 watts that are mapped to incandescent wattages that range from a 40 Watt incandescent lamp through a 150 Watt incandescent lamp. The report does not present tables with a complete set of lighting savings estimates for all of the market sectors but, instead, explains their methodology, presents examples, and includes a table that contains interior lighting savings estimates for the primary school market sector under program delivery methods.

Two methodologies for calculating demand savings are presented in this section of the DEER report. A methodology for Standard Performance Contracts (SPC) which are considered to have strict measure verification requirements and second methodology for Express Efficiency which is considered to have limited or no measure verification requirements. The significant difference between the two methodologies is the inclusion of an installation rate adjustment factor in the Express Efficiency algorithm. The Express Efficiency methodology, which includes a downward adjustment factor installation rate,

58 Itron, Inc., JJ Hirsch & Associates, Synergy Consulting, and Quantum, Inc., "2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report," December 2005, 3-1 through 3-13.

is used for the measures covered by this work paper and is discussed in greater detail in the following sections on demand and energy savings.

Demand Savings: The methodology presented in the DEER Report for the calculation of demand saving is based on several factors that include the calculation of wattage reductions resulting from replacing a base technology (incandescent lamp), matching the lumen output of the base technologies with the lumen output of a CFL measures, calculating the delta watts, then multiplying the result by an Installation Rate (the equivalent of an In Service Rate in the residential calculation) and Peak Coincidence Factor (the equivalent of a Peak Hour Load Share in the residential calculation) and applying an interactive effect[59] (Demand Interactive Effect from Table 3-2)[60].

$$\textbf{Demand Savings}\left[\frac{Watts}{unit}\right] = (\Delta Watts\ /\ unit) \times (Installation\ Rate) \times (Peak\ Coincidence\ Factor) \times (Interactive\ Effects)$$

Below is an example calculation done for a 14W CFL screw-in lamp replacing a 60W incandescent base lamp.

Energy savings are calculated in DEER following a simple formula that captures wattage level changes, hours of daily use, and estimates of lamp installation rate identified as an In Service Rate.

$$\textbf{Energy Savings}\left[\frac{kWh}{unit \cdot year}\right] = \frac{(\Delta Watts\ /\ unit) \times (annual\ hours\ of\ use) \times (Installation\ Rate) \times (Interactive\ Effects)}{1{,}000\ Watt\ hours\ /\ kWh}$$

As presented in greater detail in Section 2 of this work paper, the methodology used to calculate energy and demand saving are the same as those used in the DEER Report subject to the modification discussed below.

Interactive effects: When more efficient light sources are installed, the wattage of new lamps is lower. This lower wattage produces less heat. The lower heat emissions result in cooler air and reduced air conditioning requirements. The purpose of including demand- and energy-interactive effects in the DEER calculation algorithm is to a capture the energy and demand reductions from the avoided air conditioning load resulting from the reduction of internal heat gains produced by the more efficient lighting sources. The impact of accounting for these interactive effects is to increase calculated energy and demand savings by as much as 26% in some market types, based on the tables in the DEER Report. However, SCE is concerned that the interactive effects used in the DEER Report are not appropriate for these measures for the following reasons. The DEER

59 Ibid., 3-6,3-7.

60 Ibid., 3-5.

interactive factors do not vary by climate zone and are not scalable to account for differences in air conditioning systems and operational differences. It is unclear if the interactive factor appropriately accounts for increases in heating requirements (including fan loads) which may offset some of these savings. It is also unclear if the interactive effects presented in DEER are appropriate for the small businesses that tend to participate in this type of program. Program participants tend to be small businesses, which may not use air conditioning to the extent necessary to produce the interactive effects that are presented in the DEER Report. It should be noted that the interactive effects presented in the DEER Report are the same for large customer types and small customer types. Due to these concerns, SCE does not use interactive effects in the calculation of energy and demand savings for the measures in this work paper.

Effective Useful Life: The Effective Useful Life (EUL) used for the measures in this work paper is based on the EUL for Small Retail from *Table 11-4: Non-Weather Sensitive – Lighting EULs* of the DEER Report[61]. This is a deviation from the methodology used for calculating the annual hours of operation and coincidence factors discussed above. This deviation is due to recent concern over the true operating hours of CFL that are being purchased under this program that could impact the calculation of effective useful lives dictating a more conservative approach. Therefore, instead of using an EUL of 2.5 years based on the average EUL of the market sectors participating in the program [small retail, small office, and sit down restaurants], SCE uses an **EUL of 2.1 years**, which is the lowest effective useful life of these three market sectors, when calculating the energy and demand impact for the measures in this program.

Installation Rate: For the measures in this work paper as explained below in Section 1.4 on EM&V Market Potential, Edison has determined that the DEER installation Rate of 92% (0.92) that is used for Express Efficiency type programs that have limited or no measure verification requirements is more appropriate for these measures.

1.3 Codes and Standards Requirements Analysis

There are no current code requirements applicable to this measure through 2007. However, starting in January 2008, changes to California's Title 20 requirements become effective and will affect the Above Code baselines, but no studies are available to substantiate the timing of the market penetration of the new lamps. Therefore, no code related adjustments were made.

1.4 EM&V, Market Potential, and Other Studies

Although not directly applicable for nonresidential upstream lighting, the *2004/2005 Statewide Residential Retrofit Single-Family Energy Efficiency Rebate Evaluation* (Itron 2007)[62] examines the upstream lighting program through which bulbs are rebated. Sections 5 & 6 of this study provide an updated analysis of the upstream CFL program covered by this work paper. Itron gathered general energy efficiency data from a

61 Ibid., 11-8.

62 Itron, Inc.,2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation, June 29, 2007.

telephone survey (n=4,718), with a portion being asked in-depth questions about residential lighting (n=1000), an on-site inspection (n=100) and surveys of manufacturers and retailers.

