Residential New Construction (RNC) Programs.

Impact Evaluation – Volume I.

California Investor-Owned Utilities' Residential New Construction Program Evaluation for Program Years 2006-2008

Study ID: CPU0030.01

Final Evaluation Report - Prepared by:
KEMA, Inc.
The Cadmus Group, Inc.
Itron, Inc.
Nexus Market Research, Inc.

Prepared for:
California Public Utilities Commission – Energy Division

February 8, 2010

Submitted to:
Ayat Osman, PhD
505 Van Ness Avenue
California Public Utilities Commission
Energy Division
San Francisco, CA 94102

Submitted by:
John Stoops, Principal
KEMA, Inc.
155 Grand Avenue, Suite 500
Oakland, CA 94612
510-891-0446

Abstract

This report contains the final impact evaluation results of the California investor-owned utilities' (IOUs) 2006-08 residential new construction (RNC) programs. The report also incorporates a few smaller residential and non-residential programs that provided low energy savings during that period. The RNC programs that received a full impact evaluation included SCG's Advanced Home Program (SCG 3502), SDG&E's Advanced Home Program (SDG&E 3007), SCE's California New Homes Program (SCE 2505), and PG&E's RNC Program (PG&E 2009), with the focus of the evaluation on single-family whole-house measures, which accounted for the vast majority of RNC savings. Three programs that received verification-guided evaluations were PG&E's California Multifamily Homes New Construction Program (PG&E 2059), and SCG's and SCE's Designed for Comfort Programs (SCG 3537 and SCE 2543).

With the exception of SDG&E, which claimed no savings for the whole house approach, all of the IOUs exceeded their claims for electric and demand savings for whole house single family RNC, but fell short of their claimed gas savings. The overall statewide realization rates for net savings were 1.78 for kWh, 1.92 for kW, and 0.36 for gas savings. The high realization rates for the electric and demand savings and low realization rates for gas savings largely stemmed from the fact that the compliance model that was used to generate the ex-ante savings estimates (MICROPAS) underestimates cooling energy use, but overestimate heating energy use. This finding was based on a comparison of metered (field measurement data) and modeled data (using MICROPAS). Ex-post electricity NTG ratios for the RNC programs varied widely across IOUs and climate regions. The NTG varied from 0.45 to 1.06 for the Inland region (where values greater than 1 imply that the typical baseline home is below code). The NTG for the coastal and high desert regions were below one, implying that baseline homes in those areas were built above code.

Residential New Construction Final Report Public Information

Document access information and public comment and meeting period information:

Website: http://www.energydataweb.com/cpuc/

New Construction and Codes and Standards Programs:

- December 02, 2009: Draft evaluation report posted for public comments
- December 9, 2009: Public meeting and webinar to address questions and comments on the Residential New Construction report
- December 22, 2009: Public comment period closed
- February 8, 2010: Final evaluation report posted including responses to public comments

Evaluator Contact Information

Table ES-1: Key Evaluator Contact Information, by Firm

	Name	Address	Email	Phone
KEMA	John Stoops	155 Grand Avenue, Suite 500 Oakland, CA 94612	john.stoops@kema.com	510-891-0446
The Cadmus Group	Allen Lee	720 SW Washington, Suite 400 Portland, OR 97205	Allen.Lee@cadmusgroup.com	503-467-7127
Itron	Rachel Harcharik	11236 El Camino RealSan Diego, CA 92130	rachel.harcharik@itron.com	(858) 724-2620
Nexus Market Research, Inc.	Lynn Hoefgen	22 Haskell Street Cambridge, MA 02140	hoefgen@nexusmarketresearch.com	617-497-7544

	Name	Address	Email	Phone
CPUC: Energy Division	Ayat Osman, PhD CPUC	Energy Division	505 Van Ness Avenue	San Francisco, CA 94102 aeo@cpuc.ca.gov
MECT: Ken Keating	Ken Keating, PhD	6902 SW 14th Ave Portland, OR 97219	keatingk2@msn.com	503-550-6927

Table of Contents

Table of Contents

Table of Contents

List of Tables:

Table of Contents

Table of Contents

Table of Contents

List of Figures:

Table of Contents

The following appendices are included in a separate document: “RNC Program Impact Evaluation. Appendices to Volume I”:

Acronyms

A/C (AC)	Air Conditioning
ACCA	Air Conditioning Contractors of America
ACM	Alternative Calculation Method
ACP	Air Care Plus
ADM	ADM Associates
AEAP	Annual Earning Assessment Proceeding
AEC	Architectural Energy Cooperation
AERS	Automated Energy Review for Schools
AHP	Analytic Hierarchy Process
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BEA	Building Efficiency Analysis
Bldg	Building
C&I	Commercial
C&S	Codes & Standards
CASE	Codes and Standards Enhancement Initiative
CATI	Computer Assisted Telephone Interviewing
CBEE	California Board of Energy Efficiency
CBPCA	California Building Performance Contractor's Association
CEC	California Energy Commission
CFL	Compact Fluorescent Lamp
CG	Contract Group
CHEERS	California Home Energy Efficiency Rating Services
CIEE	California Institute for Energy Efficiency
CMFNH	California Multifamily New Homes Program
CMMHP	Comprehensive Manufactured-Mobile Home Program
CPUC	California Public Utilities Commission
CRCA	Computerized Refrigerant Charge & Airflow
CTZ	Climate Thermal Zone
CV	Coefficient of Variation
CZ	Climate Zone
DEER	Database for Energy Efficiency Resources
DfC	Designed for Comfort
DHW	Domestic Hot Water
DRET	Demand Response Emerging Technologies
DSA	Division of the State Architect
ECM	Energy Conservation Measure
ED	Energy Division
EE	Energy Efficiency
EEGA	Energy Efficiency Groupware Application
EER	Energy Efficiency Rating
EUL	Economic Useful Life

Acronyms

FLA	Full Load Amps
GWh	Gigawatt-hour
HERS	Home Energy Rating System
HIM	High Impact Measure
HMG	Heschong-Mahone Group
HUD	Housing & Urban Development
HVAC	Heating, Ventilation & Air Conditioning
ICF	ICF International
IDEEA	Innovative Designs for Energy Efficiency Applications
InDEE	Innovative Design for Energy Efficiency
IOU	Investor Owned Utility
IPMVP	International Performance Measurement and Verification Protocol
ITD	Installed To Date
kBtu	Thousand Btu
kW	Kilowatt
kWh	Kilowatt Hour
LADWP	Los Angeles Department of Water & Power
LEED	Leadership in Energy and Environmental Design
LPD	Lighting Power Density
M&V	Measurement & Verification
MECT	Master Evaluation Contractor Team
MF	Multifamily
MHRA	Manufactured Housing Research Alliance
Mil	Million
MS	Microsoft
n	Sample Size
NAC	Normalized Annual Consumption
NC	New Construction
NCCS	New Construction/Codes & Standards
NOMAD	Naturally Occurring Market Adoption
NOSAD	Normally Occurring Standards Adoption
NP	Non Participant
NRNC	Non Residential New Construction
NTG	Net to Gross
NTGR	Net to Gross Ratio
NTP	Notice to Proceed
P	Participant
PG&E	Pacific Gas & Electric
PIER	Public Interest Energy Research
PTAC	Packaged Terminal Air Conditioner
PY	Project Year
Q2	Second Quarter

Acronyms

Q3	Third Quarter
Q4	Fourth Quarter
QA	Quality Assurance
QC	Quality Control
QII	Quality Insulation Installation
RCA	Refrigerant Charge and Airflow
Res	Residential
RFP	Request for Proposal
RH	Relative Humidity
RLA	Rated Load Amps
RMSE	Root Mean Square Error
RNC	Residential New Construction
ROB	Replace on Burnout
RP	Relative Precision
SAS	Statistical Analysis Software
SBD	Savings By Design
SCE	Southern California Edison
SCG	Southern California Gas
SCP	Sustainable Communities Program
SDG&E	San Diego Gas & Electric
SDGE	San Diego Gas & Electric
SEER	Seasonal Energy Efficiency Rating
SF	Single Family
sf	Square Foot
SFA	Single Family Attached
SHGC	Solar Heat Gain Coefficient
SoCalGas	Southern California Gas
SOW	Statement of Work
sqft	Square Foot
T24	Title 24 Building Energy Efficiency Standards
TBD	To Be Determined
TDV	Time-Dependent Valuation
TXV	Thermostatic Expansion Valve
UES	Unit Energy Savings
VFD	Variable Frequency Drive
VSD	Variable Speed Drive
VSP	Verification Service Providers
W/SF	Watts per square foot
WH	Water Heater

1. Executive Summary

This report is volume 1 of the final evaluation results of the California Investor Owned Utilities' (IOUs') new construction portfolio covering the residential, multifamily and non-residential programs as well as the Codes and Standards programs for the 2006-2008 program years, collectively referred to as the New Construction/Codes and Standards evaluation project group. This volume presents evaluation results for the Residential New Construction (RNC) programs and a number of smaller new construction programs that received verification-guided evaluations or tracking-only evaluations as part of the New Construction/Codes and Standards evaluation project group. The results for non-residential new construction (NRNC) programs' evaluation and Codes and Standards (C&S) programs' evaluation are presented in separate volumes (NRNC final evaluation report in Volume II and C&S final evaluation report in Volume III).

Table 1-1 lists the programs included in this volume with the measurement and verification level employed for each evaluation. While most of these evaluations focus on residential new construction, the tracking-only evaluations include some commercial programs.

Table 1-1: Program Evaluations Included in Volume (I)

Program ID	Program Name	Evaluation Type
SCG 3502	Advanced Home Program	Full Impact
SDG&E 3007	Advanced Home Program	Full Impact
SCE 2505	CA New Homes Program	Full Impact
PG&E 2009	Residential New Construction Program	Full Impact
SCG 3537	Designed for Comfort (DfC) program	Verification
SCE 2543	Designed for Comfort (DfC) program	Verification
PG&E 2059	California Multifamily Homes New Construction Program	Verification
SDG&E 3021	Sustainable Communities	Tracking
SCE 2514	Sustainable Communities	Tracking
SCE 2534	Demand Response Emerging Technologies	Tracking
SCE 2558	Automatic Energy Review for Schools (AERS)	Tracking
SCE 2557	Transforming the Market for ENERGY STAR Manufactured (Mobile) Homes (IDEEA/InDEE) program	Tracking

The four residential new construction programs—the Advanced Home Program for SCG and SDG&E, the California New Homes Program for SCE, and the Residential New Construction

Program for PG&E—all offered energy efficiency incentives for residential new construction, including both whole house and prescriptive measures. The scope and focus of the Programs vary between the IOUs. PG&E's program focuses primarily on single-family buildings, with multi-family buildings under a separate program. The remaining programs include both single-family and multifamily components under the same program. This group of four RNC program received full impact program evaluation, designed to obtain unbiased, reliable estimates of program-level net energy and demand savings.

The two programs that received verification-guided evaluation are PG&E California Multi-family New Home program, and SCE and SCG Designed for Comfort programs. PG&E's California Multifamily New Home Program facilitates energy-efficient design and construction in multifamily housing through design assistance, cash incentives and ENERGY STAR® marketing benefits to both low-rise and high-rise multifamily projects. SCE's and SCG's Designed for Comfort Programs use a comprehensive building analysis approach that fills a gap not served by other programs. They provide incentives for the replacement of inefficient heating, cooling, and water heating equipment, insulation, and windows with models of higher efficiency.

The California Public Utilities Commission (CPUC) developed the category of "Verification-Guided Impact Evaluations" to address relatively small programs with appropriate levels of rigor and expense given their level of savings. Accordingly, the programs evaluated in this manner require only field verification of measure installation and operation in a binary manner—i.e., installed or not and operating or not. Gross energy and demand savings estimates are derived from other sources, with an option to either develop net-to-gross values or use default inputs.

The five tracking-only programs expected little or no savings during the evaluation period. SDG&E's and SCE's Sustainable Communities Programs are local programs that target residential and nonresidential market segments by working with cities and counties. SCE's Demand Response Emerging Technologies Program demonstrates the effectiveness of various energy efficiency measures on a community scale. SCE's Automatic Energy Review for Schools (AERS) identifies potential energy-saving design modification opportunities in public schools and intervenes during a time in the process when changes to building project drawings normally occur. SCE's Transforming the Market for ENERGY STAR Manufactured (Mobile) Homes provides incentives to encourage increased efficiency in new manufactured homes.

Tracking-only program evaluations expend minimal effort on programs that contribute little to the savings of the overall portfolio. Such evaluations involve a review of program reported savings and budget spent, which are compared to program goals and budgets. Interviews with program staff are conducted to explain any deviations from the planned goals.

1.1 RNC Whole House Single Family Evaluation

The Evaluation Team performed full impact evaluation on the four IOUs' residential new construction programs: the Advanced Home Program for SCG and SDG&E, the California New Homes Program for SCE, and the Residential New Construction Program for PG&E.

The primary objectives of the impact evaluation of Residential New Construction were to:

- Verify the installation of program measures;
- Conduct a baseline study of non-participating new single-family homes in California to
  - establish current typical practices in new home construction,
  - estimate the savings attributable to market effects of utility programs, and
  - quantify the savings from utility involvement in promoting codes and standards changes;
- Establish annual performance profiles for a typical residential single-family home in climate regions of interest based on metering of major end uses, measurements, and site surveys; and
- Develop gross and net impact estimates for the whole-house energy and demand savings resulting from the Residential New Construction program cluster.

The study collected detailed on-site data and end-use metering at 31 participant and 131 non-participants sites across the state. The sample design is discussed in detail in section 3.1.

The results of the data collection were used to characterize the energy use of typical new homes and to compare the metered energy use of homes in the study to the energy use of the same homes as modeled using the Title 24 compliance tool MICROPAS. Utility-claimed gross energy and demand savings were based on modeled energy usage, and any bias in the way the models calculated energy savings would affect the calculation of ex-post energy and demand. Metered energy use for the onsite homes was compared to modeled energy use for the same homes to develop a metered-to-modeled ratio that was used to adjust ex ante gross savings to correct for the bias introduced by the compliance tool. This approach also required making orientation adjustments to the modeled energy use, since the modeled use was typically not based on a home's actual orientation, but on average or worst-case orientation.

The Evaluation Team calculated net savings using a Difference of Differences approach (described in section 3.4.4). We leveraged the results of the baseline study to characterize the energy use of typical new homes. We compared the non-participant naturally occurring baseline and participant gross savings by climate regions. The difference between the two (expressed as savings-per-square-foot for comparability), is the per-square-foot estimate of net savings for each climate region. These ratios were multiplied by the corresponding square footage of participant homes obtained from the IOUs' tracking database to yield net program savings by utility. We then estimated net-to-gross ratios by dividing net savings for each utility by the ex-post gross savings. The details of the tasks performed to conduct this evaluation are given in section 3.1.

1.1.1 RNC Program Projected and Claimed Expenditures, Energy and Demand Savings

The following table compared projected and claimed utility RNC program goals and claimed (ex-ante) gross energy and demand savings, and budget spent for each utility. The program claimed achievement values were obtained from the IOUs March 2009 tracking databases, covering the programs' claims through the fourth quarter of 2008.

Table 1-2: RNC Total Program Projected and Claimed Expenditures, Energy and Demand Saving[1]

Program Name	Category	Original Program Projection	Program Claimed Achievement	Percentage claimed of program Projected
PG&E 2009 Residential New Construction Program	Program Operating Budget ($)	$ 19,999,954	$10,577,864	53%
	Demand Reduction (kW)	8,484	1,913	23%
	Energy Savings (kWh)	10,521,175	2,194,341	21%
	Gas Savings (Therms)	1,734,706	514,072	30%
SCE 2505 CA New Homes Program	Program Operating Budget ($)	$18,294,211	$3,594,041	20%
	Demand Reduction (kW)	8,719	262	3.0%
	Energy Savings (kWh)	3,275,946	287,485	8.8%
	Gas Savings (Therms)	NA	NA	NA
SDG&E 3007 Advanced Home Program	Program Operating Budget ($)	$6,639,750	$3,630,561	55%
	Demand Reduction (kW)	5,650	285	5%
	Energy Savings (kWh)	5,154,058	260,086	5%
	Gas Savings (Therms)	204,681	20,721	10%
SCG 3502 Advanced Home Program	Program Operating Budget ($)	$8,750,000	$5,984,888	68%
	Demand Reduction (kW)	6,177	2,079	34%
	Energy Savings (kWh)	5,634,516	1,944,666	35%
	Gas Savings (Therms)	220,489	142,062	64%

1.1.2 RNC Single Family Evaluation Results

Gross Energy Savings and Demand Reduction

Orientation Adjustments

The orientation of a home can significantly affect its space-cooling and heating energy requirements, chiefly due to solar gain through windows. The CalCERTS registry only contains modeled energy for each plan's worst orientation, but clearly not all homes are actually built in the worst possible orientation. On the other hand, the CHEERS registry contains the modeled energy consumption for all four orientations, and the average was used to calculate the gross

[1] Please note that the savings presented in this table are for the total RNC program savings. The evaluation of the RNC programs focused on the Whole House Single Family. The remaining (non-Whole House) measures found in the RNC programs will be treated though the Evaluation Reporting Tool (ERT) process. The final analysis for the overall program savings will be published in the ED report.

energy savings for each home. To adjust for this, the evaluation team used the CHEERS data to estimate "average" orientation energy as a function of worst orientation energy. Orientation adjustments (b-ratios) were estimated for the single-family homes. These b-ratios were used to calculate an orientation-adjusted estimate of gross savings, used in the following analysis. (More details on b-ratios are found in Appendix A).

The overall impact of the orientation adjustment on gross savings from the CHEERS/CalCERTS registries (for which savings estimates could be obtained) increased by total 6.42%. The percentage change ratios are then applied to the IOUs claimed ex-ante gross savings to adjust for orientation problems with CalCERTS (Refer to Section 3.4.3 for further discussion).

Meter Adjustments

To account for the systematic ways in which actual energy use differs from modeled energy use, the evaluation team first adjusted gross savings from the CHEERS and CalCERTS [2] participant registries for building orientation and then applied the metered-to-modeled ratio to adjust for the actual energy use obtained from field measurements. Due to the differences between the larger, desert-located cooling sites and the rest of the inland homes data and the difference between coastal and inland results seen in the data, we broke out the analysis into three climate regions: coastal (CEC climate zones 1-7), inland (CEC climate zones 8-14 and 16), and high desert (CEC climate zone 15). These distinctions were used throughout the single-family portion of the metered-adjusted ratio analysis for the cooling end use. Heating was broken out by coastal and inland, with inland including climate zone 15. Since water heating was not weather-dependent in the compliance models, its adjustment factor was not separated out by climate region.

A comparison between the metered data collected at the participant and non-participant on-sites and the modeled [3]energy usage for those homes showed that the compliance software overestimates the amount of heating energy consumed at a site and underestimates the amount of cooling energy consumed. Coastal cooling usage was, on average, 40% higher than modeled usage for coastal homes. The inland ratio indicates 6% more usage than modeled, and the

[2] CHEERS and CALCerts are databases that contain participant homes building characteristics and modeled energy use, which were necessary for the analysis.

[3] The basis of the utilities claimed gross energy and demand savings was based on the modeled energy use (using Title 24 compliance tool MICROPAS).

desert homes used 39% more energy than predicted. The heating ratios reflect a significant overestimation of usage. Both coastal and inland metered usages were about 44% of modeled projections. The hot water ratio shows an average metered usage of 93% of modeled usage across all homes. Table 1-3 shows ex-ante and ex-post gross saving with realization rates. The statewide realization rate was 1.43 for kWh savings and 1.54 for demand savings, but only 0.54 for gas savings.

Table 1-3: RNC Single-Family Whole House Ex-Ante and Ex-Post Gross Savings

Program Name	Category	Ex-Ante Gross Savings	Ex-Post Gross Savings	Realization Rates
PG&E 2009 Residential New Construction Program	Demand Reduction (kW)	2,162	2,582	1.19
	Energy Savings (MWh)	2,329	2,784	1.20
	Gas Savings (Therms)	561,447	279,878	0.50
SCE 2505 CA New Homes Program	Demand Reduction (kW)	231	1101	4.77
	Energy Savings (MWh)	150	726	4.83
	Gas Savings (Therms)	NA	32,854	NA
SDG&E 3007 Advanced Home Program	Demand Reduction (kW)	NA	NA	NA
	Energy Savings (MWh)	NA	NA	NA
	Gas Savings (Therms)	NA	NA	NA
SCG 3502 Advanced Home Program	Demand Reduction (kW)	27	54	1.95
	Energy Savings (MWh)	63	122	1.95
	Gas Savings (Therms)	14,085	700	0.05
Total Statewide	**Demand Reduction (kW)**	**2,420**	**3,737**	**1.54**
	Energy Savings (MWh)	2,542	3,631	1.43
	Gas Savings (Therms)	575,532	313,432	0.54

Net Energy Savings and Demand Reduction

The final net impact estimates are presented in Table 1-4. Only programs that provide ex-ante savings estimates for individual end-uses are included, so realization rates are not presented for all utilities. A more detailed explanation of the effects of the lack of ex-ante estimates on realization rate calculations can be found in section 3.4.4.

The electric energy savings realization rate is greater than one for all utilities, and is much greater than one for both PG&E and SCE. Because the code compliance models tend to

underestimate the amount of cooling energy use, and the ex ante per unit savings are based on the models, the ex-ante per unit savings estimates are low across the board.

KEMA used a peak factor or an “H-factor” approach to estimating coincident kW reduction[4] . KEMA used the same “H-factor” values that are found in the ex ante savings used by the utilities for program planning. These “H-factors” were applied to the ex-post net energy savings values by utility to obtain ex-post net kW savings. The demand reductions results show similar realization rates to the electric energy savings for PG&E and SDG&E, which is expected due to the calculation method. Unlike PG&E and SDG&G, SCE's H-factors varied across climate zones (see Table 3-27). Because the geographical mix of claimed homes differed from the mix that was assumed in the ex-ante estimates, SCE's demand realization rate was different from the kWh realization rate. Because PG&E and SCG had uniform H-factors, their realization rates are equal. The therms realization rate is below one. This low realization rate is partially due to the overstatement of heating-based usage in the MICROPAS models.

[4] e “H-factor” is the ratio of kW to kWh savings estimates in utility savings claims.

Table 1-4: RNC Single-Family Whole House Ex-Ante and Ex-Post Net Electric and Demand Savings and Realization Rates

Program Name	Category	Ex-Ante Net Savings	Ex-Post Net Savings	Net Realization Rates
PG&E 2009 Residential New Construction Program	Demand Reduction (kW)	1,730	2,648	1.53
	Energy Savings (MWh)	1,863	2,854	1.53
	Gas Savings (Therms)	449,158	137,945	0.38
SCE 2505 CA New Homes Program	Demand Reduction (kW)	185	1,039	5.63
	Energy Savings (MWh)	120	703	5.85
	Gas Savings (Therms)	NA	27,988	NA
SDG&E 3007 Advanced Home Program	Demand Reduction (kW)	NA	NA	NA
	Energy Savings (kWh)	NA	NA	NA
	Gas Savings (Therms)	NA	NA	NA
SCG 3502 Advanced Home Program	Demand Reduction (kW)	22	24	1.10
	Energy Savings (MWh)	50	55	1.10
	Gas Savings (Therms)	11,268	-205	-0.02
Total Statewide	**Demand Reduction (kW)**	**1,936**	**3,711**	**1.92**
	Energy Savings (MWh)	2,033	3,612	1.78
	Gas Savings (Therms)	460,426	165,728	0.36

1.1.3 RNC Single Family Key Findings and Recommendations

Key findings from the RNC evaluation

- With the exception of SDG&E, which claimed no savings for whole buildings, all of the IOUs exceeded their claims for electric and demand savings for whole house single family RNC, but fell short of their claimed gas savings.

- The compliance models used to estimate ex ante savings underestimate cooling energy use, but overestimate heating energy use, based on a comparison of metered and modeled data. This led to ex ante electric and demand savings (kWh and kW) estimates

that were too low compared to the ex-post results, and ex-ante gas savings (therms) estimates that were too high compared to the ex-post gas savings results.

- Ex-post electricity NTG ratios varied widely across IOUs and regions. The NTG varied from 0.45 to 1.06 for the Inland region (where greater than 1, implies that the typical baseline home is below code). The NTG for the coastal and high desert regions were below one, implying that baseline homes in those areas were above code.

Key recommendations from the RNC evaluation

- The estimates of baseline usage that come from the compliance software underestimate cooling energy use and overestimate heating energy use. We therefore recommend that utilities evaluate alternative modeling tools to investigate the capability of the tool to more accurately simulate energy usage for ex ante estimates.

- As evident from the evaluation results, the orientation of a home can significantly affect its space-cooling and heating energy requirements. The registries used to track building code compliance in California, CHEERS and CalCERTS, omit site-specific orientation information, which is a significant problem when using these databases to calculate energy use for specific homes Actual home orientation should be recorded in the participant registries, which should greatly improve the accuracy of program performance estimates.

- Utilities should track participation information in a common database. The discrepancies in formats between the two participant registries (CHEERS and CalCERTS) add a level of uncertainty in estimating savings and tracking program participation. In addition, there is no clear way to match homes in the registries to specific programs and participation periods, which adds an additional layer of uncertainty to the analysis. A single, well-constructed, accurate, and complete registry would save time and effort in the process of the evaluation of these programs.