Delta Wattage Assumption (ΔW): The Itron 2007 study developed ΔkW assumptions based on lumens using data from the on-site inspections[63]. Rather than determining a base wattage from which to calculate the ΔkW for each bulb, they calculated an average ΔkW for various lumen ranges. That is, a 13W and a 14W CFL of the same luminosity would be assumed to have the same average ΔkW. Unfortunately, lamps with output of 1,100 to 2,599 lumens were considered as one category, even though that range includes the lumen output of 75W, 100W, and 150W incandescent bulbs replacements. The study results were used, together with the number of non specialty CFLs from each lumen category sold under the 2006 SCE Residential Upstream Lighting Program to determine a base-wattage assumption. The ΔW assumptions were drawn from the study. Using program data, the wattages of all the bulbs in each lumen category were summed to find the average wattage of CFLs in that category. The average wattage was added to the ΔW to find a base wattage for each lumen category as shown in the Equation 1.

[Equation 1] $$\overline{\Delta W} = \frac{\Sigma(W_{base} - W_{new})}{n} \rightarrow \overline{W_{base}} = \frac{\Sigma W_{new}}{n} + \overline{\Delta W} = \overline{W_{new}} + \overline{\Delta W}$$

In addition, the same calculations were done for all of the bulbs in the 1100-2599 lumen range, using weighted averages based on the number of bulbs that were sold under the 2006 program in each category. The results are contained in Table 29:

Table 29. Base Wattage Assumptions

Lumen Range	SCE Base Wattage (Energy Star)	Average CFL Wattage (SCE 2006 Program)	SCE Average Delta W	SFEER Delta W	Inferred Base Wattage
0-799	40	9.0	31.0	46.8	55.8
800-1099	60	13.8	46.2	51.3	65.1
1100-1599	75	19.2	55.8	68.5	87.7
1600-2000	100	23.9	76.1	68.5	92.4
2000-2599	150	30.0	120.0	68.5	98.5
1100-2599	96.6	23.2	73.4	68.5	91.7

*This category is based on weighted averages for the three smaller categories

[63] Ibid., 6-6.

In each case the ENERGY STAR® wattage equivalence used in the DEER report and the program assumptions is more conservative, except for the 1600-1999 and 2000-2599 lumen range. This is most likely due to the fact that such a large lumen range was used. For the grouped 1100-2599 lumen category, the difference between the effective SCE base wattage and the inferred base wattage based on SFEER is 5.3%, well within an expected 10% error bound on the SFEER estimate. This exercise was only meant to demonstrate that the program assumptions, based on ENERGY STAR®, are reasonable and somewhat conservative. The survey relied on self-reported data about what light bulb had preceded an existing light bulb, which may not be highly reliable data. This exercise is not meant to support an increase in the base wattage assumption. We recommend maintaining the DEER equivalence over the Itron finding because it is more conservative and more specific to the lumen range of a bulb.

Net-to-Gross Assumption: To determine the Net-To-Gross (NTG) ratio, the study relied on surveys of retailers and manufacturers. This was due to the fact that in the telephone survey only 24% of respondents who had purchased CFLs during the program were aware they had received a discount, and so direct self-report data were scarce. This is a characteristic nature of upstream programs where it is difficult to adopt standard end-use-based survey methodologies for determining a net-to-gross ratio. Hence, in the surveys of retailers and manufacturers, the study asked respondents to estimate free-ridership based on their sales data for various retail channels. Although the number of respondents was very small in many cases, we accept this because the respondents represented a large portion of the sales volume in that retail channel. The study found distinct free-ridership rates for different retail channels, and then calculated a weighted average of these based on rebated sales volume during 2004-05. The overall free-ridership for SCE was calculated to be 33%, yielding a .67 NTG for 2004-05. Of the 24% of those surveyed who remembered receiving a discount, 63% were somewhat likely, not very likely, or very unlikely to purchase a CFL in the absence of the discount, and thus demonstrated some influence by the program[64]. This value is close to the value determined by the retailer and manufacturer survey data and we deem that the two different methodologies corroborate one another.
Because the study NTG results are retail channel specific and the Upstream Lighting program retail channel distribution of CFLs has shifted, we calculated the NTG using weights developed from 2006 program data. We calculated weights using proportions of sales volume, dollar amount paid by the utility, and energy savings for the utility. The results are shown in Table 30.

Table 30. Net-to-Gross Values by Distribution Channel

Channel	Units	Dollars	kWh	SFEER 04/05	Channel Free-ridership
Big Box	8.5%	6.6%	6.2%	18.0%	75%
Discount	19.2%	20.2%	20.4%	12.0%	3%
Drug	5.5%	5.6%	5.4%	4.0%	41%
Grocery	56.4%	57.4%	57.6%	51.0%	16%

64 Itron 2007, 5-23

Home Improvement	8.1%	7.8%	8.1%	12.0%	66%
Small Hardware	1.4%	1.3%	1.3%	2.0%	52%
Other	0.9%	0.9%	1.0%	1.0%	38%
Total	100.0%	100.0%	100.0%	100.0%	
Parameter					
Free-ridership	24.8%	23.4%	23.2%	33.4%	
NTG	0.75	0.77	0.77	0.67	

Weighting by dollars or by energy saved yields a slightly higher NTG, but the figures are quite similar and SCE recommends using the 0.75 net to gross ratio determined using the methodology used in the study. Because the data represent the program as a whole, and not solely the residential data, we are assuming the NTG for the residential and non-residential portions of savings are the same.

Installation rate: For the measures in this work paper, Edison has determined that the DEER Installation Rate of 92% (0.92) that is used for Express Efficiency-type programs[65] that have limited or no measure verification requirements would be more appropriate for these program measures than the 100 % installation rate for programs with strict measure verification requirements. The 92% installation rate is expected to also account for bulbs that are installed at a later time. There are no EM&V studies available that have yet calculated the future installation and savings for stored bulbs.

Hours of Operation: The "SDG&E 2004-05 Express Efficiency Lighting Program Time of Use Study" (RLW Analytics 2007)[66] sought to determine an hours of operation figure for non-residential applications. Unfortunately, because we assume that the non-residential portion of the bulbs purchased through the Residential Upstream Lighting Program tend only to go to specific applications, the general non-residential number was not applicable. RLW did have measurements for the applications we assume, but the sample size was too small (n=1 in one case) to justify a change in program assumptions. Therefore, we recommend retaining the number that was calculated from DEER.

Effective Useful Life: We recommend retaining the value of 2.1 years as no new data is available to suggest another value.

Residential/Non-Residential Split: Currently there are no studies available that directly measure the proportion of upstream rebated lighting products purchased for commercial use. This work paper assumes 10% of the measures purchased are for commercial applications. To validate this assumption, we used data gathered in a previous manufacture buy-down program. The 1994 Compact Fluorescent Lamp Manufacturers' Rebate Program provided financial incentives directly to CFL manufacturers to sell compact fluorescent equipment in Southern California Edison territory at discounted prices. As part of the program, consumer bounce–back cards

65 KEMA, CFL Metering Study Final Report, February 25, 2005, 5-3

66 RLW Analytics, SDG&E 2004-05 Express Efficiency Lighting Program Time of Use Study

collected basic information for the CFL product usage. The bounce back card included a question on use of the purchased product for business or home use. The responses to this question are provided in Table 3 as both unweighted and weighted proportions, where the weights are based on the number of CFLs purchased. Two questions were used to calculate the weighted proportions: weighted proportions based on responses to either question on "number of CFL bulbs purchased" (Q7) or "number of CFLs by location used(Q5 a-g)"; and weighted proportions based on "number of bulbs purchased (Q7) where information on location was unknown. Thus column X in Table 31 is based on an amalgam of weight proportions sensitive to location and records that could only be weighted with respect to bulb count.

Table 31. 1994 CFL Manufacturers Bounce Back Card Survey

1994 CFL Manufacturer's Bounce Back Card Survey							
Is this Compact Fluorescents Bulb for your home or business?							
Source Question * :		Column X: No. of bulbs and bulbs with location		Column Y: No. of bulbs		Column Z: No. of Cards	
		CFL(c)	Wtd.Percent	CFL(b)	Wtd.Percent	CFL(a)	Percent
Business		5,860	16%	122	11%	1,931	10%
Household		30,567	81%	934	86%	16,424	88%
Household/Business		1,350	4%	33	3%	272	1%
TOTAL		37,777		1,089		18,627	
Percent Business			19%		14%		12%

*
Column X: Q7- How Many CFLs Purchased or Q5A-Q5G - No. of CFLs in a different location
Colum Y: Q7- How Many CFLs Purchased
CFL(c) and CFL(b) are weighted counts by number of CFLs purchased.CFL(a) is unweighted count of cards

As shown in Table 31, at least 12% or as high as 19% bulbs purchased through the Manufacturers' Rebate program were for commercial use, hence supporting the conservative program planning estimate of 10%. Future EM&V study needs to update this proportion for the Upstream lighting program measures assumed to be used in commercial application as well.

Incandescent Equivalency: We can validate the CFL to incandescent equivalency assumptions made in this work paper by creating a metric using available data from field observations. This metric is the CFL to incandescent ratio, which tells us the observed relationship between the wattages of CFLs and wattages of incandescent lamps they replaced. The equivalence need not be based on wattage alone but rather can be based on lumen output, as is assumed in this work paper. SCE compared the CFL to incandescent ratio implied by the ENERGY STAR Light Output Equivalency Table (Section 1.5 below) to the ratio calculated using the results of the KEMA CFL Metering Study[7] (reproduced below for ease of reference). For the ENERGY STAR equivalence, the categories are based on lumen levels; for the CFL Metering Study they are based on incandescent base wattage. In each case, a range of CFL wattages fall into each category and so minimum and maximum values were calculated for each category and the mean was chosen. The weighted average was then calculated based on 2006 program volume for the ENERGY STAR equivalence and from KEMA's reported relative frequency. The aggregated CFL to incandescent ratio from the ENERGY STAR chart is 0.267 and that for the CFL Metering Study was 0.254. This is a difference of 5%. This suggests that the lumen mapping method recommended by ENERGY STAR roughly approximates the wattage matching that KEMA observed in the field.

Table 32. KEMA CFL Metering Study

Table 5-4

Incandescent Bulbs Replaced by CFLs

Original Incandescent Wattage	Number of Monitored Fixtures with Replacement CFLs	Percent of Monitored Fixtures	Typical CFL Replacement Wattage
60	250	57%	13-17
75	84	19%	18-22
40	55	12%	9-12
100	53	12%	23-26

Table 33. Summary of Market Parameters

Measure Parameter	*Ex-ante* Value	Revised *Ex-ante* Value
ΔkW	ENERGY STAR® lumen equivalents	No change
Hours of Operation	3,220	3,220
Net-to-Gross Ratio	0.80	0.75
Effective Useful Life	2.1	2.1
In-service Rate	90%	92%

1.5 Base Cases for Savings Estimates: Existing and Above Code

The existing equipment replaced by these measures are incandescent lamps in the range of 15 watts through 500 watts. Base measures are mapped to replacement CFLs as described in Table 34.

Table 34: Mapping of Base Wattages to CFLs by Lumen Equivalency

BASE WATTS	LUMEN RANGE ≤	LUMEN RANGE ≥	SOURCE
≥ 24	0	249	extrapolated
25	250	449	extrapolated
40	450	799	Energy Star®
60	800	1,099	Energy Star®
75	1,100	1,399	Energy Star®
90	1,400	1,599	interpolated
100	1,600	1,999	Energy Star
120	2,000	2,599	interpolated
150	2,600	3,599	Energy Star®
200	3,600	4,599	extrapolated
500	4,600		extrapolated

This table is an expansion of the Energy Star® CFL/Incandescent Equivalency Chart which can be found at http://www.energystar.gov/index.cfm?c=cfls.pr_cfls[67], which is also shown in Table 35 for ease of reference.