- Further studies should be conducted on the metering data to learn more about residential usage patterns for builder-affected end-uses, such as HVAC, cooling and water heating.

1.2 Verification Guided Program Evaluations

The two programs that received verification-guided evaluation are PG&E California Multi-family New Home program; and SCE and SCG Designed for Comfort programs.

The key objective of the evaluation of the California Multifamily New Homes Program (CMFNH) was to estimate the program free ridership, and to adjust gross savings using current DEER values. Table 1 5 shows the projected savings and original budget for the program along side claimed savings and budget spent. The program only claimed about 10 percent of the original projected savings.

Table 1-5: PG&E California Multifamily New Home Original and Claimed Budget and Savings

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	2,698	236	9%
Electricity Savings (kWh)	4,489,813	405,333	9%
Gas Savings (therms)	839,084	83,804	10%
Budget	$7,459,053	$2,336,091	31%

Savings for clothes washers and refrigerators were adjusted for current DEER 2008 values. Table 1 6 shows claimed and adjusted gross savings.

Table 1-6: PG&E California Multifamily New Home Program Adjusted Gross Savings

	Demand Reduction (kW)	Electric Savings (kWh)	Gas Savings (therms)
Claimed Gross Savings	236	405,333	83,804
Adjustments	0[5]	-20,562	-46
Adjusted Gross Savings	236	384,771	83,758

In order to establish a NTG ratio for the post-2005 code multifamily program, the team conducted interviews with developers, architects, and energy consultants regarding the level of program influence on building designs and appliance selection.

[5] Demand reduction was not adjusted, because the DEER database did not consistently provide demand reduction values for the applicable measures.

In order to establish a NTG ratio for the post-2005 code multifamily program, the team conducted interviews with developers, architects, and energy consultants regarding the level of program influence on building designs and appliance selection.

Table 1-7 presents the adjusted gross savings from Table 1-6, the net-to-gross estimates developed from the interviews with decision-makers, and the estimated net savings for the program. Note that this estimate includes free ridership but not spillover, and therefore is a conservative estimate of attribution of savings to the program.

Table 1-7: PG&E Multifamily New Home Program Net Savings

	Demand Reduction (kW)	Electric Savings (kWh)	Gas Savings (therms)
Adjusted Gross Savings	236	384,771	83,758
NTG Estimate	0.58	0.58	0.58
Net Savings	137	223,167	48,580

The goal of the Designed for Comfort Program evaluation was to determine whether program measures were installed (yes/no) and whether they were installed properly. The Designed for Comfort evaluation consisted of on-site evaluations at two multifamily affordable housing complexes. Auditors inspected heating systems, insulation and windows, and generally found them to be properly installed.

We did not adjust the reported net savings for the DfC program because there was no information available from either the onsite verifications or the DEER database that could serve as the basis for adjustments to the program's gross savings or its ex-ante NTG value. Table 1-8 shows the total ex-ante energy and demand savings for the program as of the fourth quarter of 2008. The evaluators recommend using these claimed values.

Table 1-8: Designed For Comfort Program Savings through December 2008

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	449	436	97.1%
Electricity Savings (kWh)	234,138	252,167	107.7%
Gas Savings (therms)	33,935	0	0.0%
Budget	$1,712,015	$1,545,646	90%

1.3 Tracking-Only Program Evaluations

A number of programs had small or non-existent savings by the end of 2008. These programs were tracked, but not evaluated. The goal of the evaluation for these programs was simply to follow the programs' progress in achieving their program goals, and to provide a high-level explanation of the reasons behind the tracking results.

The following five tracking-only programs showed little or no savings during the evaluation period: SDG&E's and SCE's Sustainable Communities Programs, SCE's Demand Response Emerging Technologies Program, SCE's Automatic Energy Review for Schools (AERS), and SCE's Transforming the Market for ENERGY STAR Manufactured (Mobile) Homes.

None of the tracking-only programs met their energy savings goals for the 2006-2008 period, falling significantly short of goals. Table 1-9 shows, for each program, the program targets, claimed saving through the end of 2008, and claimed savings as a percent of program targets. The reasons found for the programs falling short of their targets are discussed in the body of the report.

Table 1-9: Tracking-Only Program Target and Claimed/Adopted Savings through December 2008

Tracked Measure	Demand Response Emerging Technologies	SDG&E's Sustainable Communities	SCE Sustainable Communities	AERS	Manufactured Homes
Demand Reduction (kW)	142	5,650	4,221	242	1,897
Electricity Savings (kWh)	75,752	5,154,058	1,642,400	1,167,466	1,153,691
Gas Savings (therms)	0	204,681	0	0	0
Claimed Savings through Q4 2008					
Demand Reduction (kW)	1	161	0	0	167
Electricity Savings (kWh)	593	806,433	0	0	130,792
Gas Savings (therms)	n/a	12,042	n/a	n/a	n/a
Percent of Original					
Demand Reduction (kW)	<1%	3%	0%	0%	8.8%
Electricity Savings (kWh)	<1%	16%	0%	0%	11.3%
Gas Savings (therms)	n/a	6%	n/a	n/a	n/a

2. Introduction

This document presents the evaluation results of the Residential New Construction (RNC) component of the New Construction/Codes and Standards project evaluation group. This evaluation group comprises the California investor owned utilities' (IOUs) extensive new construction portfolio covering the residential, multifamily and non-residential markets. The IOUs include Pacific Gas and Electric (PG&E), San Diego Gas and Electric (SDG&E), Southern California Electric (SCE), and Southern California Gas (SCG).

The New Construction, Codes and Standards Evaluation group consists of twenty-one[6] utility energy efficiency programs focused on new construction or those supporting the California State Codes and Standards activities. Each of the four IOUs operates similar residential new construction programs and each supports a coordinated Codes and Standards effort. For non-residential new construction, SCE, SDG&E, and SCG operate similar Savings by Design programs. PG&E organizes their programs by market segments, but for the non-residential new construction evaluation, PG&E have created a "virtual" Savings by Design program for the commercial sector as a whole. Finally, a sub-group of several smaller programs are aimed at testing new applications or improving efficiency among a relatively small target population.

The Residential New Construction cluster of program evaluations covers a portfolio of products and services designed to increase the adoption of energy efficient equipment and practices in the single-family and multifamily building industry. The program provides support to encourage high-performance building design that exceeds the 2005 California Energy Efficiency Standards in overall performance design by 15% or more, while also aiming to increase the adoption and installation of individual high efficiency measures, such as efficient heating, cooling, lighting, and appliances in residential new construction.

2.1 EM&V Activities Grouping

The evaluation team structured the evaluation activities by grouping the IOUs programs into five evaluation clusters:

[6] Including one "virtual" PG&E program that consists of commercial new construction projects found within several actual comprehensive market sector programs

1) Residential New Construction (RNC) Evaluation (full impact evaluation), includes PG&E RNC program, SCE California New Homes program, SDG&E and SCG Advanced Home program, and PG&E Duct and Cover program;

2) Non-Residential New Construction (NRNC) Evaluation (full impact evaluation), includes the four IOUs' Savings by Design programs (SBD);

3) Codes and Standards (C&S) Evaluation (full impact evaluation), includes the four IOU's C&S programs;

4) Verification-Guided Program Evaluation, includes PG&E California Multifamily New Homes program, and SCG and SDG&E Designed for Comfort programs; and

5) Tracking-Only Program Evaluation includes SCE Demand Response Emerging Technologies program, SCE and SDG&G Sustainable Communities program, SCE Automatic Energy Review for Schools program, and SCE Transforming the Market for New Energy Start Manufactured Homes program.

This document presents the impact evaluation results for the statewide Residential New Construction (RNC) programs [7], verification-guided program evaluation, and tracking-only program evaluation for program years 2006-2008. Results for the other segments of the evaluated Group can be found in the following volumes: NRNC-Volume II and the C&S in Volume III.

2.1.1 Residential New Construction Impact Evaluation Overview

Each IOU has a new construction program to incentivize the construction of homes that are more energy efficient. These include PG&E's RNC Program, SCE's California New Homes Program, and SDG&E's and SCG's Advanced Home Program, and PG&E's Duct and Cover

[7] The residential new construction evaluation group also includes an evaluation of the market effects of the IOUs' residential single-family new construction programs, but that portion of the study is reported separately from the impact evaluations (see KEMA, Nexus Market Research, Inc., Summit Blue Consulting, Itron, Inc., The Cadmus Group, Inc. 2009. Phase I Report: Residential New Construction (Single Family Home) Market Effects Study).
Available at http://www.energydataweb.com/cpuc/default.aspx

program. The evaluation team planned to evaluate these programs using energy simulation models of a sample of participating homes [8], informed by site surveys and end-use metering. However, the ongoing collapse of the new housing market resulted in samples that were too small for the originally planned evaluations and so a simplified method was necessary. This contract group also conducted a study of non-participating new homes in California, referred to in this report as the "baseline study," to establish current typical practices in new home construction and to inform the net savings calculations[9].

The primary objectives of the full impact evaluation of Residential New Construction were to:

- To verify the installation of program measures;
- To conduct a baseline study of non-participating new single-family homes in California to establish current typical practices in new home construction, estimate the savings attributable to market effects of utility programs, and to help quantify the savings from utility involvement in promoting codes and standards changes;
- Establish annual performance profiles for a typical residential single-family home in climate regions of interest based on metering of major end uses, measurements, and site surveys; and
- To develop gross and net impact estimates for the whole building energy and demand savings resulting from the Residential New Construction program cluster.

2.1.2 Verification-Guided Program Evaluation Overview

The California Public Utilities Commission developed the category of "Verification-Guided Impact Evaluations" to address relatively small programs with appropriate levels of rigor and expense given their level of savings, thus preserving evaluation resources for programs accounting for more savings. Accordingly, the programs evaluated in this manner require only field verification of measure installation and operation in a binary manner—i.e., installed or not

[8] Participants in the RNC program are actually the builders who built homes to the program specifications. Other homes were built during the same period without participation in the program. For simplicity sake, we may often refer to the buildings and their occupants as participants and non-participants, rather than using expressions like the "occupants of homes built by participating builders."

[9] The Baseline Study was also used to inform the C&S evaluation to assess compliance.

and operating or not—with gross savings estimates derived from other sources, and with an option for either developing Net To Gross values or using default inputs.

The NCCS evaluation team performed verification-guided evaluations, as opposed to protocol-guided impact evaluations, on several smaller programs with relatively small energy and demand savings. One program in this group is PG&E's California New Homes Multifamily program, which facilitates and encourages energy-efficient design in multifamily housing through design assistance, cash incentives and marketing. This group also includes SCE's and SCG's Designed for Comfort (DfC) programs, which targets older affordable housing otherwise undergoing rehabilitation, and provides design assistance, training, and incentives to improve building energy efficiency.

The initial objectives of the evaluation of the CMFNH Program, as laid out in the work plan, in keeping with the guidelines for Verification-Guided Impact Evaluations, were to determine whether or not program measures have been installed and whether or not they have been installed properly, and to make use of available information to estimate energy impacts. However, the CPUC decided that the low savings from this program did not warrant the resources required for such an approach. Instead, the key objective of the evaluation became an estimation of program free ridership, and appropriate measures were adjusted for current DEER values.

The initial objectives of the evaluation of the DfC Program, as laid out in the work plan, in keeping with the guidelines for Verification-Guided Impact Evaluations, were to determine whether or not program measures have been installed and whether or not they have been installed properly, and to make use of available information to estimate energy impacts. However, the CPUC decided that the low savings from this program did not warrant the resources required for such an approach. Hence, while the physical inspections were conducted, the objective of re-estimating energy impacts was not addressed.

Two additional programs were assigned to this group in the original evaluation plan; SCE's Transforming the Market for ENERGY STAR Manufactured (Mobile) Homes (IDEEA/InDEE) program and PG&E's Duct & Cover Program (PGE 2083). When the Manufactured Home program recorded almost no program accomplishments, the CPUC Energy Division (ED) decided not to spend further resources evaluating this program. The Manufactured Home program evaluation was therefore grouped with the other tracking-only programs for the remainder of this document. PG&E discontinued the Duct & Cover Program, so the program was dropped from the evaluation as well.

2.1.3 Tracking-Only Programs Overview

Three evaluations were planned to be restricted to tracking and reporting only, without independent evaluation of energy savings. Savings were expected to be very small or possibly nonexistent by the end of 2008, not justifying even verification-guided evaluations. The goal of the evaluation of these programs was simply to follow the progress of the programs in achieving their program goals, if any, and to provide a high-level explanation of the issues behind the tracking results. The first two of these evaluations addressed SCE's and SDG&E's Sustainable Communities programs, which worked with developers, architects, engineers, and others to incorporate sustainable design practices into both residential and commercial developments. The third, Automatic Energy Review for Schools (AERS) (formerly known as the Modernization and New Construction Efficiency Enhancement for Schools Program in the IDEEA/InDEE project), sought to identify potential energy-saving design modification opportunities in public schools and intervene during a time in the process when changes to building project drawings normally occur. The fourth evaluation addressed SCE's Demand Response Emerging Technologies program, which is a pilot program providing incentives to builders to install emerging energy efficient technologies in newly constructed homes.

A fifth program, SCE's Transforming the Market for ENERGY STAR Manufactured (Mobile) Homes (IDEEA/InDEE) program, originally planned as a verification-guided evaluation, was added to this group due to its lack of program accomplishments. This program provides incentives to encourage increased efficiency in new manufactured homes.

2.2 Description of Programs Included in this Evaluation

2.2.1 Residential New Construction Program Descriptions

Although PG&E, SCE, SCG, and SDG&E all offered energy efficiency incentives for residential new construction, the scope and focus of the Programs vary between the IOUs. PG&E's program focuses primarily on single-family buildings because multifamily new construction efforts were organized under a separate program, PG&E 2059, which is implemented by a third party, HMG. We discuss PG&E's multifamily program with the other verification-guided evaluations. SCE also has third party implementers (ICF and HMG) for their single-family and multifamily components, but both components are included in SCE 2505. SCG and SDG&E are implementing both the single-family and multifamily portions of their programs themselves. While all of the programs include a whole house goal and incentive, the number and type of

prescriptive measure rebated by each IOU vary. The following illustrates some of the key similarities and differences between the Programs in this evaluation cluster.

The programs evaluated in the RNC evaluation cluster are listed in Table 2 1 with program descriptions[10]

[10] Whole house measures may also be referred to as performance-based measures. For this report, we have chosen to use the term “whole house measure” for clarity.

Table 2-1: RNC Program Descriptions Full Impact Evaluation Group

Programs Included in this Evaluation	Program Description	Key Program Elements
SCG 3502 Advanced Home Program	• Promotes a comprehensive residential new construction approach with a focus on sustainable design and construction and energy efficiency; • Uses a combination of education, design assistance and financial support to work with building and related industries; • Includes single family, single family attached (town homes), and low-rise multifamily (3 or fewer stories) residences.	There are three whole-house approaches to participation: 1) California Energy Star New Homes Program. Home must meet the Energy Star criteria. 2) High-rise multi-family program, increasing overall energy efficiency by 15% or more compared to Title 24. 3) High-performing new homes program. Tier 1 must be at least 15% better than Title 24 as detailed in compliance models; Tier 2 must be 35% better. Due to the high volume of measures being rebated the program was temporarily shut down and then re-opened, offering only whole-house incentives for buildings exceeding the Standards by 15%.
SDGE 3007 Advanced Home Program	• Promotes a comprehensive residential new construction approach with a focus on sustainable design and construction and energy efficiency; • Uses a combination of education, design assistance and financial support to work with building and related industries.	There are three whole-house approaches to participation: 1) California Energy Star New Homes Program. Home must meet the Energy Star criteria. 2) High-rise multi-family program, increasing overall energy efficiency by 15% or more compared to Title 24. 3) High-performing new homes program. Tier 1 must be at least 15% better than Title 24 as detailed in compliance models; Tier 2 must be 35% better.
SCE 2505 CA New Homes Program	• Awards a limited number of financial incentives to homebuilders who construct homes (single or multifamily) that exceed California's energy efficiency standards for new residential construction (Title 24); • Provides training opportunities, technical support and marketing	1) Offers incentives for homes built 15% above the Standards. 2) Offers an additional whole-house incentive to homes built 20% or 35% (single-family only) above the Standards in their inland region (T24 CZ 8, 9, 10, 14, 15, and 16). 3) Offers a selection of prescriptive incentives for various energy efficiency measures, including appliances and lighting. Approximately 70% of SCE's anticipated savings are from single-family homes.

Table 2-1: RNC Program Descriptions Full Impact Evaluation Group

Programs Included in this Evaluation	Program Description	Key Program Elements
	resources that will help homebuilders to build more energy efficient homes.	The program is implemented by two subcontractors, ICF and HMG. (HMG is also implementing SCE's Affordable Housing Program (SCE 2542, which is co-sponsored by SCG 3537) and Designed for Comfort (SCE 2543))
PGE 2009 Residential New Construction Program	Builders of single-family homes within PG&E's service area can apply for financial incentives for maximizing the energy efficiency of their new homes. Energy efficient features may be individually added to homes through the Prescriptive Option, or builders can upgrade to the California ENERGY STAR® New Homes Program by meeting the specifications of the U.S. Environmental Protection Agency (EPA).	1) Includes whole-house incentives for houses built 15% above the 2005 Title 24 Standards that qualify as Energy Star new homes. 2) PG&E also has extensive prescriptive incentives, offering rebates for measures such as energy efficient dish and clothes washers, central natural gas furnaces, tankless water heaters, and cool roofs.

2.2.2 Verification-Guided Evaluation Program Descriptions

The programs included in the verification-guided cluster are described in Table 2-2.

Table 2-2: RNC Program Descriptions: Verification-Guided Evaluation Group

Programs Included in this Evaluation	Program Description	Key Program Elements
SCG 3537 Designed for Comfort program SCE 2543 Designed for Comfort program	DfC uses a comprehensive building analysis approach that fills a gap not served by other programs by providing incentives for the replacement of older inefficient heating, cooling, and water heating equipment, insulation, and windows.	1) Targets older affordable housing, and provides design assistance, training, and incentives to improve building energy efficiency by 20% above existing conditions. The minimum efficiency requirement for any equipment or materials is specified by Title 24 code or Title 20 code. 2) The owner/developer is required to hire a HERS rater to establish the existing condition of the housing units; after the retrofit work is completed, all measure installations are verified by the HERS rater. 3) The DfC program implementer, Heschong-Mahone Group (HMG), provides quality control conducted by its own staff on 10% of all units.
PGE 2059 California Multifamily Homes New Construction Program	Facilitates energy-efficient design and construction in multifamily housing through design assistance, cash incentives and ENERGY STAR® marketing benefits to both low-rise and high-rise multifamily projects.	1) Designed to address several obstacles associated with the multifaceted structure of the multifamily new construction market. Barriers include owner-developer versus tenant split incentives, lack of market differentiation and tenant understanding, cost constraints, and market inertia. 2) Encourages the installation of qualifying energy-efficient products in individual tenant units and in the common areas of residential apartment buildings, mobile home parks, and condominium complexes. 3) The Energy Efficiency Rebates for Multifamily Properties are offered to multifamily property owners and managers of new residential dwellings that contain two or more units to achieve energy savings of 15% above Title 24.

2.2.3 Tracking Only Evaluation Program Descriptions

The programs evaluated as tracking only programs are described in Table 2 3.

Table 2-3: RNC Program Descriptions: Tracking Only Evaluation Group

Programs Included in this Evaluation	Program Description	Key Program Elements
SDG&E 3021 Sustainable Communities	• Local program targets residential and nonresidential market segments • Designed to work in concert with the cities and counties in the SDG&E service territory • Promotes sustainable development, showcases energy-efficient design and building practices, and encourages local developers to incorporate clean on-site energy generation systems in their multifamily and commercial new construction projects. 11	Participating projects must 1) Be at least 20% better than Title 24 Energy Standards on a whole-building performance basis 2) Obtain LEED certification and 3) Evaluate the installation of on-site renewable energy.
SCE 2514 Sustainable Communities	• Designed to support building construction that will meet future higher efficiency standards."12	1) Participating projects commit to a goal which is at least 20% better than Title 24 Energy Standards. 2) Other goals include on-site power generation with solar photovoltaics or the installation of a fuel cell." 13 SCE converted the SCP from a resource program (i.e., one that would claim savings) to a non-resource one, with the Savings by Design program claiming all electricity savings resulting from projects that received design assistance through the SCP.
SCE 2534 Demand Response Emerging	• Demonstrates the effectiveness of various energy efficiency measures on	1) Installs emerging energy efficient technologies in newly constructed homes. 2) Home buyers will not directly control any of the measures or affect their

[11] SDG&E 3021 Q308 Report Narrative to the CPUC (http://eega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=9)

[12] SCE 2514 Q108 Report Narrative to the CPUC (http://eega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=7)

[13] SCE 2514 Q108 Report Narrative to the CPUC (http://eega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=7)

Programs Included in this Evaluation	Program Description	Key Program Elements
Technologies	a community scale. • Seeks to identify builders to participate in constructing approximately 95 homes with these technologies and exceed 2005 Title 24 standards by a minimum of 30%.14	proper operation—either they are installed and functioning properly, or they are not. This demonstration program was originally intended to offer demand response technologies but removed them from the list of measures after staff decided that they duplicated offerings by other programs.
SCE 2558 Automatic Energy Review for Schools (AERS)	• Seeks to increase the energy performance of new and modernized school buildings beyond typical compliance with efficiency standards. • Seeks to identify potential energy-saving design modification opportunities in public schools and intervene during a time in the process when changes to building project drawings normally occur.	1) Implemented by the Benningfield Group (Benningfield), which has overall responsibility for program management. 2) Designed to increase the energy efficiency of school building projects that meet or marginally exceed state Title 24 building standards. 3) Takes advantage of a narrow window of opportunity during the Division of the State Architect (DSA) review process. 4) Four key elements: • Targets school building projects after they have been submitted to DSA for review but before DSA's approval. All projects in the DSA pipeline are reviewed for their eligibility. • Identifies candidate building projects by mining the DSA database • Focuses on low-impact changes to building plans that provide maximum efficiency savings. Intervenes at a late stage in the design process and focuses on technologies with small impacts on design. • Provides incentives to help defray the costs of design changes. Offers a stipend of $2,000 to cover the redesign costs and pays 100 percent of the DSA review fee up to $2,250.
SCE 2557 Transforming the Market for ENERGY STAR Manufactured (Mobile) Homes	• Provides incentives to encourage increased efficiency in new manufactured homes	1) Designed to move new manufactured homes from a basic level of energy efficiency to high performance Energy Star® levels by the strategic application of incentives. 2) Requires the installation of properly-sized cooling equipment. 3) The Manufactured Housing Research Alliance (MHRA) implements the program. The contract between SCE and MHRA includes a detailed Statement of Work (SOW) that defined the budget, objectives, and timeline for the program during the 2006 through 2008 program cycle. Program incentives were designed to partly offset the increased cost of

[14] SCE 2534 Q308 Report Narrative to the CPUC (http://eega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=7)

Programs Included in this Evaluation	Program Description	Key Program Elements
		manufacturing the home. Under the original SOW (PEPMA Number: 06-10008), $400 incentives were provided to manufacturers and $350 to distributors (or $350 to HVAC contractors in the case of electrically heated homes). While $400 does not cover the incremental cost of manufacturing homes meeting Energy Star® requirements, MHRA felt it would close the gap enough so the manufacturer could pass along or absorb the remaining cost. When the original incentive structure did not succeed in getting manufacturers to produce a supply of Energy Star homes, the program switched tactics to instead try to create demand. It was felt that firm orders would be needed before manufacturers would build to the Energy Star standard. In October 2007 then, the decision was made to provide incentives to retailers only with the goal of creating demand for Energy Star® manufactured homes. Rebate amounts varied depending on heating type with retailers receiving $400 for natural gas/propane heated homes and $750 for all-electric homes.

.

3. Residential New Construction Single-Family Programs: Full Impact Evaluation

This chapter covers the evaluation activities for the following programs:

- PGE 2009 Residential New Construction Program
- SCE 2505 CA New Homes Program
- SCG 3502 Advanced Home Program
- SDGE 3007 Advanced Home Program

3.1 RNC Single Family Evaluation Methodology

The RNC Evaluation consists of two key elements:

1) RNC Programs evaluation, and
2) RNC single-family baseline study.

The RNC programs Evaluation focuses on whole-building measures for single-family homes (detached and attached). Whole-building performance based measures were the only residential programs that had a large enough savings potential to justify the expense and effort of an extensive impact evaluation. Some of these programs claimed savings from whole-building multifamily measures[15] ; however, the claimed savings were relatively small to justify the expense of an additional multifamily sample. Therefore, the primary focus of this evaluation was limited to whole-building measures for single-family homes.

There was a critical need for a fully specified baseline study of residential new construction (RNC) in California[16]. This baseline study was essential to estimate net savings estimates resulting from the IOUs' RNC programs and to estimate compliance rates for use in the Codes

[15] SDG&E 3007 and SCG 3502 claim 14% and 7%, respectively of overall savings are from multifamily home.

[16] The previous Baseline Study was conducted in 2003, and included on-site surveys of 600 newly constructed single-family homes in California.

and Standards evaluation and the Market Effects Study[17]. Because the baseline study methodology was very similar to the methodology used for the single-family whole-house measures, these are discussed together in Section 3.1.1.

Due to decreased program participation and low savings claimed by the programs, the evaluation team recommended, and the CPUC ED approved, a few changes to the evaluation and baseline studies. The methodology section below focuses primarily on the final methodology used. Section 3.1.4 discusses the changes to the evaluation and compares the original plan to what was finally implemented.

3.1.1 Single-Family Whole-House Evaluation Methodology

Both the RNC single-family whole-house evaluation and the single-family baseline study relied on on-site surveys and end-use metering. Based on the on-sites, the Team adjusted or built the MICROPAS models for each site and then remodeled them with actual weather data corresponding to the metering period. By comparing the metered end-uses to those predicted by the models, the Team produced estimates of metering ratios for each end-use, utility, and coastal/inland/desert climate regions. Table 3-1 shows how California Energy Commission climate zones were aggregated into climate regions the cooling and heating analyses (water heating is not climate-dependent and was not analyzed by climate region).

[17] KEMA, Nexus Market Research, Inc., Summit Blue Consulting, Itron, Inc., The Cadmus Group, Inc... 2009. Phase I Report: Residential New Construction (Single Family Home) Market Effects Study. Available at http://www.energydataweb.com/cpuc/default.aspx

Table 3-1: Mapping of CEC Climate Zones to Climate Regions for Analysis

	Climate Region	
Climate Zone	**AC**	**Heating**
1	Coastal	Coastal
2	Coastal	Coastal
3	Coastal	Coastal
4	Coastal	Coastal
5	Coastal	Coastal
6	Coastal	Coastal
7	Coastal	Coastal
8	Inland	Inland
9	Inland	Inland
10	Inland	Inland
11	Inland	Inland
12	Inland	Inland
13	Inland	Inland
14	Inland	Inland
15	Desert	Inland
16	Inland	Inland

These metered-to-modeled ratios were then applied to the IOUs claimed savings (obtained from the program tracking databases, Q4, 2008) to estimate gross program savings. The baseline homes were analyzed to estimate the naturally occurring[18] savings. The Team used these estimates of gross program savings and naturally occurring savings to estimate net program savings.

This section discusses:

- The sample plan for participant and non-participant sites;
- Data collection methods; and

[18] Naturally Occurring' savings are the savings attributed to the non-participant (baseline) homes and are based on the energy use of non-participating homes, which reflects code compliance, market effects, and naturally adopted technologies.

- Algorithms for estimating savings.

Sample Plan

The population used for the baseline study was single-family homes built between October 1, 2006 and December 31, 2008. Homes built during the early part of 2006 were excluded from the study because there was a high probability that they were not designed to comply with the 2005 Title 24 standards, which were implemented in late 2005. Assuming a six-month to one-year lag time for tract homes, October 2006 was the earliest that we could expect most homes to be built under the 2005 Standards. Furthermore, the first savings claimed by PG&E, SCG, and SDG&E all came in the fourth quarter of 2006.

The original evaluation plan called for collecting detailed on-site data and end-use metering at 170 participant and 170 non-participant sites across the state. The proposed sample sizes were based on a target precision for the calculation of meter-to-model ratios of 25% at the 90% level of confidence (90/25), using the error ratio of the end-use ratios calculated from the 2004-05 Energy Star Homes evaluation[19].

The calculation of the AC metering ratio, with an expected error ratio of 1.00, led us to propose a sample size of 45 for PG&E and SCE, and 40 for SDG&E and SCG to achieve utility-specific ratios with 90/25 and 90/26 levels of precision, respectively. The hot water and heating ratios, due to lower error ratios, can achieve 20% relative precision with only 20 and 25 homes per utility, respectively. Thus, we proposed metering those end-uses at only a subset of the 170 homes in the AC sample. The same error ratio was expected in non-participant homes, and thus the size of samples proposed for non-participant metering were identical to those proposed for participants.

Program participation and savings fell short of program goals. This had the two-fold effect of reducing the overall significance of new construction programs to the overall energy-efficiency

[19] The error ratios from the 2004-05 Energy Star Homes evaluation were available ex ante and allowed us to estimate the expected variability in the sample. By using the error ratios from past studies, we optimize the sample design such that it oversamples strata of higher experienced variability and under samples strata with lower experienced variability.

portfolio and increasing the cost and time required to recruit participant homes for on-sites[20] . The reduced savings did not justify the level of effort that had originally been planned for the evaluation, and the CPUC ED approved terminating the metering of participants after 33 on-sites (31 metered) were completed out of the original 170 planned participants. The key data point to be calculated from the participant on-sites was the participant metered-to-modeled ratio. In the absence of additional metered data, we assumed that the participant ratio was the same as the non-participant ratio, parallel to the way we assumed that the ratio for non-participant homes were the same as for participant homes in the 04-05 evaluation. Using the 04-05 ratios wasn't an option because of Title 24 changes[21]. Basically, the logic was that if non-participants' ratios could be equivalent to participants' ratios, then participants' ratios could be equivalent to non-participants' ratios

The Study Team was able to begin activities for the Baseline Study (non-participants) prior to, and primarily separate from the RNC Evaluation activities. While new construction of single-family homes has decreased, there were still enough homes built between October 2006 and December 2008 to pull a reliable non-participant sample, although the final sample size was smaller than planned. Table 3-2 shows the original sample plan for participants, which is identical to what was originally proposed for non-participants.

[20] Keep in mind that the builders were the program participants, not the occupants of the homes. Homes are referred to as participant and non-participant homes based on whether the builder was part of the program.

[21] Note that a new building code went into effect in 2005, so the homes built under the 04-05 program and those built under the 06-08 program were built to a different code. The Micropas model was also updated to reflect the code changes, and the HVAC schedules used for the model were modified. The ratios derived in the 04-05 study are therefore not comparable to the ratios derived in the current study.

Table 3-2: Original RNC Program Participant Sample Sizes

End Use	Error Ratio (From 04-05)	Utility	Proposed	
			n	Expected RP
AC	1.00	PG&E	45	25%
		SCE	45	25%
		SDG&E	40	26%
		SCG	40	26%
		Total	170	
DHW	0.54	PG&E	20	20%
		SCE	20	20%
		SDG&E	20	20%
		SCG	20	20%
		Total	80	
Heat	0.60	PG&E	25	20%
		SCE	25	20%
		SDG&E	25	20%
		SCG	25	20%
		Total	100	

In the end, 131 non-participant sites and 31 participant sites were metered (two of the 33 participant on-sites did not include metering), with the breakdown by end-use and utility shown in Table 3-3.

Table 3-3: Final RNC Non-Participant and Participant Sample Sizes

End Use	Error Ratio (From 04-05)	Utility	Non-participant N	Participant n	Total
AC	1.00	PG&E	34	14	48
		SCE	20	1	21
		SDG&E	31	9	40
		SCG	33	0	33
		Total	118	24	142
DHW	0.54	PG&E	12	4	16
		SCE	6	0	6
		SDG&E	14	3	17
		SCG	18	0	18
		Total	50	7	57
Heat	0.60	PG&E	23	10	33
		SCE	13	1	14
		SDG&E	23	1	24
		SCG	25	0	25
		Total	84	12	96

In addition to the metered sites, the Team conducted on-site surveys at 300 non-participant sites (as planned) and 2 participant sites. The non-participant site data provided the basis for compliance modeling, and combined with the metered-to-modeled ratios calculated from the metered sites, provided the basis for calculating the naturally occurring, true baseline home consumption. Because participant homes were modeled as an element of program participation and those results were available through the participant registries, there was no need to visit additional participant sites in order to develop their models.

Table 3-4 presents the number of non-participant metered and non-metered on-site surveys completed by climate zone as part of the single-family baseline study. The final samples sizes were based on a sample design that adjusted for error ratio, population size, and estimated savings to optimize precision. A total of 424 on-sites (131 of which had meters installed) were completed as part of the RNC Baseline effort.

Table 3-4: RNC Baseline Study Completed Sample Sites: On-Site Surveys (Non-Metered) and Site End-Use Measurement (Metered)

Climate Zone	PG&E		SCE		SCG		SDG&E		Total Metered	Total Non
	Metered	Non	Metered	Non	Metered	Non	Metered	Non		
1	1	0	0	0	0	0	0	0	1	0
2	1	7	0	0	0	0	0	0	1	7
3	3	15	0	0	0	0	0	0	3	15
4	2	11	0	0	0	0	0	0	2	11
5	1	3	0	0	0	0	0	0	1	3
6	0	0	4	7	2	4	0	0	6	11
7	0	0	0	0	0	0	17	25	17	25
8	0	0	3	9	3	2	0	0	6	11
9	0	0	4	4	3	5	0	0	7	9
10	0	0	6	11	13	24	15	34	34	69
11	3	12	0	0	0	0	0	0	3	12
12	12	39	0	0	0	0	0	0	12	39
13	11	29	0	3	7	7	0	0	18	39
14	0	0	8	16	3	6	0	0	11	22
15	0	0	1	4	4	7	0	0	5	11
16	1	4	2	3	1	2	0	0	4	9
Total	35	120	28	57	36	57	32	59	131	293

Data Collection

The types of data collected during the on-sites and the specific data collection protocols used for each end-use are detailed in Appendix B. The primary data that was included the following:

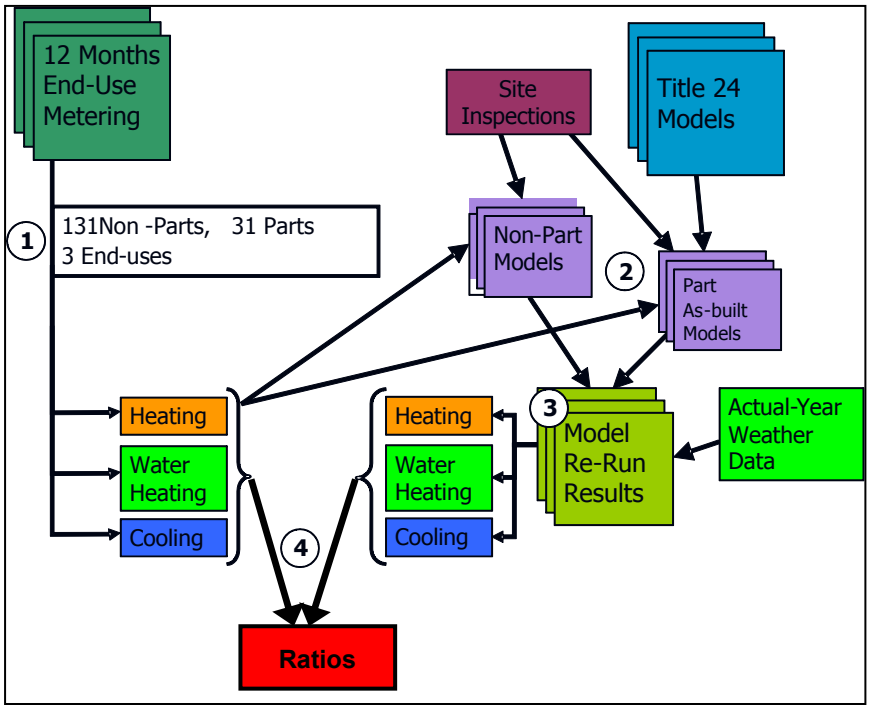
- Site overview information (e.g. floor area, number of residents),
- HVAC systems (characteristics, schedules, etc.),
- Envelope characteristics,
- Lighting inventory, and
- Appliances and other equipment inventory and characteristics.

Algorithms for Estimating Savings

The algorithms discussed in this section were used to calculate gross and naturally occurring savings for the single-family whole-house measures and single-family compliance-modeled whole-house (prescriptive measures), using the results of the participant and non-participant on-

sites. The flow of steps leading up to the calculation of "gross" savings from single-family homes is shown in Figure 3-1.

Figure 3-1: Single Family Whole House Analysis



Step 1: Collection of End-Use Meter Data. 131 non-participant sites were sampled from the IOUs' new hook-ups data. We collected AC metering data from all 131 of these sites[22] , water heating usage data from 50, and heating usage metering data from 84. These data were quality-controlled using techniques outlined in Appendix C and processed to produce 8760-hour annual load curves for each end-use for each unit metered.

[22] Not all sites had AC units, in which case the site was tracked as a 'metered' site, but the annual usage was for the meter analysis was assumed to be zero. These 'phantom' AC's account for the discrepancy between the claimed 131 non-participant AC metered homes and the number of actual AC metered homes reported in the Table 6-2

Step 2: Build on-site adjusted compliance models. We used data collected during the on-sites of the 131 metered sites with the RNC Interface program[23] to build adjusted compliance models for each site.

Step 3: Rerun compliance models with actual-year weather data. We obtained hourly weather data from weather stations local to each metered site for the 365-day year during which metering was conducted for each site. Each model was then re-run using the sites' customized weather to produce weather-adjusted model estimates of energy usage by end-use for the 8760-hour year that corresponds to the metering period.

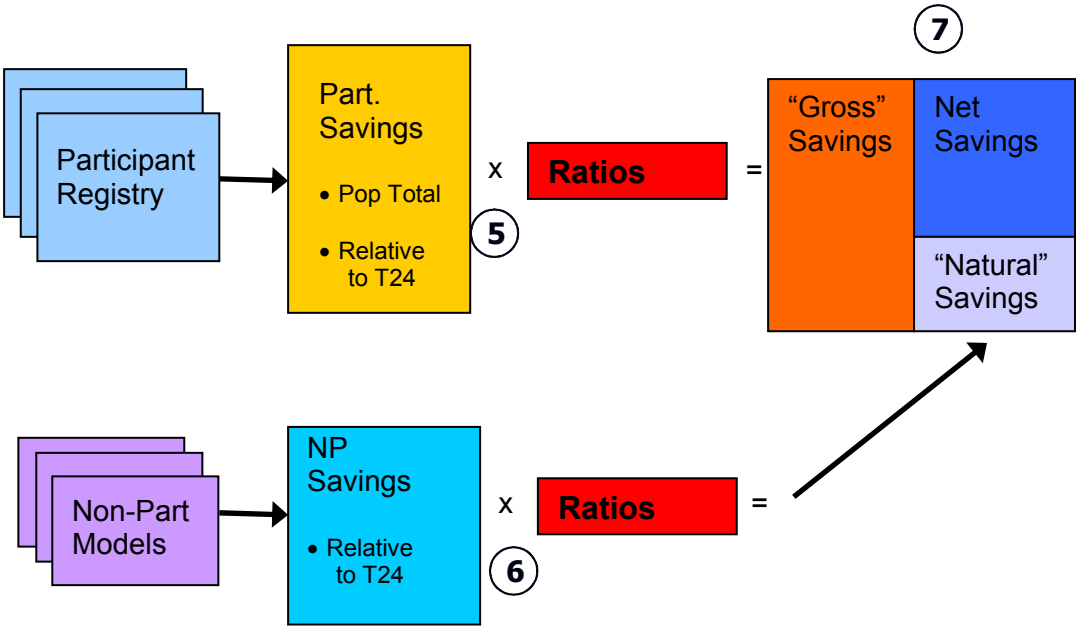
Step 4: Calculation of metering ratios. For each end-use and for each utility, we used ratio estimation to calculate the ratio between metered usage and modeled usage by end-use based on the combined participant and non-participant data for metered homes[24]. We stratified these estimates by inland, coastal, and desert climate regions[25]. These ratios were used to scale both non-participant and participant savings estimates up or down as described below.

[23] The RNC Interface Program is described in detail in Appendix E.

[24] Because data collection for participants was suspended due to the low program participation, we were not able to calculate a separate ratio for participants.

[25] Homes modeled (or built) in CEC climate zones 1-7 were classified as coastal, homes in CEC climate zone 15 was classified as desert, and homes modeled in CEC climate zones 8-16 were classified as inland.

Figure 3-2: Estimate of "Gross" and Net Savings



Step 5: Apply the meter ratios to estimate gross savings. From the participant registries, we obtained an estimate of the savings by end use (modeled) of each participant home in the program. We multiplied each of these estimates by the corresponding metering ratio estimated in Step 4 above. The resulting savings estimates are an actual-usage-scaled estimate of the annual usage of the house compared to the same home built under the Package D prescriptive code standards.

Step 6: Apply the meter ratios to non-participant models to estimate natural savings. We used the same technique to apply the associated end-use ratios to each of the 424 non-participant models' estimates of savings compared to Package D. These were totaled by climate zone to produce estimates of the naturally occurring non-participant savings by end-use.

Step 7: Use the Difference-of-Differences analysis to estimate net savings. We then estimated net savings by comparing the non-participant natural and participant gross savings by climate zone. The difference between the two (expressed as savings-per-square-foot for comparability), are the per-square-foot estimate of net savings for each climate zone. These were multiplied by the corresponding square footage of participants (obtained from the participant registries) to

yield a by-end-use estimate of net program savings. We then backed out net-to-"gross" ratios by dividing net savings for each utility by the "gross" savings.

3.1.2 Ex Ante Energy and Demand Savings Methodology

Each utility filed a Program Implementation Plan with the CPUC prior to receiving approval to implement the program. Included with those plans are Excel workbooks that estimate program energy and demand savings. The basis of those estimates is per unit energy and demand savings in conjunction with unit goals.

For program years 2006 and 2007 the utilities filed their final Annual Earning Assessment Proceeding (AEAP) report, which summarizes program accomplishments and total energy savings. The values included in the AEAP report often become the ex ante value used for program impact evaluation.

However, KEMA was not able to use the total AEAP energy saving values because, for this particular program, the AEAP energy savings values were only estimates and were inclusive of energy savings resulting from both completed and committed structures (project planned for completion at some future date) from 2006, 2007 and 2008.

The evaluation, on the other hand, considers realization of energy savings only for structures considered completed in 2006-08 but may have actually been committed to the program prior to 2006. Therefore it was necessary for KEMA to calculate the ex ante energy savings using only the total number of 'completed and approved' units.

For the purpose of measuring "ex ante" gross and net savings, KEMA obtained total energy savings estimates (kWh and therms) for single-family whole house measures from utility tracking data. These estimates were provided to the evaluators by the four utilities PG&E, SCE, SCG and SDG&E. For SDG&E, however, the tracking data did not contain any single-family whole-house measures for the Advanced Home Program. For PG&E and SCG, the estimates often included different estimates for regional differences (coastal vs. inland) and compliance margin (15% vs. 20% above code).

3.1.3 Gross Energy and Demand Savings Methodology

The starting point for energy savings analysis were the participant registries, CHEERS and CalCERTS, and the associated Gross Savings, defined as the difference between Standard (package D) and Proposed modeled energy consumption[26].

In accordance with CPUC policy, energy savings are counted in the year the savings are realized, which for this program translated into the year each home was built and passed inspection. Homes included in the population were:

1) Inspected in 2006-8
2) Structure "status" was labeled "Approved"
3) The sponsoring utility name was PGE, SCE, SoCalGas, or SDGE
4) Plan type was not labeled as "Non ENERGY STAR®[27]

Note that when, or if, incentives were paid was not a criteria used to determine participation status.

A home was classified as either coastal, desert or inland based on CEC climate region characteristics. Homes modeled (or built) in CEC climate zones 1-7 were classified as coastal, homes in CEC climate zone 15 were classified as desert, whereas homes modeled in CEC climate zones 8-14 and 16 were classified as inland.

[26] "Standard" and "Proposed" are terms used by Title 24 energy modeling software. When a new home is modeled, it is compared to a "Standard" home's energy budget, which is determined by a set of prescriptive measures and characteristics (referred to as Package D) specific for that climate zone (e.g. insulation levels, air conditioner SEER, etc.). "Proposed" is the modeled energy consumption of the new home as designed. Gross energy savings is defined as the difference between Standard and Proposed.

[27] In addition, 10 homes from CalCERTS data extract were excluded from the population as they had 0 standard or proposed energy values reported in the data.

Simple Gross (Tracking) Savings

Calculating the Adjusted Gross Savings was a two-step process:

- first, the Gross Savings were calculated, and
- second, the gross savings were adjusted to take into account differences in participant registries, CHEERS and CalCERTS, and to reflect verification inspection. Gross Savings is defined as the difference between Standard (package D) and proposed modeled energy consumption, taken from the participant registries,

Gross Savings of the RNC participating homes = $\sum_{i=1}^{N_p}(S_{p_i} - P_{p_i})SF_{p_i}$

where,

Sp[28] = Participant CF-1R standard [29] energy use (kBTU/sf-yr)

Pp = Participant CF-1R proposed energy use (kBTU/sf-yr)

SFp = Conditioned floor area of the home

Np = total number of participating homes

3.1.4 Evaluation Plan Modifications

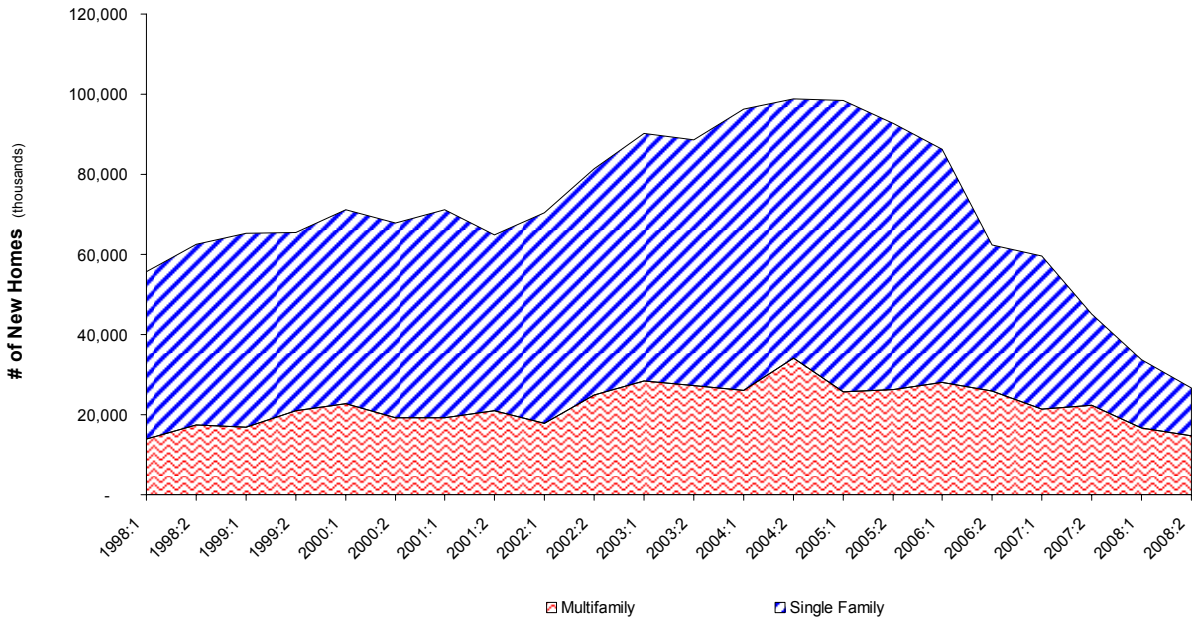
Figure 3-3 presents the number of new home permits submitted to building departments in California from 1998 through 2008 for both single-family and multi-family units. Since the data presented below are from permit data, they do not represent the number of homes actually being built in a certain period. Past studies have found that a six-month lag for single-family

[28] The subscript p is used to denote Participants, and np is used for Non-Participants.

[29] "Standard" and "Proposed" are terms used by Title 24 energy modeling software. When a new home is modeled, it is compared to a "Standard" home's energy budget, which is determined by a set of prescriptive measures and characteristics specific for that climate zone (e.g. insulation levels, air conditioner SEER, etc.). "Proposed" is the modeled energy consumption of the new home as designed. Gross energy savings is defined as the difference between Standard and Proposed.

homes and a 12-18 month lag for multifamily units are reasonable assumptions to make. However, during the current economy, these lags may be greater.

Figure 3-3: Residential New Home Starts



* Permit data from Construction Industry Research Board (CIRB).

The impacts of the residential construction slow-down were two-fold. First, RNC program participation was significantly lower than originally forecast, resulting in decreased savings compared to other programs in the efficiency portfolio. Second, the pool of participant and non-participant homes from which to draw was much smaller than anticipated, making it more difficult and costly to recruit on-site homes (many of which were not identified until too late in the program/evaluation cycle to be metered) for the evaluation. The decreased significance of the new construction programs to the overall energy-efficiency portfolio, combined with the increased difficulty in reaching the original sample targets, led the Team to request in the interim report, a number of changes to the evaluation and baseline studies.

The original evaluation plan called for 170 participant sites. When we submitted our interim report, we proposed that we stop recruiting sites and work with the 31 sites already completed. The CPUC ED approved the proposal. The final number of metered participant sites for the evaluation was 31.