Table 35. Energy Star Light Output Equivalency

LIGHT OUTPUT EQUIVALENCY

To determine which ENERGY STAR qualified light bulbs will provide the same amount of light as your current incandescent light bulbs, consult the following chart:

INCANDESCENT LIGHT BULBS WATTS	MINIMUM LIGHT OUTPUT LUMENS	COMMON ENERGY STAR QUALIFIED LIGHT BULBS WATTS
40	450	9-13
60	800	13-15
75	1,100	18-25
100	1,600	23-30
150	2,600	30-52

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Table 5-4 of the 2005 CFL Metering Study[68] also provides self-reported base incandescent replacement wattage for various CFL wattages. This is based on self-reported data on the monitored fixtures in the study.

67 Energy Star® CFL/Incandescent Equivalency Chart which can be found at http://www.energystar.gov/index.cfm?c=cfls.pr_cfls

68 KEMA 2005, 5-3.

1.6 Base Cases and Measure Effective Useful Lives

Measure effective useful lives (EULs) used for these measures are based on those found under MeasureID for D03-801 to D03-818 All Screw-in CFLs –Retail Small located in Table 11-4: Non-Weather Sensitive – Lighting EULs, p.11-8: *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, December 2005*[69].

69 Itron 2005, 11-8.

Table 36. Non-Weather Sensitive - Lighting EULs (DEER Table 11-4)

MeasureID	Measure Name	EUL	EUL Source
D03-801 to D03-818	All Screw-in CFLs - Health/Medical - Hospital	0.9	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Health/Medical - Nursing Home	0.9	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Lodging - Hotel	0.9	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Lodging - Motel	0.9	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Restaurant - Fast-Food	1.3	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Grocery	1.4	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Retail - Single-Story Large	1.8	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Retail - 3-Story Large	1.9	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Education - Community College	2.1	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Retail - Small	2.1	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Restaurant - Sit-Down	2.3	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Education - University	2.6	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Manufacturing - Light Industrial	2.8	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Storage - Conditioned	2.8	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Storage - Unconditioned	2.8	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Office - Large	2.9	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Warehouse - Refrigerated	3.1	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Office - Small	3.2	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Education - Secondary School	3.5	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Education - Primary School	5.6	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Lodging - Guest Rooms	7.0	DEER/Metering Study 2005
D03-801 to D03-818	All Screw-in CFLs - Residential	9.4	DEER/Metering Study 2005
D03-819 to D03-837	All pin based CFLs - Commercial Buildings	12.0	SERA Report - May 2005/07-14-05
D03-819 to D03-837	All pin based CFLs - Residential Buildings	16.0	SERA Report - May 2005/07-14-05
D03-838	20W CFL Table Lamp: Residential	16.0	SERA Report - May 2005/07-14-05
D03-839	25W CFL Table Lamp: Residential	16.0	SERA Report - May 2005/07-14-05
D03-840	32W CFL Table Lamp: Residential	16.0	SERA Report - May 2005/07-14-05
D03-841	50W CFL Table Lamp: Residential	16.0	SERA Report - May 2005/07-14-05
D03-842	55W CFL Torchiere: Residential	9.0	CALMAC Report - September 2000
D03-843	70W CFL Torchiere (two LAMPs): Residential	9.0	CALMAC Report - September 2000
D03-844	50W Metal Halide	16.0	CALMAC Report - September 2000
D03-845	75W Metal Halide	16.0	CALMAC Report - September 2000
D03-846	100W Metal Halide	16.0	CALMAC Report - September 2000
D03-847	175W PS Metal Halide	16.0	CALMAC Report - September 2000
D03-848	175W PS Metal Halide	16.0	CALMAC Report - September 2000
D03-849	250W PS Metal Halide	16.0	CALMAC Report - September 2000
D03-850	200W HPS	16.0	CALMAC Report - September 2000
D03-851	180W LPS	16.0	CALMAC Report - September 2000
D03-852	Premium T8 El Ballast	11.0	SERA Report - May 2005/07-14-05
D03-853	T8 32W Dimming El Ballast	11.0	SERA Report - May 2005/07-14-05
D03-854	De-lamp from 4', 4 lamp/fixture	11.0	SERA Report - May 2005/07-14-05
D03-855	De-lamp from 8', 4 lamp/fixture	11.0	SERA Report - May 2005/07-14-05
D03-856	Occ-Sensor - Wall box	8.0	CALMAC Report - September 2000
D03-857	Occ-Sensor - Plug loads	10.0	CALMAC Report - September 2000
D03-858	Timeclock:	8.0	CALMAC Report - September 2000
D03-859	Photocell:	8.0	CALMAC Report - September 2000
D03-860	LED Exit Sign (New)	16.0	CALMAC Report - September 2000
D03-861	LED Exit Sign Retrofit Kit	16.0	CALMAC Report - September 2000
D03-862	Electroluminescent Exit Sign (New)	16.0	CALMAC Report - September 2000
D03-863	Electroluminescent Exit Sign Retrofit Kit	16.0	CALMAC Report - September 2000

1.7 Net-to-Gross Ratios for Different Program Strategies

Table 37 summarizes all applicable Net-to-Gross ratios for programs that may be used by this measure.

Table 37. Net-to-Gross Ratios

Program Approach	NTG

Upstream Non Residential Lighting	0.75

As explained above in Section 1.4 EM&V Market Potential, the Net-to-Gross (NTG) ratio used for these measures is based on Edison's evaluation of actual measure distributions in combination with the methodology outlined in the *2004/2005 Statewide Residential Retrofit Single Family Energy Efficiency Rebate Evaluation,* June 29, 2007.