To evaluate the program savings based on the modified evaluation approach, we considered two alternative approaches. We could assume that the ratio of actual usage to modeled usage was the same between 2004-05 participant homes and 2006-08 participant homes, or we could assume that it is the same between 2006-08 non-participant homes and 2006-08 participant homes. The first assumption was deemed untenable because the models used for the 2004-05 participant homes were based on 2001 code and the 2006-08 models were based on 2005 code. This meant that the 2004-05 ratio had a different denominator (2001 compliance model outputs) than that needed for the 2006-08 analysis (2005 compliance model outputs). The second assumption implied that the difference in occupants' behavior relative to the model assumptions was consistent between occupants of non-participating homes and occupants of participating homes. The team adopted the second assumption, and calculated a net savings rate for the programs using the Differences-of-Differences methodology along with the meter-to-model ratios from the non-participants for compliance-modeled measures.[30] [31], This effectively turned the 2004-05 methodology around. Instead of assuming that the non-participants actual (metered) usages to modeled usage ratios were the same as the participants, we assumed that the participants were the same as the non-participants that we were able to calculate.

For the baseline study, we planned to complete all 300 non-metered sites as originally proposed. Because of the difficulty identifying and recruiting non-participant sites the number of metered sites was 131 out of the originally planned 170 and the number of non-metered sites was 293. Therefore, 424 total non-participant homes were used for analysis in the Baseline Study compared to original plan that included 470 non-participant homes. The precision impacts of this change on the impact of the meter-to-model ratio (which informed both the New Construction programs' evaluation and the Codes & Standards estimate) are noted in section 3-2 below.

[30] The difference-of-differences methodology and how it is used to calculate the net savings is described in detail in the 2004-05 ESH evaluation report, available on CALMAC. Appendix B walks the reader through the derivation of the estimate. The realization rate is imputed, after the fact, by dividing the estimated net savings for each utility by the ex ante per-unit estimate for each utility times the number of completes for each utility.

[31] This effectively turned the 2004-05 methodology around. Instead of assuming that the non-participants actual (metered) usages to modeled usage ratios were the same as the participants, we assumed that the participant ratios were the same as the non-participant ratios that we calculated.

Table 3-5: Comparison of Original Evaluation Plan to the Final Implemented Plan

Evaluation Elements	Original Plan		Modified Plan	
	Metered	Non-Metered	Metered	Non-Metered
Baseline Study (Non-Participants)	170	300	131	293
RNC Evaluation (Participants)	170	0	31	2

3.2 Confidence and Precision of Key Findings

The proposed sample sizes were based on a target precision for the calculation of meter-to-model ratios of 25% at the 90% level of confidence (90/25). Due to the lower than expected sample size the range of achieved relative precisions for the meter-to-model ratios varies between +/-70% to +/-18% at 90% level of confidence. Table 3-14 shows the achieved relative precisions by climate region and end use. Despite the revised sample plan, the desired relative precision was achieved on 3 out of the 6 meter-to-model ratios. Also, the two end use/climate region combinations with the largest relative precisions—coastal AC and coastal heat—contributed the least to overall total savings, reducing the impact of the larger relative precisions.

3.3 Validity and Reliability

The 2004 Framework describes many types of potential bias in energy efficiency evaluations. Below is a short description of potential biases for the RNC evaluation and a brief explanation how we minimized bias and/or tested for it.

Non-response bias in phone survey/recruiting – CATI staff is well trained, several members having five to ten years of experience conducting energy efficiency related surveys and recruiting participant homes for on-site surveys. Furthermore, the CATI center has strict protocols for the number of call backs in order to reduce the risk of non-response bias. Further, an incentive was offered for homes that agree to an on-site survey and/or metering at $50 for the detailed on-site survey and an additional $50 for the metered sites. Appendix K provides further information.

Measurement bias – All measurements can contain some error, but experienced engineering staff tested and calibrated metering equipment prior to installing to minimize error and quantify any identifiable bias in measurement. Furthermore, all on-site surveyors had training, both in the

office and on-site, to ensure that on-site building characteristics would be collected appropriately.

Choosing an appropriate baseline – As part of the NC and C&S Evaluation, a detailed baseline assessment of newly constructed single-family homes was conducted. Care has been taken to chose the appropriate definition of non-participant in order to properly characterize what has been installed outside of the Programs and segmented by climate zone and, if possible, socio-economic regions.

Self-selection of program participants – For RNC, the definition of Participant depended on the application. In this case, the builders were the participants (or non-participants) and the respondents to the surveys were occupants of homes built by participating builders. Depending on how a participant home is marketed, it may or may not be sold to an energy-conscious occupant. In fact, the occupants of the home may or may not have known that their home was part of the program. Past studies have found that many respondents living in high efficiency new homes were unaware of it[32]. In addition, those studies also found that many people living in standard-efficiency homes thought that their homes were high-efficiency. Even if a participant home has an energy-conscious occupant, that occupant may or may not have different behavior, on average, compared to occupants of non-participant homes. Someone might be energy-conscious in order to reduce energy costs, even if he has average or greater need for heating and cooling services.

The connection between participation and occupant behavior is not a direct one, hinging on both the occupants knowledge of whether the home is energy efficient and their motivation (if any) for choosing an energy efficient home. The decision of builders to self-select into the program is not expected to have a direct effect on occupants of the homes.

3.4 RNC Single-Family Whole House Detailed Results

This section addresses the full impact evaluation results performed on the following programs:

- PGE 2009 Residential New Construction Program

[32] 2004-2005 ENERGY STAR New Homes Program Evaluation found that only 24 of 43 residents of ENERGY STAR homes knew (56%). The Energy Trust of Oregon also found that only 60% of owners of ENERGY STAR Homes knew it; and only 90% of ENERGY STAR Manufactured Homes knew it.

- SCE 2505 CA New Homes Program
- SCG 3502 Advanced Home Program
- SDGE 3007 Advanced Home Program

The section includes discussion on the following topics:

- Program participation from utility tracking data
- Ex-ante gross and net program savings
- Ex-post Gross Program Energy and Peak Demand Savings
- Ex-post Net Program Energy and Peak Demand Savings

3.4.1 RNC Single-Family Program Participation

Table 3-6 shows the number of approved units by type and utility extracted from the CHEERS/CalCERTS registries for this analysis. The total number of single-family dwelling units used in the analysis that were completed in 2006-8 was 5,725[33] . Data for program homes were obtained from two registries – CHEERS and CalCERTS. All four utilities, PG&E, SCE, SCG and SDG&E confirmed that there were no data in CBPCA (California Building Performance Contractor's Association) registry. The participants' registries contain building characteristics and modeled energy use, which were necessary for this analysis.

There was no direct way to match program participants from the utility tracking data to the sites listed in the participant registries. To address this, the team developed selection criteria to exclude as many non-program sites from the analysis as possible. Only single-family homes were kept from the registries for the analysis - all multifamily homes were excluded. Additionally, only sites with approval dates after October 2006 and before September 2008 were

[33] The first adjustment made during the QC period, was adjusting the participants' number of sites from CHEERS and CalCERTS registries that were used in the analysis of the per unit savings to match the IOUs' tracking database estimates (this explains the difference in numbers used in this report and the draft report). Since the registries might have contained participants' sites from pervious program cycle, KEMA developed a number of criteria, such as application date, to filter the registries' population to match the IOUs' tracking unit numbers.

included. This was done to exclude participants from other program cycles in the analysis. The total number of single-family dwelling units claimed by the utilities was 4,951; the number of registry homes used to estimate per unit savings was 5,725. Table 3-6 compares the number of single-family dwelling units used from the participant registries with the number of homes claimed by each utility in the Q4 08 tracking data..

In addition to the screenings discussed above, some CalCERTS sites were excluded from the analysis because they did not have any indicator for time-dependent valuation (TDV) or source energy. KEMA attempted to resolve the missing and invalid data issues with CalCERTS, but discovered that CalCERTS was chartered to secure and distribute data, but not to verify the data submitted to them[34].

Because the number of sites from the participant registries did not reflect the actual number of participants in the program, data from the registries was used to calculate per-unit savings, which were then applied to the units claimed in the utility tracking data to estimate total ex-post savings.

Table 3-6: Summary of RNC Single Family Program Participation

Utility	2006-2008 Single- Family Dwelling Units from CHEERS/CalCERTS[35]	2006-2008 Single- Family Dwelling Units from Utility Tracking Databases (Q408)
PG&E	5,244	4,502
SCE	414	404
SCG	67	45
SDG&E	NA	NA
Total	5,725	4,951

3.4.2 RNC Single-Family Ex Ante Gross and Net Savings Results

Table 3-7, Table 3-8, and Table 3-9 show ex-ante gross and net savings claimed through of the 2008 fourth quarter tracking data (submitted by the IOUs on March, 2009) for PG&E, SCE, and SCG, respectively. Table 3-10, Table 3-11, and Table 3-12 present the corresponding per-unit ex-ante gross and net savings. We found no whole-house measures in the SDG&E tracking

[34] Personal communication with Hugo Schmidt of CalCERTS via email, November 12, 2009.

[35] These numbers are based on complete data found in the CHEERS and CalCERTS participant registry databases.

data. These tables also provide per unit ex-ante gross and net kWh for the whole house measures as obtained from the utility tracking data. For PG&E, the per unit ex-ante numbers are provided for both inland and coastal regions. SCE provided tracking data for kWh and kW for all three regions, but did not claim any gas savings. SCG only claimed savings for one whole house measure for the High Desert region (climate zone 15).

The per-unit savings from the analysis of the CHEERS/CalCERTS data were applied to the number of housing units from the utility tracking data (ex-ante) to estimate the total program savings (ex-post) for whole-house measures. The total IOUs' ex ante energy and demand savings were compared to the ex-post results to get realization rates.

Table 3-7: PG&E Ex-Ante Savings Claimed through Fourth Quarter of 2008 (March, 2009 Tracking DB)

Measure Description	Total Ex-Ante Gross kWh	Total Ex-Ante Net Savings kWh	Total Ex-Ante Gross Therms	Ex-Ante Net Therms	Total Ex-Ante Gross kW	Total Ex-Ante Net Savings kW	Ex Ante NTG Ratio
WHOLE HOUSE (15%) - SF - INLAND - ES	1,411,411	1,129,129	383,520	306,816	1312.61	1050.089	0.8
WHOLE HOUSE (15%) - SF - COASTAL - ES	70,929	56,743	25,693	20,554	65.96	52.77	0.8
WHOLE HOUSE (15%) - NSHPPM - SF - INLAND	201,826	161,461	33,559	26,847	187.7	150.16	0.8
WHOLE HOUSE (15%) - NSHPPM - SF - COASTAL	11,842	9,474	3,141	2,512	11.013	8.81	0.8
WHOLE HOUSE (35%) - NSHPPM – SF	633,048	506,438	115,534	92,427	588.73	470.99	0.8

Table 3-8: SCE Ex-Ante Savings Claimed through Fourth Quarter of 2008 (March, 2009 Tracking DB)

Measure Description	Total Ex-Ante Gross kWh	Total Ex-Ante Net kWh	Total Ex-Ante Gross kW	Total Ex-Ante Net kW	Ex-Ante NTG Ratio
SINGLE FAMILY - 15% PERFORMANCE TIER	117,497	93,997	206	164	0.8
SINGLE FAMILY - 20% PERFORMANCE TIER	32,701	26,161	25	20.12	0.8

Table 3-9: SCG Ex-Ante Savings Claimed through Fourth Quarter of 2008 (March, 2009 Tracking DB)

Measure Description	Total Ex-Ante Gross kWh	Total Ex-Ante Net kWh	Total Ex-Ante Gross Therms	Total Ex-Ante Gross Therms	Tpta; Ex-Ante Gross kW	Total Ex-Ante Net kW	Ex-Ante NTG Ratio
SINGLE FAMILY, 15%, ENERGY STAR CZ 15	62,550	50,040	14,085	11,268	27.45	21.96	0.8

Table 3-10: PG&E Per-Unit Ex-Ante Savings Claimed through Fourth Quarter of 2008 (March, 2009 Tracking DB)

Measure Description	Units	Ex-Ante Gross kWh per Unit	Ex-Ante Net Savings kWh per Unit	Ex-Ante Gross Therms per Unit	Ex-Ante Net Therms per Unit	Ex-Ante Gross kW per Unit	Ex-Ante Net Savings kW per Unit
WHOLE HOUSE (15%) - SF - INLAND - ES	3,284	430	344	117	93	0.40	0.32
WHOLE HOUSE (15%) - NSHPPM – SF – INLAND	273	260	208	94	75	0.24	0.19
WHOLE HOUSE (15%) - SF - COASTAL - ES	329	613	491	102	82	0.57	0.46
WHOLE HOUSE (15%) - SF - INLAND - ES	48	247	197	65	52	0.23	0.18
WHOLE HOUSE (35%) - NSHPPM – SF	568	1,115	892	203	163	1.04	0.83

Table 3-11: SCE Per-Unit Ex-Ante Savings Claimed through Fourth Quarter of 2008 (March, 2009 Tracking DB)

Measure Description	Units	Ex-Ante Gross kWh per Unit	Ex-Ante Net kWh per Unit	Ex-Ante Gross kW per Unit	Ex-Ante Net kW per Unit
SINGLE FAMILY - 15% PERFORMANCE TIER	351	335	268	0.59	0.47
SINGLE FAMILY - 20% PERFORMANCE TIER	53	617	494	0.47	0.38

Table 3-12: SCG Per-Unit Ex-Ante Savings Claimed through Fourth Quarter of 2008 (March, 2009 Tracking DB)

Measure Description	Units	Ex-Ante Gross kWh per Unit	Ex-Ante Net kWh per Unit	Ex-Ante Gross Therms per Unit	Ex-Ante Net Therms per Unit	Ex-Ante Gross kW per Unit	Ex-Ante Net kW per Unit
SINGLE FAMILY, 15%, ENERGY STAR CZ 15	45	1,390	1,112	313	250	0.61	0.49

3.4.3 RNC Single-Family Ex-Post Gross Energy Savings

In the analysis of the metered data, KEMA found that there were significant differences between the average usage predicted for a site through its compliance model and the end-use demand actually metered on site. We calculated meter adjustment factors and error bounds that were the estimated ratio of metered usage to modeled usage for each end use in each of three climate regions. These ratios were then applied to orientation-adjusted estimates of gross savings to yield the ex post estimates of gross single-family program savings.

Orientation Adjustment

The orientation of a home can significantly affect its space-cooling and heating energy requirements, chiefly due to solar gain through windows. While we recorded the orientation of homes in our participant and non-participant samples during the on-sites, we did not know the orientation of all participant homes. When RNC participating homes were built and entered into the participant registries (CHEERS and CalCERTS), their actual orientations were not recorded. The CalCERTS database reported savings for the worst orientation, while the CHEERS database reported the savings for all four orientations. The average savings of the four orientations in CHEERS was compared to the worst orientation in CHEERS to come up with orientation ratios for the CalCERTS data. This accommodates production builders who designed homes that were built in all possible orientations according to the layout of the streets in a development. To satisfy the RNC program requirements, builders model their homes in north, east, south, and west orientations to show that energy consumption meets minimum program requirements in all four “cardinal” orientations.

The CHEERS registry contains the modeled energy consumption for all four orientations, and the average was used to calculate the gross energy savings for each home.

The CalCERTS registry only contains modeled energy for each plans' worst orientation, but clearly not all homes are actually built in the worst possible orientation. To adjust for this, we used the CHEERS data to estimate "average" orientation energy as a function of worst orientation energy. Unique orientation adjustments (b-ratios) were estimated for the single-family homes. These b-ratios were used to calculate an orientation-adjusted estimate of gross savings, used in the following analysis. (More details on b-ratios are found in Appendix A).

The overall impact of the orientation adjustment on gross savings from the CHEERS/CalCERTS registries is presented in Table 3-13. Gross savings from the raw data (for which savings estimates could be obtained) increased by 6.42% as a result of the adjustment. We multiplied the CalCERTS portion of gross savings by the b-ratios for orientation adjustments to arrive at the orientation adjusted gross savings.

Table 3-13: Single Family CHEERS/CalCERTS Savings and Orientation Adjusted Savings

Utility	Single Family Dwelling Units	Savings before orientation adjustment (source kBtu)	Savings after orientation adjustment (source kBtu)	% change
PG&E	5,244	87,816,143	93,393,552	6.35%
SCE	414	7,513,120	8,146,578	8.43%
SCG	67	1,455,735	1,455,735	0.00%
Total	5,725	96,784,998	102,995,866	6.42%

Note that SCG had 0% change between the orientation adjusted savings numbers. This is because all of the SCG participants were in the CHEERS database, and no adjustments were needed.

Metered Energy Use vs. Modeled Energy Use

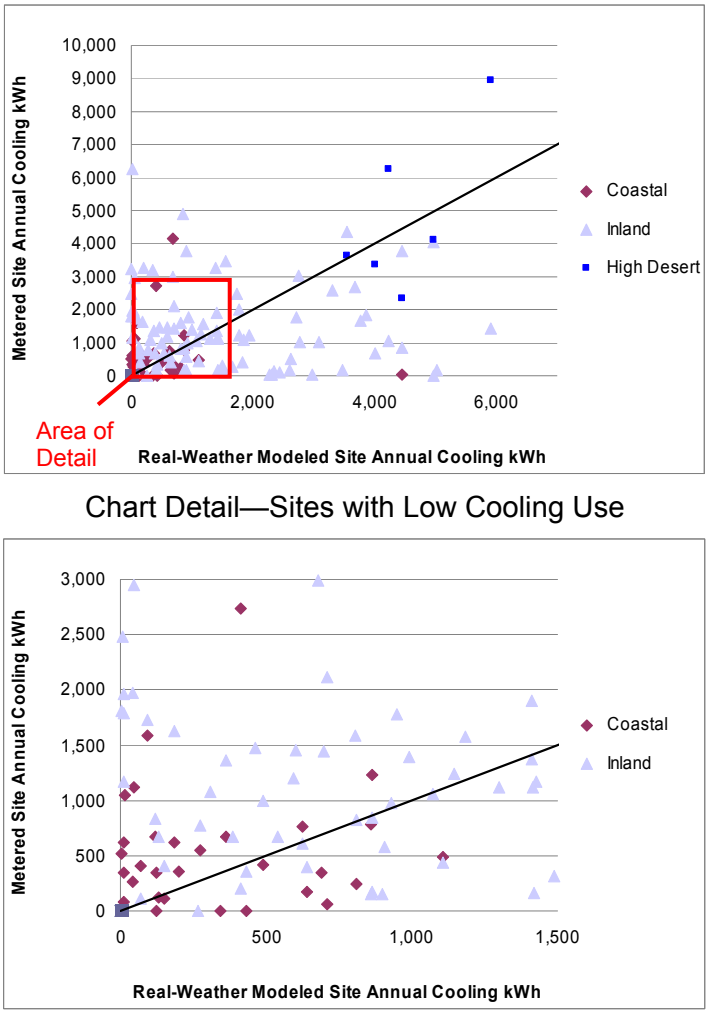
Meter Adjustment Calculation

The aggregated annual meter data were matched up by end use to the estimated usages output by the MICROPAS runs for each site[36] . As expected, the variation in actual usage was greater than the variation in modeled estimates—the models were meant to represent a home under standardized usage conditions. Figure 3-4 shows the cooling metering results plotted against the cooling load predicted by the models, with the second chart showing the detail of the inland and coastal sites clustered around the origin.

Slightly more than half of the sites had a metered usage less than the modeled usage, falling underneath the y=x line in the plot. A handful of sites exhibited considerably higher annual usages than the models predicted. Some of these sites were standard sampling outliers, larger users that were statistically balanced out by smaller users in the sample. However, most of the 34 homes located in coastal climate regions lie above the line, indicating that, generally, coastal-dwellers used more AC energy than the compliance model indicated.

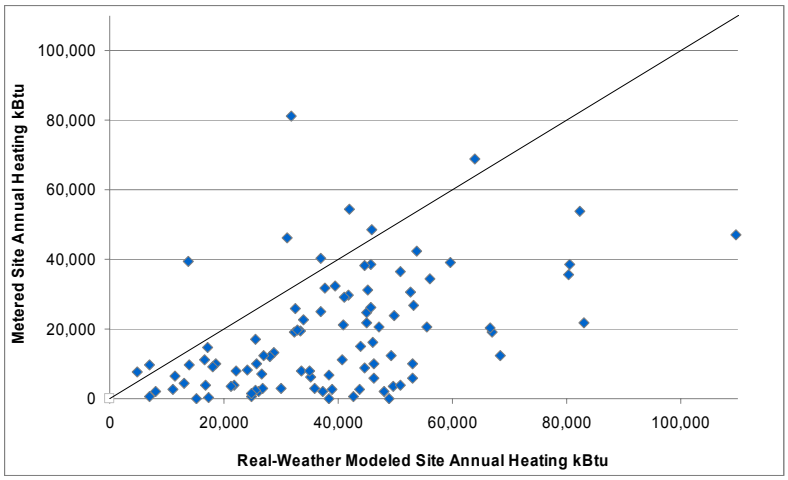
[36] An adjustment made during the QC period to mitigate for an inexplicable result from the CalCERTS database. KEMA noticed that SCE climate zone 6 (coastal region) had very high compliance margins for air conditioning. There were 40 sites in this group, and all the 40 sites were listed as having air conditioners in the database (eliminating the possibility that the high compliance margins were due to a high concentration of sites with no AC units). The minimum compliance margin was 91% and the maximum compliance margin was 96%. KEMA came to the conclusion that there is a fundamental flaw in the models for climate zone 6 in the CalCERTS database and decided to use the average compliance margin from PG&E participant coastal regions as a proxy value

Figure 3-4: Single-family Metered Annual kWh Cooling Compared to Modeled kWh Cooling



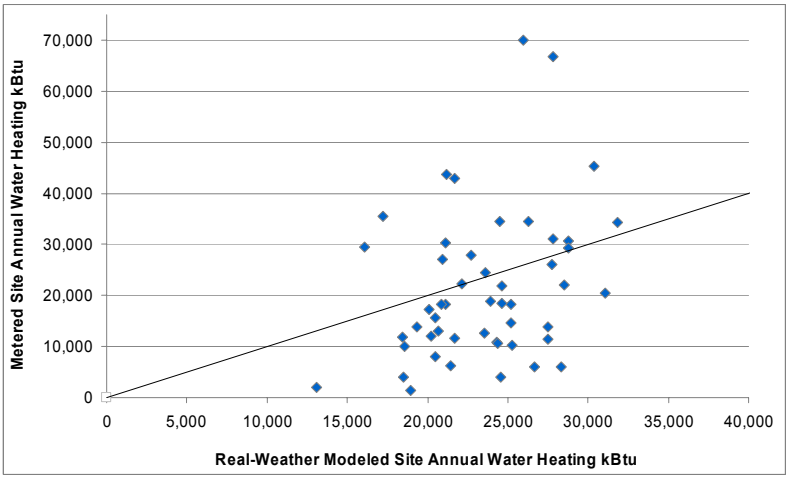
The heating results more consistently show that metered usage is less than the modeled usage. Figure 3-5 shows that just nine sites logged usage greater than the amount the compliance model predicted for them. The rest of the sites fell below the y=x line, indicating that the model over predicted heating demand relative to what the homeowner actually used during the metering period.

Figure 3-5: Single-family Metered Annual kBtu Heating Compared to Modeled kBtu Heating



The greatest variation among the metered results vis-à-vis the modeled usages was seen in the hot water results. As Figure 3-6 shows, the models predicted between 13,000 and 32,000 kBtu for the homes, whereas actual metered usage for most sites ranged from 1,400 to 45,000 kBtu—with two homes topping 60,000 kBtu. Despite the large spread, the majority of the homes showed metered usage less than the model-predicted annual usage. In fact, 36% of the homes had metered usage under 13,000 kBtu, the smallest model-predicted usage among our sample homes.

Figure 3-6: Single-family Metered Annual kBtu Water Heating Compared to Modeled kBtu Water Heating



Meter Adjustment Factor Ratio Analysis

Due to the differences between the larger, desert-located cooling sites and the rest of the inland homes and the difference between coastal and inland results seen in the data, we broke out the analysis into three climate regions: coastal (CEC climate zones 1-7), inland (CEC climate zones 8-14 and 16), and high desert (CEC climate zone 15). These distinctions were used throughout the single-family portion of the metered-adjusted ratio analysis for the cooling end use. Heating was broken out by coastal and inland, with inland including climate zone 15. Since water heating was not weather-dependent in the compliance models, its adjustment factor was not separated out by climate region.

For each climate-region/end-use combination, we used stratified ratio estimation to weight our sample up to the 2006-2008 RNC program single-family participant population and calculated the ratio of metered usage to real-weather modeled usage. The sample was projected up to the total population by CEC climate zone, such that each CEC climate zone's available sample sites for each end use were treated as a simple random sample of the participant homes in that climate zone. Once those weights were assigned to the sample homes, ratio estimation was used to calculate the adjustment factors reported in Table 3-14 for the climate regions defined in this study.

Table 3-14: Single-Family Meter Adjustment Factors by Climate Region and End Use[37]

End Use	Climate	Sample n	Ratio Meter Usage to Modeled Usage	Relative Precision
AC	Coastal	30	1.40	45.8%
	High Desert	8	1.39	19.3%
	Inland	84	1.06	25.0%
Heat	Coastal	21	0.44	69.2%
	Inland	68	0.44	36.6%
Hot Water	All	57	0.93	18.7%

As was observed in the graphs of metered versus modeled energy usage, coastal cooling usage was, on average, 40% higher than modeled usage for coastal homes. The inland ratio indicates 6% more usage than modeled. The desert homes used 39% more energy than predicted. The relative precision of the cooling ratios for the three regions provides insight into the variability of cooling based energy usage among the regions. The coastal region, with a relative precision of 45.8%, implies a wide variation in the level of usages of inhabitants of new construction homes. The relative precision of the High Desert homes of 19.3% shows a much more consistent level of cooling based energy usage of homes in the region.