Section 2. Calculation Methods

2.1 Energy Savings Estimation Methodologies

The annual energy savings formulas follow the calculation methods used in the *2004–2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, December 2005*[70], modified to exclude energy and interactive effects as explained in the DEER Difference Analysis section of these of these work papers found in Section 1.2, specifically:

[Equation 2] ΔWatts/unit:

The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit:

<u>ΔWatts/unit</u> = Base Watts/unit - Energy Efficient Unit Watts
Example: ΔWatts/unit = 100 Watts/unit - 54 Watts / units = 46 Watts

[Equation 3] Annual Energy Savings:

$$\text{Energy Savings [kWh/Unit]} = \frac{(\Delta\text{Watts/unit}) \times (\text{annual hours of operation}) \times (\text{Installation Rate})}{1{,}000 \text{ Watts / kW}}$$

$$\text{Example: Energy Savings} = \frac{(46 \text{ Watts})(3{,}220 \text{ annual hour of operation}) \times (0.92 \text{ Installation Rate})}{1{,}000 \text{ Watt / kW}} = 136.27 \text{ kWh}$$

Annual hours of operation: The DEER Report employs a methodology that is oriented toward using operating hours for specific market sectors when calculating energy and demand impacts. However, at this time there is insufficient data to determine specific allocation of measures to specific market sectors. It is however generally understood that the primary nonresidential participants in this program are small businesses. Accordingly, SCE uses a simple average of the annual operating hours for small retail, small office, and sit-down restaurants. The annual hours of operation used in this work paper are based on a simple average of the DEER operating hours for three building types that are considered to be the primary participants in this program: small retail, small office, and sit-down restaurants. The operating hours are obtained from *Table 3-2: Annual Lighting Hours, energy and demand Diversity Factors, and Coincident Diversity*

[70] Ibid., 2-2, 2-3

Factors by Building Type for CFL Lighting[71] Current assumptions are that the most likely participants in this program will the owners and operators of small businesses. The market sectors that most closely represent this general category are small offices, sit-down restaurants, and small retail establishments. A simple average of these market segments was calculated as follows:

[Equation 4] $$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{1}{n}(x_1 + \cdots + x_n).$$

3220 average operating hours = (2,492 office-small + 3,444 restaurant-sit down + 3,724 retail-small)/3 observations

2.2 Demand Reduction Estimation Methodologies

The demand reduction formulas follow the calculation methods used in the *2004–2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, December 2005*[72], on page 3-6, modified to exclude energy and interactive effects, as explained in the DEER Difference Analysis section of these work papers, found in Section 1.2, specifically:

[Equation 5] ΔWatts/unit:

The demand difference (watts per unit) is simply the difference between the electric demand of the base unit and the electric demand of the energy efficient unit.

ΔWatts/unit = *Base Watts/unit - Energy Efficient Unit Watts*

Example: *ΔWatts/unit = 100 Watts/unit - 54 Watts / units = 46 Watts*

[Equation 6] Demand Reduction:

$$\text{Demand Reduction [kW/Unit]} = \frac{(\Delta\text{Watts/unit}) \times (\text{Installation Rate}) \times (\text{Peak Coincidence Factor})}{1{,}000\ \text{Watts s/ kW}}$$

Example: $$\text{Demand Reduction} = \frac{(46\ \text{Watts} \ x\ (0.92)\ x\ (0.79)}{1{,}000\ \text{Watt s /kW}} = 0.03343\ \text{kW}$$

Coincident Diversity Factors: Section 3, the non residential section of the 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study, uses a coincident diversity factor in place of the peak load share used in the residential section to calculate the portion of energy demand produced by a lighting measure that occurs during an on peak period. For reasons elaborated on in the above discussion on hours of operation, the Coincident Diversity Factors used in this work paper are based on a simple average of the

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71 Itron, Inc., "2004-2005 Database for Energy Efficiency Resources Update Study, Final Report," Table 3-5 Annual Lighting Hours, Energy and Demand Diversity Factors and Coincident Diversity Factors by Building Type for Non-CFL Lighting, December 2005, page 3-

72 Itron 2005, 3-6.

DEER coincident diversity factors for the same three building types: small retail, small office, and sit-down restaurants, which are considered to be the primary participants in this program. These factors were obtained from *Table 3-2: Annual Lighting Hours, Energy and Demand Diversity Factors, and Coincident Diversity Factors by Building Type for CFL Lighting*[73]. Using the same formula as cited above for the calculation of average operating hours, an average coincident factor is calculated as follows.

0.79 Coincident Diversity Factor = (0.81 office-small + 0.68 restaurant-sit down + 0.88 retail-small)/3 observations

In all cases, the values were extracted directly from Table 3-2, which is reproduced below.

Table 38. Annual Lighting Hours and Demand Diversity Factors, and Coincident Diversity Factors by Building Type for CFL Lighting (DEER Table 3-2)

Market Sector	Annual Operating Hours	Energy Interactive Effects	Coincident Diversity Factors	Demand Interactive Effects
Education - Primary School	1,440	1.15	0.42	1.23
Education - Secondary School	2,305	1.15	0.42	1.23
Education - Community College	3,792	1.15	0.68	1.22
Education - University	3,073	1.15	0.68	1.22
Grocery	5,824	1.13	0.81	1.25
Health/Medical - Hospital	8,736	1.18	0.74	1.26
Health/Medical - Clinic	8,736	1.18	0.74	1.26
Lodging - Hotel	8,736	1.14	0.67	1.14
Lodging - Motel	8,736	1.14	0.67	1.14
Lodging - Guest Rooms	1,145*	1.14	0.67	1.14
Manufacturing - Light Industrial	2,860	1.04	0.99	1.08
Office - Large	2,739*	1.17	0.81	1.25
Office - Small	2,492*	1.17	0.81	1.25
Restaurant - Sit-Down	3,444*	1.15	0.68	1.26
Restaurant - Fast-Food	6,188	1.15	0.68	1.26
Retail - 3-Story Large	4,259	1.11	0.88	1.19
Retail - Single-Story Large	4,368	1.11	0.88	1.19
Retail - Small	3,724*	1.11	0.88	1.19
Storage - Conditioned	2,860	1.06	0.84	1.09
Storage - Unconditioned	2,860	1.06	0.84	1.09
Warehouse - Refrigerated	2,600	1.06	0.84	1.09

* Different from the values used in Table 3-5

Section 3 Load Shapes

73 Ibid 2005, 3-5.

Load Shapes are a graphic representation of electrical load over a period of time and are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure's load shape. The measure's load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure's total resource cost (TRC) benefit.

3.1 Base Cases Load Shapes

The base case indoor lighting system's demand would be expected to follow an indoor lighting end-use load shape for each market sector as shown in the E3 Calculator.

3.2 Measure Load Shapes

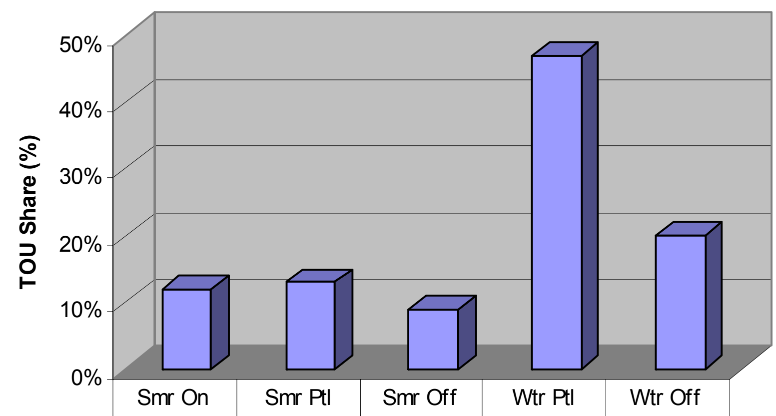
For purposes of the net benefits estimates in the E3 calculator, what is required is the demand load shape that ideally represents the *difference* between the base equipment and the installed energy efficiency measure. This *difference* load profile is what is called the Measure Load Shape and would be the preferred load shape for use in the net benefits calculations. The measure equipment and controls may alter the typical commercial indoor lighting hourly demand profile differently, making it difficult to select a single demand profile to represent the category. The commercial indoor lighting measures demand profile under this Direct Install measure category (fluorescent lighting system) is expected to be slightly lower when compared to the base system.

The Load Shape Update Initiative Study determined that for load-following measures, the end-use load shape can be substituted for the measure shape:

> "It can be argued that for measures that are roughly load-following (have a similar pattern to the end-use itself), substituting the end-use load shape for the measure shape is a reasonable simplification. Errors introduced by this substitution may be minor compared to other uncertainties in the savings valuation process. Distinguishing measure shape from end-use shape may be an unnecessary complication except for measures that are not load-following. This perspective was suggested by some workshop participants and interviewees."[74]

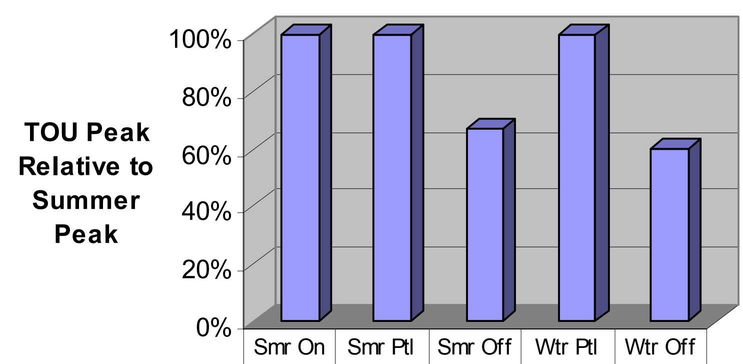
74 KEMA, Final Report Load Shape Initiative, Revised November 17, 2006.

The E3 Calculator contains a fixed set of load shapes selections that are the combination of the hourly avoided costs and whatever load shape data were available at the time of the tool's creation. In the case of SCE's E3 Calculator, the majority of the load shape data at the time were TOU End Use load shapes and not Hourly Measure load shapes. Figure 10 and Figure 11 represent the TOU End Use Energy and Peak Demand factors for indoor lighting measures that are embedded within the SCE E3 Calculator.



	Smr On	Smr Ptl	Smr Off	Wtr Ptl	Wtr Off
TOU %	12%	13%	9%	47%	20%

Figure 10. TOU energy Factors - Indoor Lighting End Use



	Smr On	Smr Ptl	Smr Off	Wtr Ptl	Wtr Off
Peak Ratio	100%	100%	67%	100%	60%

Figure 11. TOU Demand Factors - Indoor Lighting End Use

In the E3 Calculator, for the "Measure Electric End Use Shape" selection, the "Indoor Lighting" (Indoor LT) load shape is the only appropriate selection for the Commercial Indoor Lighting System Replacement measure category. The "Indoor Lighting" selection is enabled for most of the nonresidential Target Sectors in Version 3c3-2000 of the E3 Calculator. The exceptions are:

- Grocery Store, select Food Store to enable the IndoorLT load shape,

- Fast Food Restaurant, select Restaurant to enable the IndoorLT load shape,
- Sit Down Restaurant, select Restaurant to enable the IndoorLT load shape,
- Storage Building, select Non-Refrigerated Warehouse to enable the IndoorLT load shape,
- School, select K-12 School to enable the IndootLT load shape, and
- Assembly, select Miscellaneous Commercial to enable the IndoorLT load shape.

Section 4. Base Case and Measure Costs

Measure costs were obtained directly from Table C-4: DEER Non-Weather Sensitive Measure List, in most instances. As explained in section 4.3 below, for certain measures that were not represented in the DEER tables, lamp wattages were extrapolated to match available cost data.

4.1 Base Cases Costs

Base equipment costs were obtained from the DEER for this work paper as listed in Table 39 below.

4.2 Measure Costs

For screw-in compact fluorescent lamps, measure costs were extracted from the *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, Appendix C, Table C-4 DEER Non – Weather Sensitive Measure List*[75]. Wattages of CFLs measures were matched to those in the DEER table and the incremental measure costs were used as presented in the table. In instances where direct mappings of wattages were not possible, costs from the closest available DEER wattages were used. For example, Table C-4 in DEER did not have costs for a 9 Watt, 10 Watt, or 11 Watt CFLs. The first available costs in the DEER table were for a 13 Watt CFL. So the costs presented for the 13 Watt CFLs were used for the 9, 10, and 11 watt CFLs. Using the above example, 9 Watt, 10 Watt, 11 Watt, and 13 Watt CFLs would all be priced at the next available cost of $4.98/unit.