The heating ratios reflect a significant overestimation of usage. Both coastal and inland metered usages were just 44% of modeled projections. The relative precisions reflect the high level of variation in the heating usage among the metered homes.

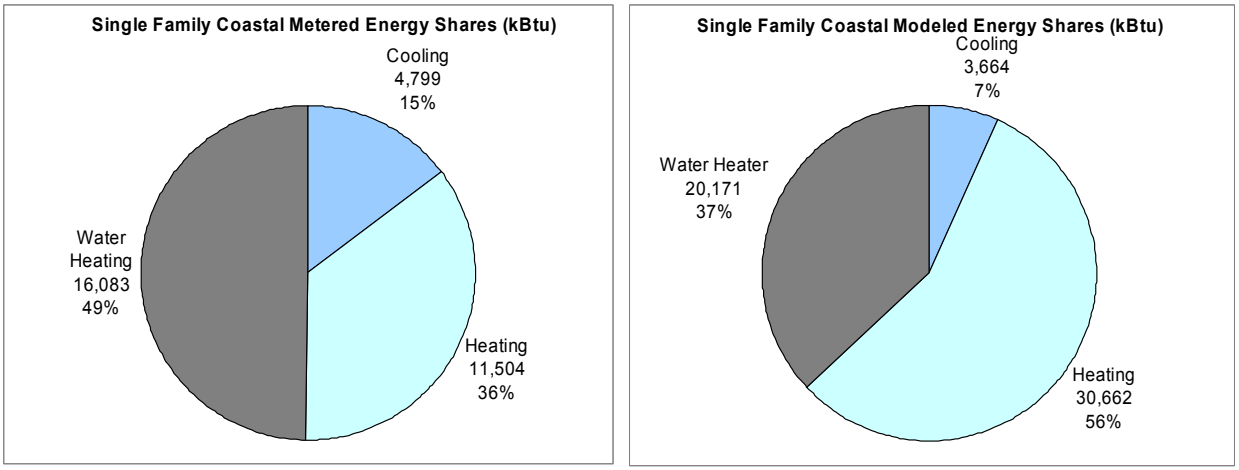
The hot water ratio shows an average metered usage of 93% of modeled usage across all homes at a 19% relative precision.

[37] All relative precisions were computed at the 90% level of confidence. The relative precisions indicate what percentage of the estimates the error bounds represent. If the estimate plus or minus that error bound does not include 1, then the estimate is determined to be statistically different from 1.

Meter adjustment Impacts on End-use Shares

The metered data can also be looked at to see how they affect the proportion of builder-affected energy use that goes to each of the three major end-uses (heating, cooling, and water heating) compared to the end-use shares predicted by the modeling software. Figure 3-7 shows the proportion of energy[38], aggregated across the single-family metering sample that goes to each of the end-uses according to the meter data (on the left) and the modeled data (on the right). The models predict that heating is the majority of usage, with cooling taking a small 7% share. The metering results show much less heating energy usage and more cooling usage than predicted. The result is that cooling share increases to 15% and heating's drops from 56% to 36% of total builder-affected energy usage. Water heating accounts for about half of metered usage, compared to 37% of modeled energy use.

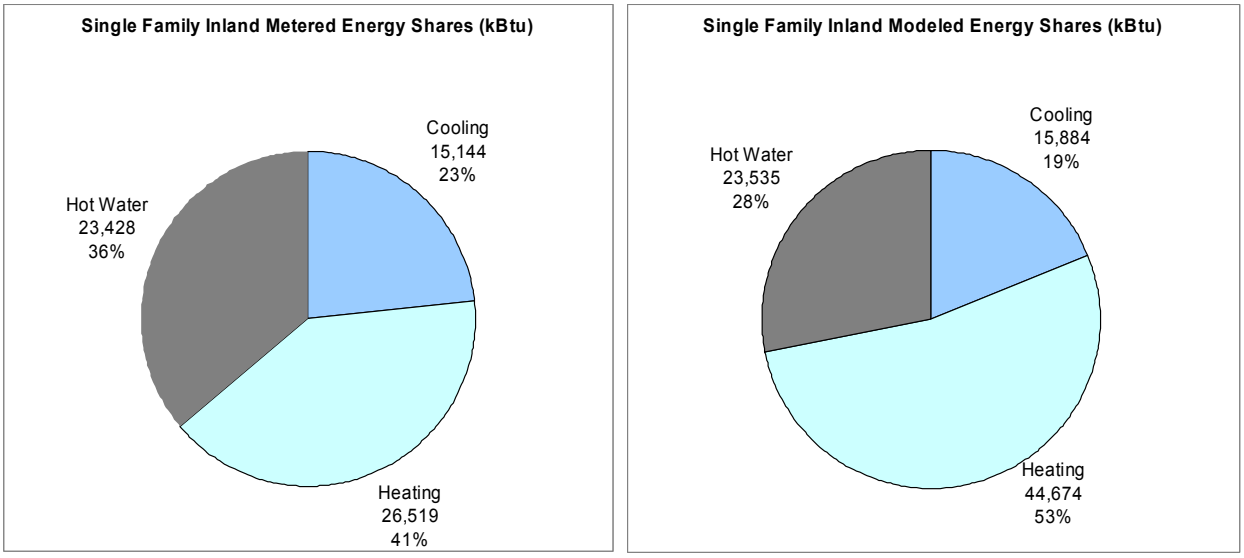
Figure 3-7: Single Family Metered vs. Modeled Energy Usage Shares, Coastal



The impacts on inland energy use share, shown in Figure 3-8, while not quite as dramatic as the coastal region, are still significant. Again, the metering results show less heating energy usage and more cooling usage than predicted. The cooling share increases from 19% to 23%, while the heating share drops from 53% to 41%. Metered water heating usage is 36% of the total, compared to the 28% predicted.

[38] The end-use shares charts present all end-uses in source kBtu for ease of comparability between end uses.

Figure 3-8: Single Family Metered vs. Modeled Energy Usage Shares, Inland



Meter-Adjusted Savings

The orientation-adjusted gross savings were broken down by utility and into coastal, inland, and desert so that the different ratios for the three climate regions could be applied. Table 3-15, Table 3-16, and Table 3-17 show how the ratios were applied to orientation-adjusted gross savings by utility for cooling, heating and water heating, respectively. The reported error bounds represent the error from the estimates of the meter-adjustment ratios. Because all three climate regions had cooling meter ratios greater than one, the ex post gross savings was estimated to be greater than the orientation-adjusted ex ante gross savings.

As previously discussed, the number of homes included in the analysis from the participant registries do not reflect the number of units listed in the utility tracking data. Therefore, the presentation of the results focuses primarily on per-unit savings.

Table 3-15: RNC Single-Family Cooling Meter-adjusted Per-Unit Savings (kWh/unit)

Utility	Region	Orientation Adjusted Gross kWh	Meter Adjustment Factor	Ex Post Gross Savings kWh	Error Bound
PG&E	Coastal	364	1.4	510	233
	Inland	591	1.06	626	157
SCE	Coastal	494	1.4	692	317
	High Desert	5,337	1.392	7,429	1,437
	Inland	1,511	1.06	1,602	401
SCG	High Desert	1,947	1.392	2,710	524

Table 3-16: Single-Family Heating Meter-adjusted Per-Unit Savings (Therms/unit)

Utility	Region	Orientation Adjusted Gross	Meter Adjustment Factor	Ex Post Gross Savings	Error Bound
PG&E	Coastal	119	0.44	52	36
	Inland	98	0.44	44	16
SCE	Coastal	12	0.44	5	4
	Inland	63	0.44	28	10
SCG	High Desert	3	0.44	1	0

Table 3-17: Single-Family Water Heating Meter-adjusted Per-Unit Savings (Therms/unit)

Utility	Region	Orientation Adjusted Gross	Meter Adjustment Factor	Ex Post Gross Savings	Error Bound
PG&E	Coastal	5	0.93	4	1
	Inland	21	0.93	19	4
SCE	Coastal	5	0.93	4	1
	Inland	60	0.93	55	10
SCG	High Desert	16	0.93	14	3

The orientation adjusted gross numbers essentially represent the participant homes' savings over code. SCE inland and high desert orientation adjusted gross values are extremely high for their regions. The SCE inland cooling savings are about 2.5 times as high as the PG&E inland savings and the SCE high desert savings are about 2.7 times the SCG high desert savings. The high SCE inland numbers are probably driven by a number of factors. The majority of the SCE inland sites were located in climate zone 13 and 14. The usage levels in these zones are relatively high compared to the other climate zones included in the inland region. The PG&E participants had a larger concentration in climate zones 8, 9 and 10, which have much more moderate climates. This may explain the discrepancy between the modeled savings. There were only two sites in the participant registry from the SCE high desert region. Such a small sample greatly reduced the significance of the results.

Ex-Post Gross Energy Savings

Table 3-18 shows the gross per-unit kWh savings after taking into account the meter adjustment factor. The per-unit savings for inland structures ranged from PG&E's 628 kWh/yr/unit to SCE's average 1,606 kWh/yr/unit. Coastal savings had a smaller range of gross unit savings with a high of 693 kWh/yr/unit to a low of 511 kWh/yr/unit. The large range in Gross Unit Savings for the Desert region was caused by the low participant home populations for both SCE and SCG.

Table 3-18: Single-Family Meter-adjusted Gross Per-Unit Electricity Savings (kWh)

Utility	Inland		Coastal		Desert	
	Gross Unit Savings	Error Bound	Gross Unit Savings	Error Bound	Gross Unit Savings	Error Bound
PG&E	628	157	511	234	NA	NA
SCE	1,606	402	693	317	7,428	1,436
SCG	NA	NA	NA	NA	2,709	524

The meter ratios for heating end-uses implied that modeled savings were drastically overstated, while the meter ratios for hot water end-uses demonstrated a consistent level of usage between the modeled and metered consumptions. The combined savings of the two end-uses are reflected in the gross gas savings shown in Table 3-19. The Gross Unit Savings ranged from 16 to 63 therms/yr/unit in the Inland region and from 38 to 57 therms/yr/unit in the Coastal region.

Table 3-19: Single-Family Meter-adjusted Gross Per-Unit Gas Savings (therms)

Utility	Inland		Coastal	
	Gross Unit Savings	Error Bound	Gross Unit Savings	Error Bound
PG&E	63	20	57	37
SCE	83	21	38	10
SCG	16	3.1	NA	NA

3.4.4 RNC Single-Family Ex-Post Net Energy Savings

Difference of Differences

In order to account for any naturally occurring savings in the baseline, the models from the baseline sample were adjusted by the meter ratios and the savings were deducted from the ex-post gross numbers. The resulting ex-post net numbers represent the estimated impact of the programs. Table 3-20 shows electricity net to gross ratios; Table 3-21 shows natural gas net to gross ratios. Electricity NTG ratios vary widely across IOUs and region, from 0.45 to 1.06 Both

of the inland NTG numbers were greater than 1, implying that the typical baseline home from the inland region is below code. The NTG for the coastal and high desert regions are below one, implying that baseline homes are above code in those regions.

Table 3-20: Per-Unit kWh Impacts and Net to Gross Ratios by Climate Region[39]

Utility	Inland			Coastal			Desert		
	Ex Post Gross Savings	Ex Post Net Savings	Net-to-Gross Ratio	Ex Post Gross Savings	Ex Post Net Savings	Net-to-Gross Ratio	Ex Post Gross Savings	Ex Post Net Savings	Net-to-Gross Ratio
PG&E	628	665	1.06	511	293	0.57	NA	NA	NA
SCE	1,606	1,695	1.06	693	359	0.52	7,428	4,324	0.58
SCG	NA	NA	NA	NA	NA	NA	2,709	1,221	0.45

Gas NTG ratios, shown in Table 3 21, ranged from -0.29 for the SCG Coastal region to 1.2 for the SCE Coastal region. The negative NTG ratio means that the average baseline home was more code compliant than the average participant home in the particular region. Both the SCG high desert and the PG&E coastal regions have negative NTG numbers. The only NTG number greater than one is SCE coastal. Overall, the baseline compliance numbers significantly reduce the impact of the gas savings. The widespread presence of instantaneous water heating in the baseline population, an average of 24% (15-40%, depending on climate region) is one important reason for this.

[39] The Ex Post Gross is the Meter Adjusted Gross Savings, while the Net Ex Post is the difference-of-differences result.

Table 3-21: Therm Impacts Net to Gross Ratios By Climate Region

Utility	Inland			Coastal		
	Ex Post Gross Savings	Ex Post Net Savings	Net-to-Gross Ratio	Ex Post Gross Savings	Ex Post Net Savings	Net-to-Gross Ratio
PG&E	63	33	0.53	57	-1	-0.02
SCE	83	70	0.84	38	46	1.20
SCG	16	-5	-0.29	NA	NA	NA

Single-Family Net Savings and Realization Rates. Ex ante estimates were calculated for each utility based on per unit savings estimates and the number of homes actually committed to the program[40]. The Net Unit Savings were provided to KEMA by the individual utilities. SDG&E did not claim any savings for whole house measure and therefore they were not included in this analysis. SCE did not claim any gas savings, and under the assumption that SCE's kWh units apply to only cooling end-uses, we estimated realization rates for kWh, but not gas. Additionally, SCE's per unit savings were not broken down by region, and therefore the weighted average of estimates was applied across the Inland and Coastal regions. There were no program participants for PG&E and SCG in the High Desert and Coastal regions respectively, which is why no realization rates were estimated for those utility/region combinations[41].

Single-family electricity savings and realizations rates for Coastal, Inland, and Desert climate regions are presented in Table 3-22, Table 3-23, and Table 3-24, respectively., Most of the realization rates fell in the range of 0.98 to 1.57.

SCE's Inland and Desert regions had extremely high realization rates, at 6.23 and 4.87, respectively. We applied consistent analytical methodologies to all the data yet the SCE savings results are significantly different from the results for other utilities. The SCE inland kWh per unit savings were high compared to the savings estimated for the same region for the other utilities.

[40] At the time utilities filed Program information with the CPUC, estimates were based on homes committed (approved applications) within a Program year – not constructed. Since that time, it was determined to conduct this evaluation based on homes actually constructed within a Program year. Due to this accounting change, it was necessary to calculate new ex ante estimates.

[41] This is consistent with all the other tables in this report.

We tracked the source of the large savings back to the participant compliance numbers in the CalCERTS and CHEERS databases. Without the availability of the original utilities' compliance documentation paperwork we were unable to verify the accuracy of the numbers reported in the databases, but we but we suspect that the models used in the registries significantly overestimate air conditioning electricity consumption.. Considering that the participant registries are the initial source of the savings estimates for the RNC impact analysis, we recommend for future studies that an effort to verify the compliance numbers reported in the databases be undertaken and/or the original models input files be included in utilities' energy claims estimates.

With the exception of PG&E's Coastal region at 0.98, all the realization rates were above one. These realization rates were a product of a number of factors: (1) The meter to modeled ratios showed that the models were underestimating typical usage, and therefore savings. The ratios adjusted for this by increasing the estimated usage and savings of the models. (2) The net-to-gross ratios imply that baseline practices were lower than assumed in the ex ante calculations (that is, the naturally occurring savings were negative) for the two regions with the most claimed participants (PG&E and SCE inland); (3) The per-unit savings estimates provided to us by the utilities were conservatively low.

Table 3-22: Single-Family Annual Electricity Savings & Realization Rates – Inland

Utility	Per Unit Net Ex Ante kWh	Per Unit Net Ex Post kWh	Units	Total Net Ex Ante kWh	Total Net Ex Post kWh	Realization Rate
PG&E	424	665	4,131	1,752,033	2,745,435	1.57
SCE	272	1,695	370	100,689	626,974	6.23
SCG	NA	NA	NA	NA	NA	NA

Table 3-23: Single-Family Annual Electricity Savings & Realization Rates – Coastal

Utility	Per Unit Net Ex Ante kWh	Per Unit Net Ex Post kWh	Units	Total Net Ex Ante kWh	Total Net Ex Post kWh	Realization Rate
PG&E	299	293	371	111,212	108,888	0.98
SCE	292	359	18	5,263	6,460	1.23
SCG	NA	NA	NA	NA	NA	NA

Table 3-24: Single-Family Annual Electricity Savings & Realization Rates – Desert

Utility	Per Unit Net Ex Ante kWh	Per Unit Net Ex Post kWh	Units	Total Net Ex Ante kWh	Total Net Ex Post kWh	Realization Rate
PG&E	NA	NA	NA	NA	NA	NA
SCE	888	4,324	16	14,206	69,189	4.87
SCG	1,112	1,221	45	50,040	54,935	1.10

Single-family gas savings and realization rates for coastal and inland climate regions are presented in Table 3-25 and Table 3-26, respectively. The calculation of therm realization rates, as with kWh, was limited to utilities that provided net unit savings in their tracking data. As previously mentioned, SDG&E did not provide any tracking data and SCE did not provide any therm savings estimates. The SCG tracking data contained unit savings estimates for one whole-building program measure in CZ 15 (High Desert). For the therm analysis, the High Desert region was combined with the Inland region.

The gas realization rates for both Inland and Coastal were much lower than the kWh realization rates, and in fact negative for SCG's Inland region and PG&E's Coastal region due to the negative net savings estimated for those regions. The realization rate for PG&E's Inland region was the highest, at only 0.33. The low gas realization rates were primarily driven by low participant compliance rates and relatively high baseline compliance, resulting in low savings over baseline.

Table 3-25: Single-Family Annual Gas Net Savings & Realization Rates—Inland

Utility	Per Unit Net Ex Ante Therms	Per Unit Net Ex Post Therms	Units	Total Ex Ante Therms	Total Ex Post Therms	Realization Rate
PG&E	101	33	4,131	417,879	138,293	0.33
SCE	NA	70	386	NA	27,160	NA
SCG	250	-5	45	11,268	-205	-0.02

Table 3-26: Single-Family Annual Gas Net Savings & Realization Rates—Coastal

Utility	Per Unit Net Ex Ante Therms	Per Unit Net Ex Post Therms	Units	Total Ex Ante Therms	Total Ex Post Therms	Realization Rate
PG&E	84	-1	371	31,279	-348	-0.01
SCE	NA	46	18	NA	828	NA
SCG	0	NA	NA	NA	NA	NA

Savings Compared to Gross and Non-Meter-Adjusted Net. Figure 3-9 and Figure 3-10 show how the ex-post net savings estimates compare to the orientation-adjusted gross and meter-adjusted (ex-post) gross savings results reported above for electricity and gas, respectively. For electricity, a combination of factors affected the final savings numbers in different ways for different utilities and regions. The savings from the participant registries was very high for some sub-groups, but reasonable for others. The meter-to-model ratios generally increased the level of savings. However, adjusting for baseline compliance increased the inland regions but significantly lowered the savings in the other regions.

Figure 3-9: Single-Family Per-unit Estimated Electricity Savings

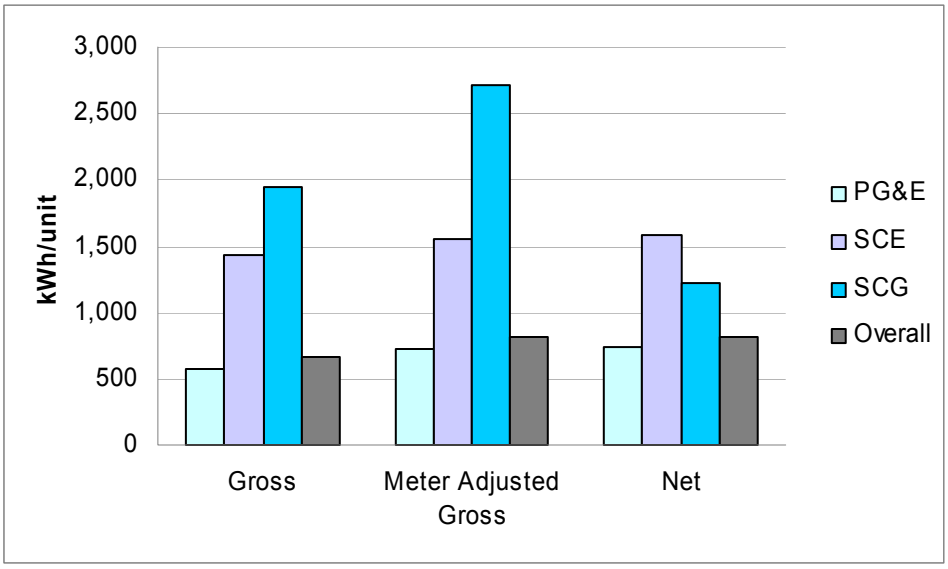
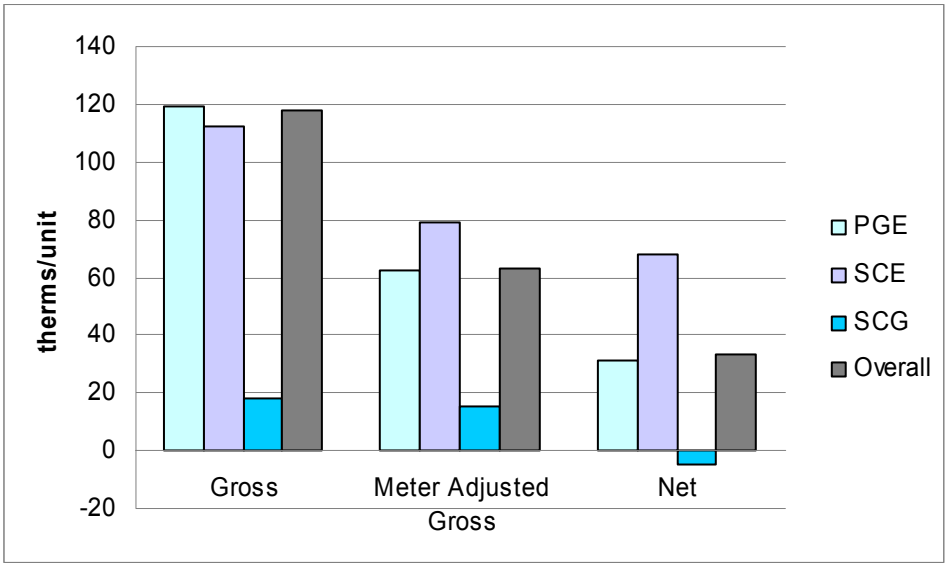


Figure 3-10: Single-Family Per-unit Estimated Natural Gas Savings



For gas savings, high heating and water heating compliance margins pushed the net gas savings well below the gross estimates, with SCG having a negative net savings. Additionally, the low meter-to-model ratio dropped gas savings for all utilities and regions. The overall net savings estimate was approximately 30% of gross savings.

Several findings from the analysis of the results are:

- The RNC program's largest sources of net energy savings were cooling end-uses.
- Negative naturally-occurring savings for cooling in the inland region means that new non-program homes on average do not meet Title 24 cooling budget requirements. The fact that non-participant homes were performing worse than code means that some of net electricity savings were attributable to the low performance of the baseline group.
- Significant naturally occurring (gas) savings were present for heating and water heating, translating to high gas free-ridership rates.

3.4.5 RNC Single-Family Ex-Post Net Peak Demand (kW) Reduction

Under the original sample plan, the size of the metered participant sample would have been large enough to conduct an independent verification of kW savings. Unfortunately, with the reduction in the sample size of metered homes, this was not possible. Instead, KEMA applied a peak factor method used in past studies[42], called the "H-factor" approach.

KEMA used utility tracking data for gross per-unit kWh and gross per-unit kW to calculate the ratio of kW to kWh that was assumed by the utilities for their program planning. These ratios are referred to as "H-factors" and are presented in Table 3-27. (SDG&E is not included in the table for lack of data.)

KEMA then estimated ex-post net kW savings by applying these H-factors to the ex-post net energy savings value. This method does not provide any independent verification of actual kW savings. It is only as accurate as the proportions in the IOU ex ante calculations were, and only reflects the demand reduction definition in DEER to the extent that the IOU claimed savings did.

[42] See, for example: Evaluation, Measurement, and Verification of the 2004 & 2005 California Statewide ENERGY STAR New Homes Program. Prepared for California Public utilities Commission. Prepared by RLW Analytics & SERA. 2007.

Table 3-27: Single-Family H-Factors

Utility	Region	IOU Ex-Ante from Tracking		H-Factor Used in Evaluation
		Gross Coincident Peak Demand Reduction per Unit (kW)	Gross Annual Energy Savings per Unit (kWh)	
PG&E	Coastal	0.35	374	0.000928
	Inland	0.49	530	0.000928
SCE	Coastal	5.78	365	0.015806
	High Desert	0.50	1,110	0.000289
	Inland	0.32	340	0.001463
SCG	High Desert	0.61	1,390	0.000439

3.5 RNC Single-Family Discussion of Findings and Recommendations

3.5.1 Single-Family Baseline Study Findings

The results of the Baseline Study were applied in three ways:

1) To establish the current practices in new home construction. Some of these results were applied to develop the new savings estimates for the RNC program evaluations;

2) To provide a measure of compliance for the Codes and Standards Program, allowing us to quantify the savings from utility involvement in promoting codes and standards changes (Volume III: C&S Evaluation Report); and

3) To estimate the savings attributable to the market affects of utility single-family residential new construction programs (RNC Market Effects, Phase I report)[43].

The Baseline Study also provides a wealth of information on characteristics of new single-family homes in California. Here is a brief summary of those results (additional information and detail can be found in Appendix F).

- Glazing
  - The average percent of glazing in new homes fell from 17% in homes built under the 1995 standards to 14% in homes built under the 2005 standards.
  - The percentage of glass that was two-paned vinyl and low-e increased from 5% in homes built under the 1995 standards to 95% in homes built under the 2005 standards.
- Space heating
  - The average furnace efficiency increased from 80% in homes built under the 1995 standards to 83% in homes built under the 2005 standards.
  - The percentage of 90%+ AFUE furnaces increased from 2% in homes built under the 1995 standards to 19% in homes built under the 2005 standards.
- Space cooling
  - The average central air conditioner SEER level increased from 10.5 SEER in homes built under the 1995 standards to 13.3 SEER in homes built under the 2005 standards; 13 SEER became the federal minimum standard in January of 2006.
  - The percentage of central air conditioners with SEER levels greater than 13 increased from 0% in homes built under the 1995 standards to 34% in homes built under the 2005 standards.

[43] KEMA, Nexus Market Research, Inc., Summit Blue Consulting, Itron, Inc., The Cadmus Group, Inc.. 2009. Phase I Report: Residential New Construction (Single Family Home) Market Effects Study. Available at http://www.energydataweb.com/cpuc/default.aspx

- Water heating
  - The percentage of water heaters that were instantaneous increased from 0% in homes built under the 1995 standards to 24% in homes built under the 2005 standards.
- Ceiling insulation
  - The average R-value of ceiling insulation increased from 29.1 in homes built under the 1995 standards to 33.1 in homes built under the 2005 standards.
- Radiant barriers
  - The percentage of homes with radiant barriers increased from 2% of homes built under the 1995 standards to 16% of homes built under the 2005 standards.
- Duct leakage
  - The average duct leakage decreased from 13.5% in homes built under the 1995 standards to 11.4% of homes built under the 2005 standards.

3.5.2 RNC Single-Family Ex-Post Net Energy Savings

Table 3-28 and Table 3-29 summarize the IOU's claimed per-unit gross and net savings and the corresponding ex-post savings. With the exception of SD&E, which had no claimed savings for whole buildings, the IOUs exceeded their goals for electricity and peak demand savings, but fell short of their goals for gas savings. The overall final net impact estimates for the RNC SF programs[44] are presented in Table 3-30. Only programs that provided an ex ante savings estimate for individual end-uses are included. A more detailed explanation of the effects of the availability of ex-ante estimates on realization rate calculations can be found in section 3.4.4.

[44] The impact of the adjustments made during the QC period resulted in the following-when comparing the results included in the draft report to the final results presented in this report: lower compliance margins for DHW end uses which caused an overall drop in gas savings; coastal per unit savings dropped; PG&E inland savings dropped; and SCE inland per unit kWh number remained higher than PG&E, because most of the SCE inland sites were concentrated in hotter climate zones compared to the PG&E inland sites.

Table 3-28: RNC Single-Family Whole House IOUs' Ex-ante Claimed Savings per Housing Unit

Utility	PG&E	SCE	SCG	SDG&E
Ex-Ante Gross Electricity Savings per Unit (kWh/Unit)	517	372	1390	NA
Ex-Ante Net Electricity Savings per Unit (kWh/Unit)	414	298	1112	NA
Ex-Ante Gross Gas Savings per Unit (Therms/Unit)	125	NA	313	NA
Ex-Ante Net Gas Savings per Unit (Therms/Unit)	100	NA	250.4	NA
Ex-Ante Gross Peak Demand Reduction per Unit (kW/Unit)	0.48	0.57	0.61	NA
Ex-Ante Net Peak Demand Reduction per Unit (kW/Unit)	0.38	0.45	0.49	NA

Note: SDG&E's tracking database showed no whole house measures.

Table 3-29: RNC Single-Family Whole House Ex-Post Savings per Housing Unit

Utility	PG&E	SCE	SCG	SDG&E
Ex-Post Gross Electricity Savings per Unit (kWh/unit)	618	1,796	2,709	NA
Ex-Post Net Electricity Savings per Unit (kWh/unit)	634	1,739	1,221	NA
Ex-Post Gross Gas Savings per Unit (Therms/unit)	62	NA	16	NA
Ex-Post Net Gas Savings per Unit (Therms/unit)	30.6	NA	-4.5	NA
Ex-Post Gross Peak Demand Reduction per Unit (kW/unit)	0.57	2.73	1.19	NA
Ex-Post Net Peak Demand Reduction per Unit (kW/unit)	0.59	2.57	0.54	NA

Note: SDG&E's tracking database showed no whole house measures.

Table 3-30: RNC Single Family Whole House Total Electricity and Gas Savings Realization Rates

Utility	kWh			Therms			kW		
	Net Ex Ante	Net Ex Post	Realization Rate	Net Ex Ante	Net Ex Post	Realization Rate	Net Ex Ante	Net Ex Post	Realization Rate
PG&E	1,863,245	2,854,323	1.53	449,158	137,945	0.38	1,730	2,648	1.53
SCE	120,158	702,623	5.85	NA	27,988	NA	185	1,039	5.63
SCG	50,040	54,935	1.10	11,268	-205	-0.02	22	24	1.10
Total	2,033,442	3,611,881	1.78	460,426	165,728	0.36	1,812	2,818	1.56

The kWh realization rate was greater than one for all utilities, and was much greater than one for SCE. This was a result of low ex-ante per-unit savings estimates across the board, as well as having a large concentration of program participants in high usage climate zones. The kW results showed similar realization rates as the kWh results, which was expected, due to the method of calculation. The kW results were estimated using the H-factor analysis, which essentially adjusted the kW savings per unit based on the difference between ex ante and net ex post savings.

The therms realization rate was below one. This low realization rate was primarily caused by the high compliance margins of the baseline homes as well as the adjustments that were made to the savings from them meter-to-model ratios.

The estimates of baseline usage that were obtained from the compliance software might have been overestimated for non-participant homes. The evaluation team found homes that were approved as Title-24 compliant use less energy for water and heat than the compliance software estimates. It was entirely possible that some non-participant homes used HERS credits towards compliance. During the field work, it was difficult, if not impossible, to visually verify HERS measures such as quality insulation installation, duct leakage credit, and air infiltration. Windows were another component where the exact performance specification was largely unknown. The window stickers were no longer present at our post construction visit, thus limiting our observations about them..

Utilities should reevaluate how they calculate ex ante savings. The utilities used Micropas compliance software to estimate their ex-ante savings claims, but based on our metering, the

software underestimates cooling energy consumption and overestimates heating consumption. There are alternatives to using Micropas for modeling building energy use. The Department of Energy's DOE2 and EnergyPlus simulation tools are two such options. The data collected for this study could be used, for future program planning, to evaluate alternative simulation tools and find one that aligns more closely with metered usage over the range of California climates.

The orientation of a home can significantly affect its space-cooling and heating energy requirements. The orientation results show that inland energy savings can be increased by 29% for space cooling, and 14% for space heating, by orienting a home from its worst energy orientation to its average energy orientation. Even greater energy savings could be achieved by orienting homes to their best orientation or by selecting designs specific to the orientation of the site. This is not a “new” discovery, as the advantages of passive solar design and home orientation have been known for centuries, but the orientation adjustment b-ratios (discussed in Appendix A), based on analysis of thousands of homes, provide a quantitative estimate of the energy “cost” to builders of ignoring orientation.

The lack of home-specific orientation information in CHEERS/CalCERTS can dramatically misstate savings of specific homes. Orientation has such a significant impact on home energy use, yet the CHEERS and CalCERTS participant registries frequently record only the worst orientation or only the average of the orientations of a homes (for example for homes in a housing development that are identical except for orientation). This can dramatically misstate the savings of specific homes. Implementing a method of incorporating the actual home orientation into the participant registries has the potential to greatly improve the accuracy of program performance estimates.

The metered data indicate that the compliance software overestimates the amount of heating energy consumed at a site and underestimates the amount of cooling energy consumed. Further exploration of this issue through billing data analysis, additional mining of the existing metered data, and added metering should be undertaken to verify the finding and understand the impact on compliance and overall residential consumption in the state. Special attention should be paid to solar gains, as these have the potential to influence the heating and cooling in opposite directions, while not affecting water heating usage, which is similar to what we observed in our meter to model comparisons.

Utilities should track participation information in a common database. The implementers need a statewide program tracking system (other than the CHEERS, CalCERTS, and CBPCA registries) that ties a building plan to a payment amount and date. The registries are not an effective system for tracking program information, especially as new C-HERS providers become

active and begin working with participant builders. In data from the registries, reported standard and proposed energy are sometimes “source energy” values or time-dependent valuations (TDVs). For direct comparison purposes, it will be useful if a uniform unit (either source energy or TDV or consistently both) is reported for all plans.

Studies should be conducted on the metering data to learn more about residential usage patterns for builder-affected end-uses. As a result of this study, we have collected one of the most extensive sets of residential end-use meter data ever collected in the state of California. This study made several uses of those data. However, the data could be used in many other research areas, for example, to build complete annual hourly load curves for each end-use.

RNC Single-Family Ex-Post Net Peak Demand Savings. In order to compute ex-post peak kW, a peak load factor was applied to the net ex-post kWh savings to obtain net ex-post kW savings. This method does not provide any independent verification of actual kW savings but instead applies an estimated “H-factor” to the evaluated kWh savings. KEMA did not provide any verification of the “H-factor” in this evaluation. In future evaluations, we recommend that the evaluation contractor use metered participant and non-participant data to verify peak savings.

4. PG&E California Multifamily New Homes Program: Verification-Guided Evaluation

Pacific Gas and Electric's (PGE 2059) California Multifamily New Homes Program (CMFNH) facilitates and encourages energy-efficient design in multifamily housing through design assistance, cash incentives and ENERGY STAR® marketing benefits. It is designed to address several obstacles associated with the multifaceted structure of the multifamily new construction market. Barriers include owner-developer versus tenant split incentives, lack of market differentiation and tenant understanding, cost constraints, and market inertia. The program encourages the installation of qualifying energy-efficient products in individual tenant units and in the common areas of residential apartment buildings, mobile home parks, and condominium complexes. The Energy Efficiency Rebates for Multifamily Properties are offered to multifamily property owners and managers of new residential dwellings that contain two or more units to achieve energy savings of 15% above Title 24.

4.1 Evaluation Objectives

The California Public Utilities Commission developed the category of "Verification-Guided Impact Evaluations" to address relatively small programs with levels of rigor and expense in keeping with the savings they are responsible for, thus preserving evaluation resources for programs accounting for more savings. Accordingly, the programs evaluated in this manner require only field verification of measure installation and operation in a binary manner—i.e., installed or not and operating or not—with gross savings estimates derived from other sources, and with an option for either developing Net To Gross values or using default inputs. Because the CMFNH program is relatively small and does not warrant the resources required for more extensive impact evaluations, the verification-guided approach was chosen.

The initial objectives of the evaluation of the CMFNH Program, as laid out in the work plan, in keeping with the guidelines for Verification-Guided Impact Evaluations, were to determine whether or not program measures have been installed and whether or not they have been installed properly, and to make use of available information to estimate energy impacts. However, the CPUC decided that the low savings from this program did not warrant the resources required for such an approach. Instead, the key objective became an estimation of program free ridership.

4.2 Methods Used

This section describes the initial evaluation plan,[45] modifications to that plan, and the final evaluation tasks.

4.2.1 Initial Evaluation Plan

The initial verification-guided plan provided for onsite inspections of 70 units that were to be completed in 2008. Prior to the on-sites, the evaluation team was to identify the list of compliant measures at the project, building and unit levels. Projects were to be randomly selected across climate zones for inspection, and within projects, with buildings and units begin randomly selected; subject to file review, it was assumed that installation quality would be fairly uniform across units within projects and/or buildings.

A technician was to visit the sampled units to verify through visual inspection that each of the listed measures was installed and operating. The visual inspection data were then to be compared to model inputs (e.g. MICROPAS or EnergyPro). The plan was also to review program savings estimation methods to ensure proper application of the modeled data and program energy savings claims. In addition to the visual inspections, the team had planned to speak to building managers providing access to these units for their perspective on proper installation and operation.

If onsite visits confirmed that the inputs to the models used by the program were correct and the models were properly applied, then the team was to use the program's energy savings estimates, subject to comparisons with savings claims from similar programs based on secondary sources. If the inputs to the models required adjustment, then more onsite visits could have been required and the models themselves would have needed to be rerun, necessitating a revision to the work plan and an expansion in scope.

4.2.2 Modifications to Initial Evaluation Plan

Because the CMFNH program had relatively low savings relative to the overall program portfolio, the evaluation plan was modified by eliminating the on-site verifications. However, given the Energy Division's interest in establishing a net-to-gross (NTG) ratio for the program,

[45] New Construction / Codes & Standards Direct Impact Evaluation. RLW, et al. December 18, 2007.

the team conducted interviews with participating builders/developers in order to assess the level of program influence.

4.2.3 Final Evaluation Tasks

Below we provide some background regarding NTG for multifamily programs, and discuss the NTG interview plan.

Multifamily Net-to-Gross Background. The investor-owned utilities (Southern California Edison, Southern California Gas, and PG&E) proposed an ex-ante NTG ratio of 0.80 for the multifamily new construction programs. This proposal was filed before the results for the 2004-2005 ENERGY STAR Homes program evaluation[46] were available. When these results became available, with net of free-ridership ratios reported as potentially being between 0.46 and 0.63, the Database of Energy Efficient Resources (DEER) update of May 30, 2008 changed the value to 0.50. This NTG value of 0.50 was required to be used for the 2009-2011 portfolio planning. The investor-owned utilities countered with a work paper in Appendix E of the 2009-2011 PG&E filing (July 21, 2008) that asserted sufficient evidence to plan based on a NTG of 1.0.

The 2004-2005 ENERGY STAR Homes program evaluation attributed the high free-ridership in the 2003-2005 programs to loopholes in the 2001 version of Title 24. The evaluation stated that the program in subsequent years should not produce similarly high free-ridership levels after the 2005 Title 24 revisions closed the most serious loopholes for multifamily buildings.

4.2.4 Final Evaluation Plan

In order to establish a NTG ratio for the post-2005 code multifamily program, the team conducted interviews with developers, architects, and energy consultants regarding the level of program influence on building designs and appliance selection. In May and June of 2009, NMR conducted interviews with 33 people representing twenty-two unique projects. These twenty-two projects represent 42% of the 53 total projects and 38% of the 3,446 housing units completed through the CMFNH program.

[46] Evaluation, Measurement, and Verification of the 2004 & 2005 California Statewide ENERGY STAR New Homes Program. Prepared for California Public utilities Commission. Prepared by RLW Analytics & SERA. 2007.

HMG, the program implementer, had asserted that some building plans received by the program did not meet Title 24 code. Therefore, while we conducted interviews with decision makers from projects with all three types of program components (performance only, performance plus appliances, and appliances only) in order to represent all program projects, we also specifically targeted projects with the performance component,. Thus, the 22 interviewed projects include projects from all three program tracks: five performance-only projects, five appliance-only projects, and twelve performance + appliance projects. The seventeen interviewed performance track projects represent nearly one-half (46%) of the gross energy savings from all 32 performance track projects. The seventeen interviewed projects that received appliance incentives represent 39% of the appliances installed and 36% of the gross appliance energy savings from all 41 appliance track projects.

Interviewees. Because commercial construction projects typically have multiple decision makers/influencers, we attempted to interview the developer, architect, and energy consultant. For the five appliance-only projects, we interviewed only the developer. For the remaining seventeen projects with a performance component, we attempted to interview multiple contacts including the developer or the architect, plus the Title 24 (T24) consultant. Despite repeated attempts, however, this was not always possible. For twelve of the seventeen performance projects, we interviewed multiple respondents: the developer plus architect (three projects), developer plus T24 consultant (seven projects), and architect plus T24 consultant (two projects). For the remaining five projects, we interviewed one person per project: the developer (two projects), the architect (two projects), and the T24 consultant (one project). Overall, we interviewed the T24 consultant for ten of the 17 performance track projects, usually asking them only the Title 24 related questions.

4.3 Confidence and Precision of Key Findings

At the unit level, the sampling error for the 1316 sampled units (out of 3446 units covered by the program) is +/-2% at the 90% confidence level. At the project level, the sampling error for the 22 sampled projects (out of 53 projects covered by the program) is +/-16% at the 90% confidence level.

4.4 Validity and Reliability

To help assure validity of results, when possible the team conducted interviews with multiple respondents—including developers, architects, and Title 24 respondents—representing the same projects for Performance-track questions (but not for Appliance-only track questions since

the developers usually make such decisions on their own without input from Title 24 consultants or architects). Generally, different respondents supported each other's responses. If there was a contradiction, the team gave primacy to the Title 24 consultant's responses since they were most involved with the modeling and with the program implementers.

The team also employed consistency checks with multiple questions to help minimize response bias.

To address possible non-response bias, the team made multiple callbacks to maximize response rates. The team conducted interviews with 33 people representing twenty-two unique projects. These twenty-two projects represent 42% of the 53 total projects and 38% of the 3,446 housing units completed through the CMFNH program. The seventeen interviewed performance-track projects represent nearly one-half (46%) of the gross energy savings from all 32 performance track projects. The seventeen interviewed projects that received appliance incentives represent 39% of the appliances installed and 36% of the gross appliance energy savings from all 41 appliance-track projects.

One threat to validity is the lapsed time since the decision to participate in the program was made and its effect on respondents' ability to recall the details of their decisions, which is the case for any self-reporting approach covering the 2006-2008 program period in a survey conducted in 2009.

4.5 Detailed Results

This section presents the results of the Net-to-Gross interviews and analysis.

4.5.1 Net-to-Gross Interview Results

In this section we present the criteria, calculations, and estimates of NTG for the Performance track and Appliance track.

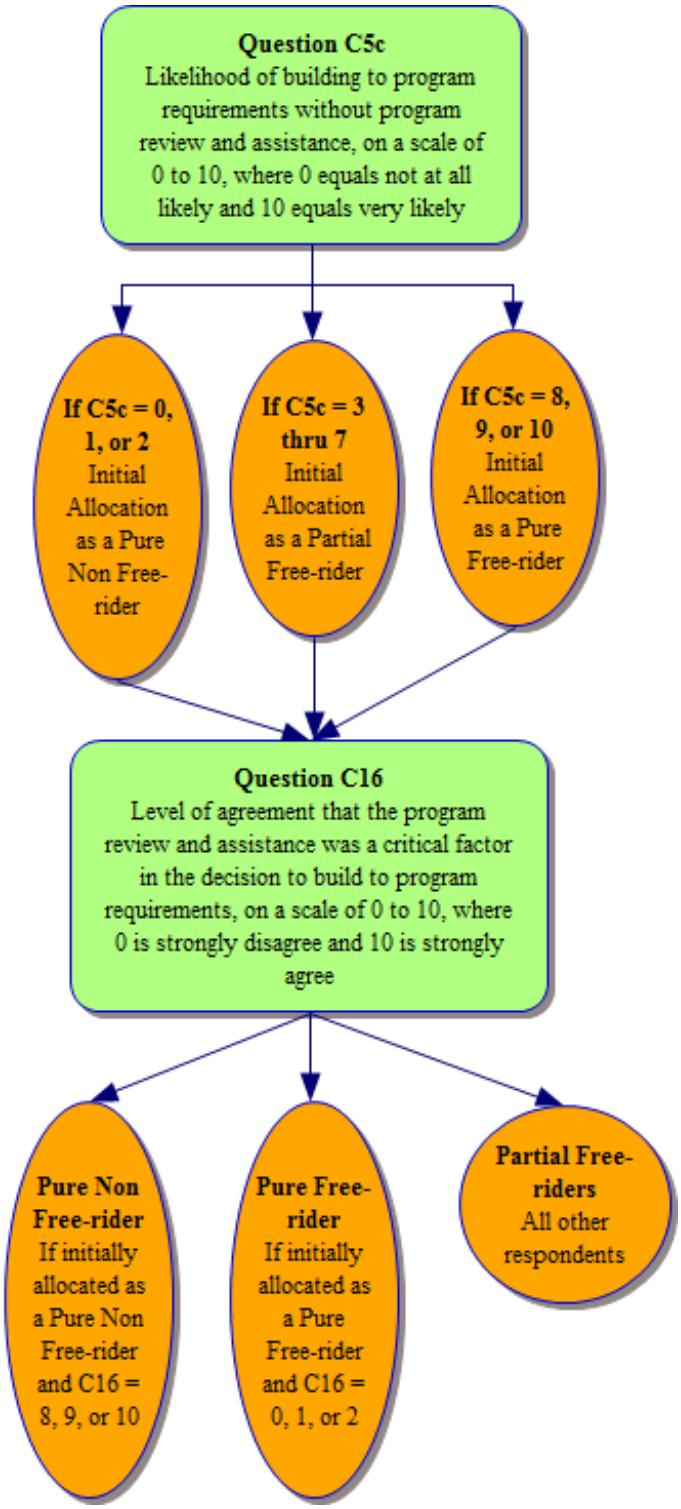
Performance Track

In this section, we present the criteria established to estimate the net-to-gross values for the performance track, as well as the results of this analysis.

Free-ridership Criteria: Below we show the question response criteria developed to categorize respondents into one of three free-ridership categories: pure free rider, pure non-free rider, and partial free rider. Figure 4-1 summarizes questions used in the analysis. Question C5c, which

measured the likelihood to have built to program requirements without program review and assistance, was used for initial allocation of respondents. Question C16—which measured the level of agreement that the program's review and assistance was a critical factor in their decision to build to 15% above Title 24 code—served as a consistency check regarding the level of program influence. Respondents were shifted into the partial NTG category if their responses were not consistent with their earlier response to question C5c. Figure 4-1 displays the Net-to-Gross criteria in a flow diagram.

Figure 4-1: Flow Diagram of Performance Track Net-to-Gross Criteria



Net-To-Gross Calculation: The NTG was calculated relative to the program requirement to exceed Title 24 code by 15%, as described below.

- We excluded savings reported by respondents that exceed 15% above code, as we assume any savings beyond 15% was accounted for in the estimates of gross savings. However, we did include the additional savings from projects where the respondent reports that the plans came in below code.
- Some respondents indicated that the HMG plan review resulted in improvements to the efficiency of their plans. Regardless of the assigned free-ridership category, we assumed that improvements made to the original plans due to HMG review were entirely influenced by the program.
- The estimated percent above code of the original plans (Q.C3) was adjusted depending on the free-ridership classification.
  - For pure free riders, we assumed no program influence on the original percent above code. Therefore, the adjusted Q.C3 = 0%.
  - For pure non-free riders, we assumed full program influence on the original percent above code. Therefore, the adjusted Q.C3 = Q.C3.
  - For partial free riders, we applied the program influence factor (Q.C5c_Q.C16) to the estimated initial percent above code. Therefore, the adjusted Q.C3 = Q.C5c_Q.C16 * Q.C3.
    - Q.C5c_Q.C16 equals the average rating of Q. C5C (after reverse scoring) and Q. C16, divided by 10
- The NTG was estimated by adding the adjusted Q.C3 value to the percent change due to HMG review (Q.C8b), then dividing the total by 15%.
  - NTG = (Adjusted Q.C3 + Q.C8b) / 15%
    - Adjusted Q.C3 is the adjusted percent above code of the original plans
    - Q.C8b is the estimated percent change relative to code due to HMG plan review

- Mean substitution for missing values. If either Q.C3 or Q.C8b wee missing and Q.C7=1 (made changes due to HMG's feedback) and Q.C1=1 (original plans were above code), then we used the average Q.C8b value from all other respondents with Q.C1=1 and Q.C7=1 who provided a valid Q.C8b or Q.C3 response. A similar approach applied to respondents with Q.C1=2 (original plans below code) and/or Q.C7≠1 (did not make changes due to HMG's feedback).

Free-ridership Classification: Based on their responses to question C5c, ten of the 17 performance track projects were initially allocated as pure free riders, five were classified as partial free riders, and two were classified as non-free riders (Table 4 1). After factoring in the consistency check from question C16, the final distribution was five pure free-riders, ten partial free-riders, and two non-free-riders.

Table 4-1: Performance Track Free-ridership Allocation

	Initial Count	Final Count
Pure Free-rider	10	5
Partial Free-rider	5	10
Non-Free-rider	2	2
Number of Performance projects	17	17

Net-to-Gross Estimates: None of the five projects classified as pure free riders reported making changes due to HMG review; thus their NTG equals zero. The NTG value for the two pure non-free-rider projects was estimated to be 1.33, because their initial project plans came in 5% below code.