4.3 Incremental and Full Measure Costs

For screw-in compact fluorescent lamps, incremental costs were extracted from the *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study Final Report, Appendix C, Table C-4 DEER Non – Weather Sensitive Measure List*[75]. Wattages of CFLs measures were matched to those in the DEER table and the incremental measure costs were used as presented. In instances where direct mappings of wattages were not possible, costs from the closest available DEER wattages were used. For example, Table C-4 in DEER did not have costs for a 9 Watt, 10 Watt, or 11 Watt CFLs. The first available costs in the DEER table were for a 13 Watt CFL. Therefore, the costs presented for the 13 Watt CFLs were used for the 9, 10, and 11 watt CFLs. Using the above

75 Ibid., C-5

example, 9 Watt, 10 Watt, 11 Watt, and 13 Watt CFLs would all be priced at the next available cost of $4.40/unit.

Installation costs were not used for these measures for the following reason: the participants in this non residential program are most likely small business owners that would install these units as part of their normal maintenance routines and not incur any additional expense over and above the level of effort in replacing a standard incandescent lamp. An argument could be made that due to the longer life on CFLs, those installations would occur less frequently and that an installation credit due to the reduced frequency of replacement could be easily calculated. However, SCE has decided not to calculate and claim an installation credit at this time.

Table 39. DEER Non-Weather Sensitive Measure List (DEER Table C-4)