For the 10 projects classified as partial free riders, Table 4 2 displays the median, average, minimum, and maximum NTG estimates. Note that two partial free-rider projects had a NTG over 1.0 because, even though the respondents did not attribute all of their energy savings to the program, the respondents reported that the HMG review resulted in substantial improvements to the original plans. Thus, the calculated NTG exceeds 1.0 because we attribute to the program the entire efficiency improvement due to HMG review, but discount the initial percent above code by the self-reported level of program influence.

Table 4-2: Performance Net-to-Gross Estimate for Partial Free Riders

(Performance Track projects classified as Partial Free Riders)

	Value
Median	0.58
Average	0.77
Minimum	0.25
Maximum	2.13
Number of Performance projects	10

Table 4-3 displays the question responses and calculated values that feed into the NTG estimate for each project.

Table 4-3: Performance Track Net to Gross Values for Each Project

(Performance Track projects)

Project	Question C5c—likelihood to have built to program requirements in absence of program	Initial Free-Rider Allocation	Question C16—level of agreement that program was critical to the decision to build to program requirements	Final Free-rider Allocation	Question C3—estimated percent above code of the original plans	Question C7—made changes due to HMG's review	Question C8b—percent change due to HMG review	NTG
1	0	Non	10	Non	-5%	Yes	20%	1.33
2	0	Non	10	Non	-5%	Yes	20%	1.33
3	10	Pure	5	Partial	-12%	Yes	32%	2.13
4	4	Partial	8	Partial	12%	Yes	19%	1.27
5	3	Partial	7	Partial	10%	Yes	6%	0.82
6	9	Pure	5	Partial	20%	Yes	8%	0.65
7	5	Partial	7	Partial	17%	No		0.60
8	4	Partial	5	Partial	20%	No		0.55
9	4	Partial	4	Partial	36%	No		0.50
10	8	Pure	8	Partial	15%	DK		0.50
11	10	Pure	3	Partial	20%	Yes	5%	0.43
12	8	Pure	3	Partial	15%	Yes	0%	0.25
13	10	Pure	0	Pure	20%	No		0.00
14	8	Pure	0	Pure	18%	No		0.00
15	9	Pure	0	Pure	35%	No		0.00
16	10	Pure	2	Pure	15%	No		0.00
17	10	Pure	DK	Pure	23%	No		0.00

Applying the NTG values derived for each project to the estimated electric and gas savings for that project (from the HMG program database), we estimated the overall NTG value for the

performance track (Table 4-4). Electric savings (kWh) were converted to gas savings (therms) assuming one therm equals 29.4 kWh.[47]

Table 4-4: Initial Appliance Free-ridership Allocation

(Appliance Track projects)

	Energy Savings (Therms)
Gross Performance Savings (therms)	38,795
Net Performance Savings (therms)	24,248
Performance NTG Estimate	0.63
Number of Performance Projects	17

Appliance Track

In this section, we present the criteria established to estimate the net-to-gross values for the Appliance track, as well as the results of this analysis.

Free-ridership Criteria: Below is the question response criteria used to categorize respondents into one of three free-ridership categories: pure free rider, pure non-free-rider, and partial free rider. The following questions were used to initially allocate respondents:

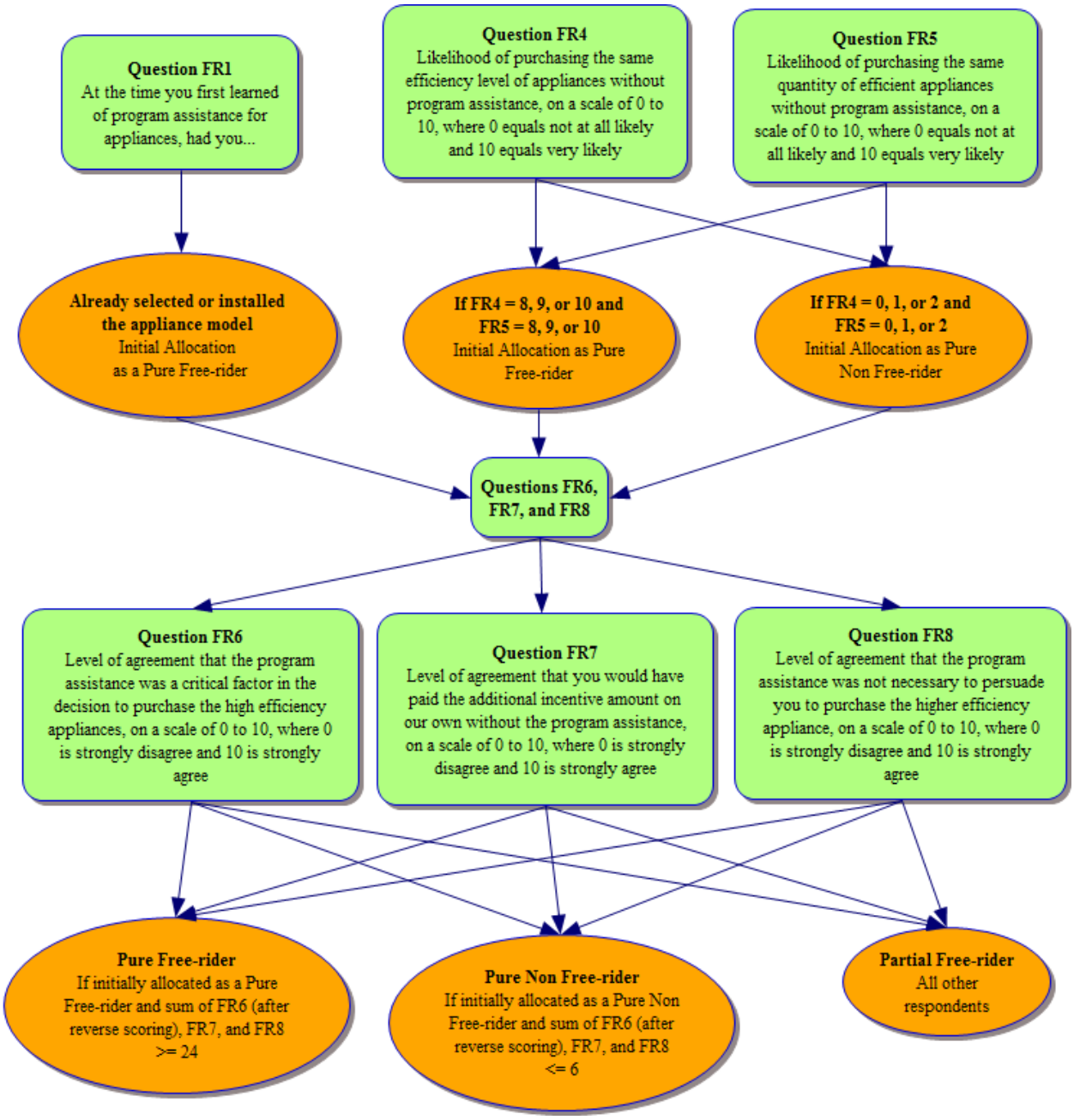
- Question FR1, which assessed when respondents first learned of program assistance
- Question FR3, which assessed whether the respondent made changes to their appliance plans in order to receive program incentives
- Question FR4 and Question FR5, which measured the likelihood that respondents would have purchased the same efficiency level and quantity of efficient appliances if they had not received any program assistance.

Questions FR6, FR7, and FR8 served as a consistency check; these questions measured the respondents' agreement with a series of statements designed to assess the level of program influence on their appliance purchase decision. Respondents were shifted into the partial NTG

[47] http://www.ceere.org/iac/assessment%20tool/enrgymng.html

category if their responses were not consistent with the responses that had resulted in their initial allocation. Figure 4-2 displays the Net-to-Gross criteria in a flow diagram.

Figure 4-2: Flow Diagram of Appliance Track Net-to-Gross Criteria



Net-To-Gross Calculation: The NTG is calculated as follows:

- For pure free-riders, NTG=0.0
- For pure non-free-riders, NTG = 1.0
- For partial free riders, NTG was calculated using the average rating from Q.FR4, Q.FR5, Q.FR6, Q.FR7, & Q.FR8 (after reverse scoring Q.FR6). Subtract this average rating from 10 then divide by 10 to calculate the NTG value. Each of the five questions contributes an equal amount to the overall NTG calculation.

Free-ridership Classification: Eleven of the 27 appliances were initially allocated as pure free riders because the respondent indicated that they had already selected the appliance model before learning of the program and did not make any changes in order to receive program incentives. Based on their response to questions FR4 and FR5, another nine appliances were classified as pure free riders, two as non-free-riders, and five respondents were classified as partial free riders.

Based on the responses to questions FR6, FR7, and FR8, some pure free rider and non-free-rider respondents were re-classified as partial free riders if they indicated a level of program influence that was not consistent with their responses to earlier questions. Based on this analysis, eight respondents were categorized as pure free riders and nineteen as partial free riders.

Table 4-5: Initial Appliance Free-ridership Allocation

(Appliance Track projects)

	Initial Count	Final Count
Pure Free-rider	20	8
Partial Free-rider	5	19
Non-Free-rider	2	0
Number of Appliance Types	27	27

Net-to-Gross Estimates: By definition, pure free riders have a NTG of zero and non-free-riders have a NTG of one. For the nineteen appliances classified as partial free riders, Table 4-6 displays the median, average, minimum, and maximum NTG values.

Table 4-6: Appliance Net-to-Gross Estimate for Partial Free Riders

(Appliance Track projects classified as Partial Free Riders)

	Value
Median	0.34
Average	0.39
Minimum	0.14
Maximum	0.90
Number of Appliance Types	19

Table 4-7 displays the question responses and calculated values that feed into the NTG estimate for each appliance.

Table 4-7: Appliance Track Net-to-Gross Values for Each Project (Appliance Track projects)

Appliance	Question FR1 – Status of plans when learned of program	Question FR3 – Made changes to plans in order to meet program requirements	Question FR4 – likelihood of purchasing same efficiency level of appliances without program	Question FR5 - likelihood of purchasing same quantity of efficient appliances without program	Initial Free-Rider Allocation	Question FR6 – Agreement that the program was a critical factor in decision	Question FR7 – Agreement that would have paid full cost without program	Question FR8 – Agreement that the program was not necessary for purchase	Final Free-Rider Allocation	NTG
Dishwasher	4	No	0	0	Pure	5	0	0	Partial	0.90
Dishwasher	4	Yes	2	0	Non	3	3	3	Partial	0.78
Refrigerator	4	Yes	2	0	Non	3	3	3	Partial	0.78
Clothes Washer	3	Yes	6	10	Partial	3	4	5	Partial	0.44
Dishwasher	2	No	6	10	Partial	3	6	4	Partial	0.42
Refrigerator	2	No	6	10	Partial	3	6	4	Partial	0.42
Refrigerator	1	No	7	10	Partial	2	8	3	Partial	0.40
Dishwasher	3	No	10	2	Partial	7	8	4	Partial	0.38
Dishwasher	3	No	8	10	Pure	3	5	7	Partial	0.34
Refrigerator	3	Yes	8	8	Pure	0	8	9	Partial	0.34
Refrigerator	3	No	8	10	Pure	3	5	7	Partial	0.34
Refrigerator	2	No	10	10	Pure	5	5	5	Partial	0.30
Dishwasher	4	No	8	10	Pure	6	7	7	Partial	0.24
Dishwasher	4	No	8	8	Pure	5	10	7	Partial	0.24
Refrigerator	4	No	8	8	Pure	5	10	7	Partial	0.24
Refrigerator	4	No	8	10	Pure	6	7	7	Partial	0.24
Refrigerator	3	No	10	10	Pure	8	3	8	Partial	0.22
Dishwasher	3	No	10	10	Pure	5	8	8	Partial	0.18
Dishwasher	1	No	10	10	Pure	3	10	10	Partial	0.14
Clothes Washer	4	No	10	10	Pure	10	10	10	Pure	0.00
Dishwasher	4	No	10	10	Pure	10	10	10	Pure	0.00
Dishwasher	4	No	10	10	Pure	10	10	10	Pure	0.00
Lighting	4	No	10	10	Pure	10	10	10	Pure	0.00
Refrigerator	3	No	10	10	Pure	10	10	10	Pure	0.00
Refrigerator	4	No	10	10	Pure	10	10	10	Pure	0.00
Refrigerator	3	No	10	10	Pure	10	10	10	Pure	0.00
Refrigerator	3	No	10	10	Pure	5	9	10	Pure	0.00

Applying the NTG values for each appliance to the estimated electric and gas savings for that appliance from the HMG program database, we estimated the overall NTG value for the appliance track (Table 4 8). Electric savings (kWh) were converted to gas savings (therms) assuming one therm equals 29.4 kWh.

Table 4-8: Appliance Savings and Net-to-Gross Estimate

(Appliance Track projects)

	Energy Savings (Therms)
Gross Appliance Savings (therms)	4,069
Net Appliance Savings (therms)	1,101
Appliance NTG Estimate	0.27
Number of Appliance Types	27
Number of Appliance Projects	17

4.5.2 Overall Net-to-Gross

In Table 4-9, we present the NTG estimates developed from the interviewed performance track and appliance track Projects, and apply them to all of the projects listed in the HMG database. According to the HMG project database, the performance track yields most of the gross program energy savings (88%); therefore the overall program NTG estimate of 0.58 closely matches the NTG estimate from the performance track.

Table 4-9: Overall Net Program Savings

	Performance Track	Appliance Track	Overall Program
Gross Savings (therms)	84,714	11,242	95,956
NTG Estimate	0.63	0.27	0.58
Number of Projects	32	41	53

Because the overall program NTG is driven by the performance track savings, we restrict our discussion to the performance track results. There are three items that influence the performance track net-to-gross estimates: the percent above code of the original plans, the effect of HMG plan review on building designs, and the self-reported level of program influence. Each of these issues is discussed below.

Original Plans relative to Title 24 Code. Respondents enumerated several factors, besides the program, that motivated them to exceed Title 24 code. According to interview respondents, 14 of the 17 original plans submitted to HMG exceeded Title 24 code; respondents estimated that these plans were an average of 20% and a median of 18% above code. Three respondents who were familiar with the rationale to design above code indicated that they did so in order to earn California low-income tax incentives. While these respondents were unable to name the low-income tax incentive program, we believe it is administered by the California Tax Credit Allocation Committee.[48] This program offers tax incentives for low-income new construction that either exceeds Title 24 code by 15% and also incorporates several sustainable design features, or exceeds Title 24 code by 35%. In addition, two respondents stated that exceeding code is standard practice for their organizations, and one respondent reported that their project was working toward LEED certification.

HMG plan review. The interview results suggest that the HMG review of project plans provided value in meeting program requirements for about one-half of projects. Five respondents reported that HMG did not provide any comments upon their review of the original building plans. In addition, two others said that HMG simply verified that their plans met program requirements. However, three respondents mentioned that HMG provided technical comments, Title 24 adjustments, or plan check with recommendations. In addition, five respondents cited more specific items, including details on qualifying appliances, improving the efficiency of windows, and radiant barriers; two of these respondents reported that HMG made recommendations to elevate the building efficiency in order to meet the 15% program requirement.[49]

In addition, nearly one-half (8 of 17) respondents reported that the HMG review resulted in changes to the original plans. These changes include higher efficiency windows, boilers, air conditioning, and solar hot water. The five respondents who were able to estimate the percent change relative to Title 24 code yielded an average change of 12% and a median change of 6%. Because only one-half of respondents reported making changes to building plans based on

[48] http://www.treasurer.ca.gov/CTCAC/

[49] In most cases the respondents provide a reasonably accurate description of the level of feedback – whether it was major or minor, but without the details listed in the HMG review documents. Because most of the projects occurred several years ago, it is not surprising that respondents cannot recall specific details of the HMG review.

HMG's feedback, this result provides further evidence that the HMG review improves efficiency for some, but not all, projects.

Program Influence: The interviews indicate that few projects were strongly influenced by the program to achieve higher efficiency, and that most projects were only partially influenced by the program to improve efficiency. Of the seventeen performance track projects, five were categorized as pure free riders, ten as partial free riders, and two as non-free-riders.

Ten of seventeen respondents reported that they were very likely to have built to program requirements without program review and assistance. Only two respondents were unlikely to have built to program requirements without the program; the remaining five respondents varied between somewhat unlikely and somewhat likely. In addition, only three of the seventeen respondents agreed that the program's review and assistance was a critical factor in their decision to build to 15% above Title 24 code. Five respondents disagreed that the program's review and assistance was critical; the ratings of the remaining eight respondents varied between somewhat disagree and somewhat agree.

4.6 Program Results

4.6.1 Claimed Savings

Table 4-10 displays the claimed savings for the CMFNH program for the 2006 – 2008 program cycle; the program first reported savings in March of 2008. The program had achieved 9% of projected demand reduction, 9% of projected electricity savings, and 10% of projected natural gas savings.[50] PG&E reports that the "program is falling short of expectations,"[51] for the following reasons:

- The housing market downturn, which has led to project delays, termination of designed projects, and/or elimination of planned projects, all of which reduce the pool from which to recruit projects.

[50] Source: March 2009 tracking data

[51] PGE 2059 Q4 2008 Report Narrative. (http://eega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=6)

- Increased effort to overcome energy consultant and design team lack of expertise on how to properly design and model energy efficiency.

- The majority of the multifamily projects are located in the cooler climate zones and not installing cooling. Also, the quantity of projects that could potentially yield electric energy savings are mostly located in areas served by municipalities where the program cannot claim the savings.

Table 4-10: PGE 2059 Claimed Savings through December 2008

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	2,698	236	9%
Electricity Savings (kWh)	4,489,813	405,333	9%
Gas Savings (therms)	839,084	83,804	10%
Budget	$7,459,053	$2,336,091	31%

4.6.1.1 DEER Measure Analysis

The CMFNH program uses whole-building energy modeling to assess whether performance-track buildings meet the program requirement to exceed Title 24 code by 15%; therefore, we cannot use DEER values to assess gross savings assumptions for the performance track. However, the CMFNH program also offers incentives for several prescriptive measures in the appliance track, including refrigerators, clothes washers, dishwashers, gas dryers, and lighting, for which DEER values are available.

Table 4-11 displays the product type, efficiency level, and the energy savings values from both the program and the DEER database for each of the five products that qualify for the prescriptive incentives. The different levels of gas and electric savings for the clothes washers at the same Tier level are due to the type of fuel used by the clothes washer or clothes dryer. In addition, the different savings values for refrigerators are due to various sizes and freezer door

configurations. The gross savings values from the DEER database[52] are for newly constructed single-family buildings[53] in the PG&E service territory, using Title 24 code as the baseline.[54]

Clothes Washers: At the same efficiency level, the DEER savings per unit for an electric clothes washer and dryer combination is 37%-39% higher than the program assumptions. A similar pattern holds true for the gas clothes washer and dryer combination: DEER savings are 19% to 21% higher.

Refrigerators: The program savings assumptions for refrigerators vary from 53 to 64 kWh, somewhat higher than the 41 to 60 kWh for similar DEER models. The model types that appear to be most comparable include the top-freezer (53 vs. 46 kWh) and side-by-side model (64 vs. 60 kWh), for which program assumptions also exceed DEER values, by 13% and 6%, respectively.

Dishwashers: The DEER database provides savings values for dishwashers that meet ENERGY STAR certification with an Energy Factor of 0.58, which is lower efficiency than the Tier 1 (EF=0.62) and Tier 2 (EF=0.68) models required by the program. Therefore, as expected, the program dishwashers have higher savings values than do the DEER dishwashers.

Lighting: Table 4-11 displays electricity savings for three common sizes of CFLs: 15 watt, 19 watt, and 23 watt. The DEER saving values for these three models range from 30 kWh to 46 kWh, all less than the program assumption of 57 kWh. However, the program also requires lighting controls, which are not available in the DEER database and likely account for the additional savings.

[52] 2008 Database for Energy-Efficient Resources. Version 2008.2.05. December 16, 2008. http://www.deeresources.com

[53] In most cases, DEER measures for multifamily buildings do not appear to include appliances and lighting products, therefore we used appliance measures for single-family homes, and assume that usage patterns for these products are similar to single-family homes.

[54] Except for CFLs, where the only available baseline was 'Customer Average'.

Table 4-11: Annual Savings Values from CMFNH Program and DEER Database

Product	Efficiency Level	CMFNH Savings Assumptions, 2006-2008			DEER Savings Values		
		Fuel / Size-Feature	Annual Energy Savings		Fuel / Size-Feature / Efficiency	Annual Energy Savings	
			kWh	Therms		kWh	Therms
Clothes Washer	CEE Tier I	Electric-Electric	221	0	Electric-Electric	308.4	-1
		Electric-Gas	159	2.2	Gas-Electric	225.5	2.7
		Gas-Electric	63	7.2			
		Gas-Gas	0	9.4	Gas-Gas	13.4	11.2
	CEE Tier II	Electric-Electric	253	0	Electric-Electric	346.7	-0.9
		Electric-Gas	182	2.5			
		Gas-Electric	72	8.2	Gas-Electric	240.6	3.7
		Gas-Gas	0	10.7	Gas-Gas	12.9	12.9
Refrigerator	ENERGY STAR	Top, no ice	53	0	Med-Top, no ice	45.9	0
		Bottom, no ice	58	0	Small-Bottom, no ice	46.5	0
		Side-by-Side, no ice	64	0	Med-Side, no ice	60.3	0
			n/a	n/a	Small-Top, no ice	41.3	0
Dishwasher	CEE Tier I		100	2.2	ENERGY STAR, multi-family	72	3
	CEE Tier II		113	2.2	ENERGY STAR, single family	97	4
Gas Dryer			0	1.9		n/a	n/a
Lighting		Pin-based hardwired CFL fixture w/ controls	57	0	CFL Bulb, 15W	30.0	0
			n/a	n/a	CFL Bulb, 19W	38.0	0
			n/a	n/a	CFL Bulb, 23W	46.0	0

4.6.2 Adjusted Gross Savings

In this section, we adjust the gross energy savings presented in Table 4-11 as a result of the comparison with the DEER database values. Because clothes washers and refrigerators are the

only products with comparable DEER measures available, we have applied DEER values for these two appliances. Because there are no comparable DEER measures with which to adjust the remaining products – dishwashers, gas dryers, and lighting – we utilize the program savings assumptions. The adjusted gross energy savings estimates are displayed in Table 4-12.

Table 4-12: Adjusted Gross Savings

	Demand Reduction (kW)	Electric Savings (kWh)	Gas Savings (therms)
Claimed Gross Savings	236	405,333	83,804
Adjustments	0[55]	-20,562	-46
Adjusted Gross Savings	236	384,771	83,758

4.6.3 Net Savings

Table 4-13 presents the adjusted gross savings from Table 4-12, the Net-to-Gross estimates developed from the interviews of decision-makers presented earlier in Table 4-9, and the estimated net savings for the program. Note that this estimate includes free ridership but not spillover, and therefore is a conservative estimate of attribution of savings to the program.

Table 4-13: Net Savings

	Demand Reduction (kW)	Electric Savings (kWh)	Gas Savings (therms)
Adjusted Gross Savings	236	384,771	83,758
NTG Estimate	0.58	0.58	0.58
Net Savings	137	223,167	48,580

4.7 Discussion of Findings and Recommendations

The 2004-2005 ENERGY STAR Homes program evaluation[56] yielded a multifamily NTG ratio of 0.50, primarily because developers were building to 15% above code without making any

[55] Demand reduction was not adjusted because the DEER database did not consistently provide demand reduction values for the applicable measures.

[56] Evaluation, Measurement, and Verification of the 2004 & 2005 California Statewide ENERGY STAR New Homes Program. Prepared for California Public utilities Commission. Prepared by RLW Analytics & SERA. 2007.

design changes, due to Title 24 loopholes for multifamily buildings regarding glazing percentages and occupancy levels for water heating. These loopholes were closed during the 2005 revisions to Title 24, suggesting that free-ridership levels could decline in future program years. However, since that time, the market for commercial new construction has changed substantially, due to a growing awareness of energy efficiency and environmental sustainability, and programs expanding to support those goals, such as LEED[57].

In addition, several of the respondents from low-income projects indicated that their buildings were designed to exceed Title 24 code in order to earn California low-income tax incentives. Thus, a portion of the low-income projects, which represented 58% of the projects in the program, may be at least partially motivated to exceed code due to these tax incentives. Other respondents indicated that their project was working toward LEED certification, or that exceeding code is standard practice for their organization. Supporting this finding is the fact that, of the 14 respondents who believed their original plans exceeded code, nine said it was standard practice. These nine respondents believe their original plans exceeded code by an average of 19% and a median of 17%, which exceeds the program requirement of 15% above code.

Given the variety of other factors now influencing the energy efficiency of commercial building design in California – including low-income tax credits, LEED, the Green Point Rated program,[58] and the nationwide push toward greater energy efficiency, it is likely that participating projects are being designed to exceed code for many reasons and thus the program is responsible for only a portion of their energy savings. In light of this situation, the estimated overall program NTG value of 0.58 seems reasonable.

In keeping with the findings of this evaluation, the team recommends attributing net savings of 137 kW, 223,167 kWh, and 48,580 therms to the CMFNH Program.

[57] The US Green Building Council website lists a total of 64 LEED – NC certified building projects in California, under versions 2.0 (8 projects), v2.1 (43 projects), and v2.2 (13 projects).

[58] http://www.builditgreen.org/ Also, while not specifically mentioned by any respondents, another program that may have influenced the incorporation of solar energy systems in several projects is the Go Solar California program. http://www.gosolarcalifornia.ca.gov/

5. SCE and SCG Designed for Comfort Programs: Verification-Guided Evaluation

The Designed for Comfort (DfC) program, jointly administered by SCG (Program 3537) and SCE (Program 2543), targets older affordable housing, and provides design assistance, training, and incentives to improve building energy efficiency by 20% above existing conditions. The minimum efficiency requirement for any equipment or materials is specified by Title 24 code or Title 20 code.

DfC uses a comprehensive building analysis approach that fills a gap not served by other programs by providing incentives for the replacement of older inefficient heating, cooling, and water heating equipment, insulation, and windows. The owner/developer is required to hire a HERS rater to establish the existing condition of the housing units; after the retrofit work is completed, all measure installations are verified by the HERS rater. In addition, the DfC program implementer, Heschong-Mahone Group (HMG), provides quality control conducted by its own staff on 10% of all units.[59]

5.1 Evaluation Objectives

The California Public Utilities Commission developed the category of "Verification-Guided Impact Evaluations" to address relatively small programs with levels of rigor and expense in keeping with the savings they are responsible for, thus preserving evaluation resources for programs accounting for more savings. Accordingly, the programs evaluated in this manner require only field verification of measure installation and operation in a binary manner—i.e., installed or not and operating or not—with gross savings estimates derived from other sources, and with an option for either developing Net To Gross values or using default inputs. Because the DfC program is relatively small and does not warrant the resources required for more extensive impact evaluations, the verification-guided approach was chosen.

The initial objectives of the evaluation of the DfC Program, as laid out in the work plan, in keeping with the guidelines for Verification-Guided Impact Evaluations, were to determine whether or not program measures have been installed and whether or not they have been

[59] SCG 3537 and SCE 2543 Program Implementation Plans, 2006-2008.

installed properly, and to make use of available information to estimate energy impacts. However, the CPUC decided that the low savings from this program did not warrant the resources required for such an approach. Hence, while the physical inspections were conducted, the objective of estimating energy impacts was not addressed.

5.2 Methods Used

A verification-guided approach was chosen because the DfC program savings are small relative to the overall portfolio savings and did not warrant the resources required for more extensive impact evaluations. This section describes the initial evaluation plan,[60] changes to that plan, and the final evaluation tasks.

5.2.1 Initial Evaluation Plan

The initial evaluation plan recommended field visits to compare a random sample of program-documented outcomes (QC data) to a random sample of other (non-QC) sites among projects claiming savings in the 2007 program year. This approach was to determine if there were any systematic differences between the two groups in terms of QC unit selection, installation quality, or equipment operation, and whether the QC unit results could be relied on for a partial assessment of installation quality moving forward, in which case telephone interviews could be appropriate for future evaluation research. If onsite visits confirmed that the inputs to the models used by the program were correct and the models were properly applied, and QC'd results matched non-QC'd results, then the team was to use the program's energy savings estimates, subject to comparisons with savings claims from similar programs based on secondary sources.

On-site Verifications: A technician was to visit the sampled units to verify through visual inspection that each of the listed measures was installed and operating. The visual inspection data were then to be compared to model inputs (e.g. MICROPAS or EnergyPro). The team was also planning to review program savings estimation methods to ensure proper application of the modeled data and program energy savings claims. In addition to the visual inspections, the team had planned to speak to building managers providing access to these units for their perspective on proper installation and operation. The technicians were also to review the list of

[60] New Construction / Codes & Standards Direct Impact Evaluation. RLW, et al. December 18, 2007.

EnergySmart Pak measures[61] and ensure current operation and that the measures had not been modified or removed.

Based on assumptions about units likely to be completed, the team initially proposed on-site verification of a sample of 84 completed housing units across combinations of documented measures proportionately weighted by project size, number of buildings, or as available. Included in this sample were a random sample of 32 units from implementers' QC data and a random sample of 52 other units to compare results.

Telephone Interviews: The team also planned to conduct in-depth interviews with building managers covering all buildings and projects included in the 2007 on-site verifications. Assuming the 2007 QC data are fundamentally similar to the non-QC data, the telephone interviews in 2007 would serve several important functions:

- To test the survey instrument for the 2008 evaluation
- To assess in a limited way the appropriateness of using the survey instrument to compare to on-site data
- To explore potential free-ridership and spillover issues

For 2008 projects, in order to save project resources, the team had proposed relying primarily on building manager interviews (sampling with certainty to cover all projects, buildings, and units), supplemented by QC data. However, if there were significant differences between the QC data and the team's on-site data from the non-QC sample from the 2007 assessment, then the team would have considered expanding the 2008 plan to include full on-site verification.

5.2.2 Changes to Initial Evaluation Plan

Due to constraints with evaluation budgets, the High Impact Measure review re-allocated resources to programs and measures with relatively high energy impacts. Because the DfC program has low savings relative to the overall program portfolio, resources were shifted from the DfC evaluation. This shift resulted in the elimination of the comparison of visual inspection data to model inputs (e.g. MICROPAS or EnergyPro), the review of program savings estimation

[61] Compact fluorescent lamps and low-flow faucet aerators and showerheads.

methods, and the telephone interviews with building managers from the evaluation plan. However, the team did conduct the on-site verifications and associated analysis.

5.2.3 Final Evaluation Plan

As discussed earlier, the on-site verifications served to verify that program-supported measures were in fact installed and operating. In addition, the approach was also designed to determine whether the program's internal quality control procedures provide data of sufficient reliability to be used in future evaluation research.

Inspections were carried out at Mira Vista and Pepperwood, two affordable housing complexes located in Camarillo and Rancho Cucamonga, respectively. They were selected because they were the only two complexes that had completed program participation at the time that the planning for the on-site verifications began. Forty-eight of the 304 housing units were inspected at Mira Vista and 48 of the 230 housing units were inspected at Pepperwood; 33 of these 96 units had undergone program quality control (QC) and 63 units had not undergone program quality control (non-QC).[62]

The DfC program incentivized new heating units, cooling units, windows, water heaters, and attic insulation in both complexes, but did not incentivize or require programmable thermostats, duct sealing, or pipe insulation. Most of the measures—such as windows, HVAC units, and water heaters at Pepperwood—were installed in each housing unit; however, some measures—including attic insulation or whole building water heaters at Mira Vista—serve entire buildings. According to program staff, if at least one housing unit in a building underwent program quality control, then the building-level measures did as well. Thus, all of the building-level measures (e.g., attic insulation and Mira Vista water heaters) underwent quality control.

At each building, the inspectors recorded information regarding the housing unit, the HVAC system (including equipment type, operation, level of sealing or obstruction, model number, date of service, duct insulation, and thermostat type and settings), water heating unit (including type, date of service, model number matches program data, pipe insulation, and water temperature), windows (including number of panes, seals, operation, and installation), and attic insulation (including type, depth, and coverage).

[62] The program quality control check essentially repeats the HERS inspection by verifying that each of the incentivized measures was installed.

5.3 Confidence and Precision of Key Findings

The maximum sampling error for the total sample is +/- 9% at the 90% confidence level. For assessing differences between QC'd and non-QC'd units, a difference of at least 10% is significant at the 90% confidence level if an average of 89% or more of the two sampled groups (i.e., QC'd and non-QC'd) has a given characteristic, or if an average of 11% or less of the two sampled groups has a given characteristic. For example, if 84% of sampled QC'd units have a given characteristic vs. 94% of sampled non-QC'd units, the difference is significant. Likewise, if 16% of sampled QC'd units have a given characteristic vs. 6% of sampled non-QC'd units, the difference is significant. If 50% of sampled QC'd units and 60% of sampled non-QC'd units have a given characteristic, the difference is not significant.

5.4 Validity and Reliability

With this approach, bias could arise through the selective sampling of housing units and energy savings measures. In order to ensure that a representative sample of housing units was inspected within each stratum, each unit was assigned a random number, and auditors were instructed to request permission to inspect the unit in each stratum with the lowest randomly assigned number (and thus highest priority). If that unit was not accessible, the auditors were to move on to the unit with the next highest priority. Inability to secure tenant permission to inspect higher priority units forced auditors to inspect some lower priority units in a few of the strata, primarily at Pepperwood. Auditors also inspected some lower priority units at Mira Vista in order to include a sufficient number of large housing units in the sample.

As a verification-guided evaluation, another source of risk in the reliability estimates is that the specified rigor level is low. For example, in the spirit of verification-guided evaluation, one major assumption of this approach is that units are fairly uniform in installation and operational quality; however, this may not be the case or it could vary by building within a given project. The potential bias in this approach, however, is mitigated by the program design, which includes several layers of quality control, including a design plan check by program implementers, HERS raters and quality control checks on 10% of all units.

Also, at the time the sample was designed there were only two projects participating in the program, both of which were included. By the time the program ended, however, there were a total of 11 projects. There could have been differences in the quality of installations between the two sampled projects and the nine projects that were not sampled.

5.5 Detailed Results

Results are presented here for the following measures:[63]

- Heating and Air Conditioning equipment
- Water Heating
- Windows
- Attic Insulation

For heating and cooling equipment, windows, and water heaters (at Pepperwood), results are presented for the overall sample of 96 units, as well as for the units that had undergone internal quality control (QC) and those that had not undergone internal quality control (non-QC) for each housing complex. Because attic insulation at both complexes and the building-wide water heaters at Mira Vista underwent quality control in all cases, non-QC results are not available for comparison.

5.5.1 HVAC Systems

Auditors found that most of the HVAC systems were installed properly, with few systems showing any problems. All of the HVAC units were the same model that was incentivized by the DfC program, all of the visible ductwork was properly sealed, and all of the units were capable of producing both hot and cold air. However, while all of the HVAC units at Pepperwood had adequate wall seals, 10% of the Mira Vista units had grill obstructions; this indicates that there may be an opportunity to educate occupants about maintaining a clear space in front of the HVAC grill area. None of the systems showed any indication of recent service, although that might be expected with units that were less than two years old; one HVAC unit produced unusual sounds and another leaked air. In addition, the average thermostat setting for heat at

[63] Because Mira Vista and Pepperwood were among the first DfC program participants, they were provided with Energysmart Paks after project completion. The program altered their approach to allow the HERS rater to verify the installation of CFLs and low flow devices at later projects. In addition, the Pepperwood complex already had low-flow devices installed prior to DfC participation; thus the program did not claim savings for these measures.

QC units (70°F) was significantly lower (at the 90% confidence level) than at non-QC units (77°F), suggesting that the QC process itself may have an effect on tenant behavior.[64]

5.5.2 Water Heating Systems

The auditors found that the water heating units incentivized by the DfC program were, in fact, installed, and generally were working properly. The auditors did not observe any unusual sounds emanating from the water heaters. The auditors did not find any indication that any water heaters had been serviced recently, although, again, that might be expected with units that were less than two years old. The building manager at Mira Vista reported replacing the igniter in one water heater. In addition, the 19 water heating thermostats at Mira Vista were set to an average or 123°F; at Pepperwood, the 48 water heating thermostats had an average temperature setting of 138°F. Water heaters were not accessible to tenants at either complex.

Hot Water Pipe Insulation: Hot water piping insulation appears to be an area with opportunity for improvement, though pipe insulation is not required or incentivized by the DfC program. In 82% of the 96 inspected housing units, some portion of the visible hot water piping had inadequate insulation. Overall, 15% of hot water piping in all units was inadequately insulated[65]. The difference between the percentage of piping in QC units and non-QC units with inadequate insulation was not statistically significant.

5.5.3 Windows

Most of the windows appear to have been properly installed, though exterior sealing could be improved for a small portion. The auditors reported that all windows had been replaced with operable double-paned windows that were securely installed to the building frame using adequate interior seals. However, while all of the windows at Pepperwood had adequate exterior seals, 15% to 16% of the windows, all second floor locations, at Mira Vista had

[64] For some projects, the units were occupied during the installation of measures and the inspections, for other projects the units were unoccupied; however, the DfC program did not track this information, so the cause of the difference remains speculation. Note that tenants at both Mira Vista and Pepperwood did receive training from the program.

[65] This analysis assumes that a consistent length of piping was visible in each housing unit. The verification audit collected the percent of piping with inadequate insulation, but did not record length.

inadequate exterior seals. The difference between the percentage of windows in QC units and non-QC units that had inadequate exterior seals was not statistically significant.

5.5.4 Attic Insulation

The attic insulation depth was adequate, although the perimeter coverage could be improved at Mira Vista. Seventeen of the 19 Mira Vista buildings had adequate attic insulation depth; but in two buildings, the area surrounding the access hatch had insufficient insulation, representing about one percent of total attic floor space. Also at Mira Vista, 20% of the corner, eave, and roofline insulation coverage was inadequate around the perimeter of the attic; all of the perimeter insulation at the seven Pepperwood buildings was sufficient. Ventilation systems were not obscured by attic insulation in either complex.

The cumulative R-Values for the attic insulation at Mira Vista and at Pepperwood are estimated to be R-49 and R-41, respectively. The R-values installed in both complexes substantially exceed minimum program requirements; Title 24 specifies attic insulation of R-30 for both projects.[66]

5.6 Program Results

Table 5-1 displays the estimated savings for the DfC program. Through December of 2008, the program had achieved 7% of projected demand reduction, 3% of projected electricity savings, and 64% of projected natural gas savings.

[66] Rancho Cucamonga is in climate zone 10 and Camarillo is in climate zone 6.
http://www.energy.ca.gov/maps/building_climate_zones.html
http://www.energy.ca.gov/title24/2005standards/residential_manual.html

Table 5-1: Designed For Comfort Program Savings through December 2008

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	449	436	97.1%
Electricity Savings (kWh)	234,138	252,167	107.7%
Gas Savings (therms)	33,935	0	0.0%
Budget	$1,712,015	$1,545,646	90%

The onsite inspections found minor problems with the installation of two incentivized measures: windows and attic insulation. Although 7% of windows were found to have inadequate exterior caulking, we do not adjust the gross program savings because the DEER database does not provide energy impact estimates for window caulking. Attic insulation depth was found to be inadequate near several access hatches and along 20% of the building perimeter at the Mira Vista complex. The full-depth R-values for attic insulation at Mira Vista is estimated to be R-49, while the program estimated savings using an attic insulation level of R-30. Based on a simple calculation of effective R-value,[67] the relatively small area with inadequate insulation is compensated for by the much larger area of attic that is covered in additional insulation. Therefore, we believe that the gross savings, which were based on the R-30 value, do not warrant any adjustments due to the installation of attic insulation.

The DfC program uses whole-building energy modeling to estimate gross energy savings for each project. Because the DEER database includes savings estimates only for individual measures, we cannot assess or adjust the gross savings assumptions for the program using DEER values. In addition, the DEER database does not provide a NTG estimate for multifamily retrofit programs/measures (other than the default values); therefore, we recommend using the ex-ante NTG program value of 0.80. In summary, we do not adjust the reported net savings for the DfC program because there is no information available from either the onsite verifications or the DEER database that could serve as the basis for adjustments to the program's gross savings or its ex-ante NTG value.

[67] Assuming the reduced insulation depth is R-19 and represents 40% or less of the total area, then the effective insulation value for the entire area is at least R-30. Based on the inspection results, these assumptions are conservative.

5.7 Discussion of Findings and Recommendations

The inspections found that, in general, the energy efficiency measures incentivized by the DfC Program were properly installed and were operating as expected. However, the onsite audits yield several suggestions to consider for improving the DfC program, as described below.

The HERS verification and QC inspections should emphasize windows and attic insulation

The audits found that about 15% of windows at the Mira Vista complex (all on the second floor), representing 7% of all inspected windows, did not have adequate exterior caulking. In addition, the audits found that attic insulation was not installed to an adequate depth for 20% of the building perimeter and near a few access hatches at Mira Vista. This indicates that HERS verification inspections should focus on these hard-to-reach measures, which may be more difficult to access than other measures.

Require or incentivize hot water pipe insulation

The audits found that hot water pipe insulation was inadequate at 82% of the inspected housing units at both complexes, representing about 15% of the piping. This suggests that the DfC program should consider offering incentives for the insulation of hot water piping or require it when incentivizing new water heating units.

Educate facility staff about water heater temperature settings

At both complexes, the water heating thermostats were controlled by facility staff, and not by the tenants. At Mira Vista, the water heating thermostats were set at an average of 123□F and at Pepperwood they were set at an average of 138°F. The Department of Energy recommends that water heaters be set to 120°F,[68] which suggests that educating facility staff regarding the energy savings from lower temperature settings may be an effective strategy.

Tenant training should emphasize thermostat settings and grill obstructions

The DfC tenant training is offered to all projects, but not always accepted by participants; the trainings are conducted by DfC staff or facility staff, depending on the preference of the

[68] http://apps1.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13090

participant. The audits found that the HVAC grills were obstructed in 10% of Mira Vista units, and that the heating thermostats were set seven degrees higher at QC units than at non-CQ units. These results suggest that tenant training (which typically covers thermostat settings, among other issues) should emphasize the energy savings of lower thermostat settings to a greater degree and also discuss the importance of maintaining unobstructed HVAC grills.

Future Evaluation Research

The inspections did not find any statistically significant differences between the quality of DfC measure installations at housing units that underwent program quality control and those that did not undergo quality control. However, the inspections did uncover problems at the QC units that were not found during the internal quality control process, indicating that onsite inspections are warranted for future evaluation efforts. In addition, there are indications—not confirmed through interviews—that tenant behavior may be positively affected by the QC process, as four of five units with obstructed heating/cooling grills were in non-QC units, and the average thermostat setting for heat at QC units was significantly lower than at non-QC units.

6. SCE and SDG&E Sustainable Communities Programs, SCE Demand Response Emerging Technologies Program, SCE AERS Program, SCE Transforming the Market for ENERGY STAR Manufactured Homes Program: Tracking-Only Program Evaluations

6.1 Evaluation Objectives

Programs that were expected to achieve very small savings were designated tracking only evaluations. The goal of the evaluations was to track program progress and compare it to program goals.

6.2 Methodology and Specific Methods Used

Tracking of program progress involved reviewing monthly quantitative reports and quarterly narrative and quantitative reports, conducting quarterly interviews with program staff, and summarizing key program metrics.

6.2.1 Initial Evaluation Plan

The initial evaluation plan called for a tracking-only approach for SCE's Demand Response Emerging Technologies Program, and for SCE's and SDG&E's Sustainable Communities programs. It called for a verification-guided evaluation of SCE's Transforming the Market for New Energy Star Manufactured Homes Program.

6.2.2 Changes to Initial Evaluation Plan

No changes were made to the initial evaluation plan for DRET or the Sustainable Communities programs. However, in light of the minimal savings achieved by the Energy Star Manufactured Homes Program and changing budget priorities, the decision was made by the Energy Division (ED) not to spend further resources evaluating these programs. For this reason, we made no further effort to verify these savings claims.

6.2.3 Final Evaluation Plan

The final evaluation plan called simply for tracking program progress.

6.3 Detailed Findings

6.3.1 SCE 2534 Demand Response Emerging Technologies Program Detailed Findings

The results of the data tracking efforts reveal that the program fell short of expectations. The program staff indicates that this was due largely to the following:

- Decline in housing market
- Damage caused by subcontractor to buried duct systems after the correct installation of the supported measure
- Cancellation of the program

Regarding the second point, the program staff indicated that a subcontractor damaged previously installed buried duct systems, but before this came to light, the primary contractor had already paid the subcontractor for their work. While the primary contractor was attempting to resolve the situation, disputes over responsibility for fixing the measures slowed the repair process down, as well as the savings verification process. The most recent interview (March 2009) reveals that the program was able to verify savings from just one measure installed in three different homes before the program was completely closed out on December 31, 2008. The implementation contractor was unable to rectify the damage to the buried duct systems or to verify savings for the 14 of the 17 homes receiving the measure before the program's end.

SCE has no plans to continue DRET in the future and will instead explore emerging technologies through the Advanced Homes Program.

6.3.2 SDGE 3021 Sustainable Communities Program Detailed Findings

Interviews with program staff focused on issues not always addressed in quarterly narratives and reports, such as changes in program design or offering, issues faced during implementation, and external factors influencing the program. The SDG&E program staff members were extremely enthusiastic about the SCP even as they recognized that the program

had not met its electricity and gas savings goals for the 2006 to 2008 cycle. As the staff members explained, few projects had been completed through the SCP largely due to the slow economy. Program staff expected committed projects to proceed more slowly than originally anticipated. Therefore, some programs funded under the current 2006 to 2008 cycle were expected to be completed and claimed in the next program cycle. Furthermore, during the most recent interview (in March of 2009), program staff indicated that the 2009 to 2011 program had yet to be approved, so the 2006 to 2008 program would be operated with "bridge funding" until the programs for the next cycle were approved. However, they did not anticipate any new projects to be committed during this period.

6.3.3 SCE 2514 Sustainable Communities Program Detailed Findings

The results of the data tracking efforts reveal that the program fell short of expectations, which SCP staff suggested was primarily because of the economic downturn.

6.3.4 SCE 2558 Automatic Energy Review for Schools Detailed Findings

As part of the New Construction, Codes, and Standards (NCCS) evaluation, The Cadmus Group developed an evaluation plan for this program. This plan called for a small number of interviews with the program managers at SCE and at Benningfield. Following these initial interviews, Cadmus monitored the program accomplishments through SCE reports.

From these reports, we learned that a number of school projects were "in the pipeline" but that none of these would be completed before the end of 2008. In the narrative that is provided with the SCE Q4 2008 report, the consultant stated that projects identified during the 2006-2008 program cycle would eventually deliver "61% of the contractual gross savings for kW and 101% of contractual gross savings for kWh." Since these projects were to be completed after the program cycle, SCE did not claim any savings as of the end of 2008.

In light of the absence of savings and changing budget priorities, the decision was made by the Energy Division (ED) not to spend further resources evaluating this program.

6.3.5 SCE 2557 Transforming the Market for New Energy Star Manufactured Homes Detailed Findings

From SCE reports, we learned that actual installations were far below the installation goals defined in the SOW. Towards the end of 2007, the program reported installations of only a few

units. We continued to track program results through 2008. Some additional units were installed, with 172 reported by the end of the year.

6.4 Program Specific Results

6.4.1 SCE 2534 Demand Response Emerging Technologies Program Specific Results

Table 6-1 displays the claimed savings for the DRET program. Through December of 2008, the program had achieved <1% of projected demand reduction and <1% of projected electricity savings.[69] Only 17 homes, all in one complex, participated.

Table 6-1: Demand Response Emerging Technologies Program Savings through December 2008

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	142	1	<1%
Electricity Savings (kWh)	75,752	593	<1%
Gas Savings (therms)	0	n/a	n/a

6.4.2 SDGE 3021 Sustainable Communities—Program-Specific Results

Table 6-2 displays the claimed savings for the SDG&E SCP program. Through December of 2008, the program had achieved 3% of projected demand reduction, 16% of projected electricity savings, and 6% of projected natural gas savings,[7071] Twelve projects were completed.

[69] Source: March 2009 tracking data

[70] Note that discrepancies exist between the CPUC tracking database and the SDG&E tracking database.

[71] Source: March 2009 tracking data

Table 6-2: SDG&E Sustainable Communities Program Savings through December 2008

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	5,650	161	3%
Electricity Savings (kWh)	5,154,058	806,433	16%
Gas Savings (therms)	204,681	12,042	6%

6.4.3 SCE 2514 Sustainable Communities—Program-Specific Results

No projects were completed under the SCE SCP program. The SCE SC program was classified as non-resource, and no savings were claimed (Table 6-3).

Table 6-3: SCE Sustainable Communities Program Savings through December 2008

Tracked Measure	Original Adopted or Projected	Claimed through December 2008	Percent of Original
Demand Reduction (kW)	4,221	0	0%
Electricity Savings (kWh)	1,642,400	0	0%
Gas Savings (therms)	0	n/a	n/a

Table 6-4: SCE 2558 Program Expenditures and Claimed Savings through December 2008

Tracked Measure	Targets: Original Adopted / Projected	Actual Spending and Claimed Savings through Q4 2008	Percent of Original
Budget	$825,264	$751,274	91%
Demand Reduction kW	242	0	0%
Electricity Savings kWh	1,167,466	0	0%
Gas Savings	0	n/a	n/a

6.4.4 SCE 2557 Transforming the Market for New Energy Star Manufactured Homes—Program-Specific Results

Table 6-5 summarizes the program's original targets and actual performance in terms of spending and savings claims. One hundred and seventy two manufactured homes were installed under the program.

Tracked Measure	Targets: Original Adopted / Projected	Actual Spending and Claimed Savings through Q4 2008	Percent of Original
Budget	$885,000	$316,359	36%
Demand Reduction kW	1,897	167	8.8%
Electricity Savings kWh	1,153,691	130,792	11.3%
Gas Savings	0	n/a	n/a

6.5 Discussion of Findings

As a whole, the five tracking-only programs fell far short of expectations, largely due to a decline in the construction industry resulting from the economic downturn. Therefore, anticipated projects were either never begun, halted, or delayed such that savings cannot be claimed during the 2006-2008 program cycle. In light of the small level of energy savings achieved by these programs, several were cancelled or re-classified as non-resource programs.