MeasureID	Measure Name	Energy Common Units	Cost Common Units	Base Equipment Cost ($)	Measure Equipment Cost ($)	Incremental Equipment Cost ($)	Labor Cost ($)	Installed Cost ($)
D03-801	13 Watt CFL < 800 Lumens - screw-in	LAMP	Lamp	$0.57	$4.98	$4.40	$3.77	$8.18
D03-802	13 Watt CFL =800 Lumens - screw-in	LAMP	Lamp	$0.61	$4.87	$4.26	$3.77	$8.04
D03-803	14 Watt CFL - screw-in	LAMP	Lamp	$0.61	$5.25	$4.64	$3.77	$8.41
D03-804	15 Watt CFL - screw-in	LAMP	Lamp	$0.61	$5.62	$5.01	$3.77	$8.79
D03-805	16 Watt CFL - screw-in	LAMP	Lamp	$0.61	$6.00	$5.39	$3.77	$9.16
D03-806	18 Watt CFL < 1,100 Lumens - screw-in	LAMP	Lamp	$0.61	$6.74	$6.14	$3.77	$9.91
D03-807	18 Watt CFL =1,100 Lumens - screw-in	LAMP	Lamp	$0.61	$6.37	$5.77	$3.77	$9.54
D03-808	19 Watt CFL =1,100 Lumens - screw-in	LAMP	Lamp	$0.61	$6.73	$6.12	$3.77	$9.89
D03-809	20 Watt CFL - screw-in	LAMP	Lamp	$0.61	$7.08	$6.47	$3.77	$10.25
D03-810	23 Watt CFL - screw-in	LAMP	Lamp	$0.61	$6.66	$6.05	$3.77	$9.82
D03-811	25 Watt CFL <1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$8.85	$8.24	$3.77	$12.02
D03-812	25 Watt CFL =1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$7.24	$6.63	$3.77	$10.40
D03-813	26 Watt CFL <1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$9.21	$8.60	$3.77	$12.37
D03-814	26 Watt CFL =1,600 Lumens - screw-in	LAMP	Lamp	$0.61	$7.52	$6.92	$3.77	$10.69
D03-815	28 Watt CFL - screw-in	LAMP	Lamp	$0.61	$8.10	$7.50	$3.77	$11.27
D03-816	30 Watt CFL - screw-in	LAMP	Lamp	$0.61	$9.26	$8.65	$3.77	$12.43
D03-817	36 Watt CFL - screw-in	LAMP	Lamp	$2.22	$9.19	$6.97	$3.77	$10.75
D03-818	40 Watt CFL - screw-in	LAMP	Lamp	$2.22	$12.77	$10.55	$3.77	$14.32
D03-819	13 Watt CFL < 800 Lumens - pin based	LAMP	Lamp	$0.00	$17.88	$0.00	$27.14	$45.02
D03-820	13 Watt CFL =800 Lumens - pin based	LAMP	Lamp	$0.00	$17.88	$0.00	$27.14	$45.02
D03-821	14 Watt CFL - pin based	LAMP	Lamp	$0.00	$18.38	$0.00	$27.14	$45.51
D03-822	15 Watt CFL - pin based	LAMP	Lamp	$0.00	$18.87	$0.00	$27.14	$46.01
D03-823	16 Watt CFL - pin based	LAMP	Lamp	$0.00	$19.36	$0.00	$27.14	$46.50
D03-824	18 Watt CFL < 1,100 Lumens - pin based	LAMP	Lamp	$0.00	$20.35	$0.00	$27.14	$47.49
D03-825	18 Watt CFL =1,100 Lumens - pin based	LAMP	Lamp	$0.00	$20.35	$0.00	$27.14	$47.49
D03-826	19 Watt CFL =1,100 Lumens - pin based	LAMP	Lamp	$0.00	$20.84	$0.00	$27.14	$47.98
D03-827	20 Watt CFL - pin based	LAMP	Lamp	$0.00	$21.34	$0.00	$27.14	$48.48
D03-828	23 Watt CFL - pin based	LAMP	Lamp	$0.00	$22.82	$0.00	$27.14	$49.96
D03-829	25 Watt CFL <1,600 Lumens - pin based	LAMP	Lamp	$0.00	$23.80	$0.00	$27.14	$50.94
D03-830	25 Watt CFL =1,600 Lumens - pin based	LAMP	Lamp	$0.00	$23.80	$0.00	$27.14	$50.94
D03-831	26 Watt CFL <1,600 Lumens - pin based	LAMP	Lamp	$0.00	$24.30	$0.00	$27.14	$51.44
D03-832	26 Watt CFL =1,600 Lumens - pin based	LAMP	Lamp	$0.00	$24.30	$0.00	$27.14	$51.44
D03-833	28 Watt CFL - pin based	LAMP	Lamp	$0.00	$25.28	$0.00	$27.14	$52.42
D03-834	30 Watt CFL - pin based	LAMP	Lamp	$0.00	$26.27	$0.00	$27.14	$53.41
D03-835	40 Watt CFL - pin based	LAMP	Lamp	$0.00	$31.20	$0.00	$27.14	$58.34
D03-836	55 Watt CFL - pin based	LAMP	Lamp	$0.00	$38.60	$0.00	$27.14	$65.74
D03-837	65 Watt CFL - pin based	LAMP	Lamp	$0.00	$43.54	$0.00	$27.14	$70.68
D03-838	20W CFL Table Lamp	Fixture	Fixture	$50.43	$50.43	$0.00	$0.00	$0.00
D03-839	25W CFL Table Lamp	Fixture	Fixture	$61.13	$61.13	$0.00	$0.00	$0.00
D03-840	32W CFL Table Lamp	Fixture	Fixture	$63.20	$63.20	$0.00	$0.00	$0.00
D03-841	50W CFL Table Lamp	Fixture	Fixture	$122.96	$122.96	$0.00	$0.00	$0.00
D03-842	55W CFL Torchiere	Fixture	Torchiere	$59.39	$59.39	$0.00	$0.00	$0.00
D03-843	70W CFL Torchiere (two LAMPs)	Fixture	Torchiere	$55.76	$55.76	$0.00	$0.00	$0.00
D03-844	50W Metal Halide	Fixture	Fixture	$0.00	$113.85	$0.00	$100.51	$214.36
D03-845	75W Metal Halide	Fixture	Fixture	$0.00	$120.09	$0.00	$100.51	$220.60
D03-846	100W Metal Halide	Fixture	Fixture	$0.00	$126.66	$0.00	$100.51	$227.17
D03-847	175W PS Metal Halide	Fixture	Fixture	$0.00	$129.01	$0.00	$67.84	$196.86
D03-848	175W PS Metal Halide	Fixture	Fixture	$0.00	$129.01	$0.00	$67.84	$196.86
D03-849	250W PS Metal Halide	Fixture	Fixture	$0.00	$152.08	$0.00	$67.84	$219.92
D03-850	200W HPS	Fixture	Fixture	$0.00	$91.05	$0.00	$67.84	$158.89
D03-851	180W LPS	Fixture	Fixture	$0.00	$74.62	$0.00	$67.84	$142.46
D03-852	Premium T8 El Ballast	Fixture	Fixture	$19.23	$23.42	$4.19	$0.00	$0.00
D03-853	T8 32W Dimming El Ballast	Fixture	Fixture	$16.54	$72.89	$56.34	$16.96	$89.85
D03-854	De-lamp from 4', 4 lamp/fixture	Fixture	Fixture	$0.00	$3.08	$0.00	$22.63	$25.71
D03-855	De-lamp from 8', 4 lamp/fixture	Fixture	Fixture	$0.00	$3.28	$0.00	$22.63	$25.91
D03-856	Occ-Sensor - Wall box	Sensor	Sensor	$0.00	$42.28	$0.00	$35.00	$77.28
D03-857	Occ-Sensor - Plug loads	Sensor	Sensor	$0.00	$82.25	$0.00	$35.00	$117.25
D03-858	Timeclock:	Timeclock	Timeclock	$0.00	$123.01	$0.00	$116.88	$239.89
D03-859	Photocell:	Photocell	Photocell	$0.00	$12.06	$0.00	$47.75	$59.81
D03-860	LED Exit Sign (New)	Exit Sign	Sign	$0.00	$31.52	$0.00	$33.92	$65.44
D03-861	LED Exit Sign Retrofit Kit	Exit Sign	Sign	$0.00	$16.66	$0.00	$33.92	$50.58
D03-862	Electroluminescent Exit Sign (New)	Exit Sign	Sign	$0.00	$73.42	$0.00	$33.92	$107.34
D03-863	Electroluminescent Exit Sign Retrofit Kit	Exit Sign	Sign	$0.00	$70.14	$0.00	$33.92	$104.06
D03-901	High Efficiency Copier	Copy Machine	copier	$1,616.38	$1,773.14	$156.76	$0.00	$0.00
D03-902	High Efficiency Copier	Copy Machine	copier	$4,686.00	$7,654.69	$2,968.69	$0.00	$0.00
D03-903	High Efficiency Copier	Copy Machine	copier	$0.00	$10,924.63	$0.00	$0.00	$0.00
D03-904	High Efficiency Gas Fryer	Fryer	Fryer	$1,520.61	$4,103.15	$2,582.54	$0.00	$0.00
D03-905	High Efficiency Gas Griddle	Griddle	Griddle	$1,758.36	$3,860.67	$2,102.31	$0.00	$0.00
D03-906	High Efficiency Electric Fryer	Fryer	Fryer	$3,326.73	$12,088.62	$8,761.89	$0.00	$0.00
D03-907	Hot Food Holding Cabinet	Cabinet	Cabinet	$1,545.67	$2,589.81	$1,044.13	$0.00	$0.00
D03-908	Connectionless Steamer	Steamer	Steamer	$5,128.24	$3,206.64	-$1,921.61	$0.00	$0.00
D03-909	Point of Use Water Heat	1000 sqft building	WtrHtr	$492.96	$863.60	$370.64	$250.90	$1,114.50

Attachments

Attachment 1. Non-Residential CFL Integral Screw-In Fixtures Worksheet.

WPSCRELG0022
Summary