Non-Residential New Construction (NRNC) Programs Impact Evaluation

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

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Final Evaluation Report

Volume II

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Acronyms

A/C (AC)	Air Conditioning
ACCA	Air Conditioning Contractors of America
ACM	Alternative Calculation Method
ACP	Air Care Plus
ADM	ADM Associates
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
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
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
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
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
SEER	Seasonal Energy Efficiency Rating
SF	Single Family
SFA	Single Family Attached
SHGC	Solar Heat Gain Coefficient
SOW	Statement of Work
sqft	Square Foot
T24	Title 24 Building Energy Efficiency Standards
TBD	To Be Determined
TXV	Thermostatic Expansion Value
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 document presents the results of the evaluation of the Investor Owned Utilities (IOUs') Non-Residential New Construction (NRNC) programs implemented during the 2006-2008 program years. This volume is part of the New Construction and Codes and Standards direct impact program evaluation group, which comprises the California investor owned utilities' (IOUs) extensive new construction portfolio covering the residential, multifamily and non-residential, as well as, Codes and Standards programs. The results for Residential New Construction (RNC) and Codes and Standards (C&S) programs evaluation are presented in separate volumes (RNC in Volume I and C&S in Volume III).

The Evaluation Team assessed and evaluated the Non-Residential New Construction (NRNC) Programs, Savings By Design (SBD), for all four of the investor owned Utilities as identified in Table 1-1 in the 2006 to 2008 program cycle.

The PG&E segment of the Savings By Design program is a "virtual" program because PG&E did not maintain a separate database for new construction projects. Instead, they treated new construction projects in the general market segments including commercial, industrial, agricultural, and data centers markets[1]. The Evaluators worked with PG&E to identify the commercial sector of non-residential new construction. The initial intent was to not cover SBD agricultural and industrial segments for PG&E in this evaluation. However, the PG&E tracking systems identified multiple industrial and agricultural projects as commercial new construction projects. Therefore the evaluated projects included some industrial and agricultural projects as well as the commercial new construction projects.

Table 1-1 : Investor Owned Utility NRNC (SBD) Programs

Utility	Program ID	Program Name
Pacific Gas and Electric	Multiple	Savings by Design
Southern California Edison	SCE 2512	Savings by Design
Southern California Gas	SCG 3542	Savings by Design
San Diego Gas and Electric	SDGE 3018	Savings by Design

[1] PG&E industrial, agricultural and data centers new construction projects were evaluated by Itron and ADM. ED worked with the contractors to make sure none of these projects were not counted twice or were left out of evaluation.

1.1 Evaluation Methodology Overview

The key objectives of the NRNC study were to:

- Develop gross and net electricity and gas energy and electricity demand impact estimates for the Savings By Design program, for each Utility;
- Develop estimates of free-ridership, for each utility; and
- Develop "Whole Building[2]" electricity and gas energy and electricity demand impact estimates for the Savings By Design program, for each Utility.

The evaluation methodology was based on engineering models of participating projects that were statistically projected to the Savings By Design program populations. A simplified methodology is presented below with a more complete explanation of the methodology contained in the body of this report with supplemental information provided in the appendices.

The Team has developed a comprehensive and efficient process for estimating the impact of California Investor Owned Utilities' Statewide NRNC program, Savings By Design (SBD) over the last several evaluation cycles and refined that approach for the current cycle. The methodology builds upon the approach used for evaluating the net and gross impacts of the 1999-2001, 2002, and 2004-05 Savings By Design Program as part of the Building Efficiency Assessment. These same methodologies have been developed on an on-going basis as part of prior work on the 1994, 1996, 1998, and 1999 NRNC program evaluations, as well as work on the CBEE Nonresidential New Construction Statewide Baseline Study.

The evaluation team performed the following main steps:

- Developed and selected a representative sample by utility based on site level kWh savings provided by the utilities;
- Conducted detailed on-site surveys, performed measurements and built DOE-2 models of "Whole Building" sites in the sample;
- Developed and conducted specific industrial site evaluations for the segment of the sample that were industrial sites;
- Conducted short-term end-use metering, with portable data loggers. Short term metered data was necessary for the impact evaluation of many industrial measures. Short term end-use metered data from commercial sites were used calibrate simulation models;
- Calculated ex-post gross energy impacts for all sites in the sample, as the difference between as-built and baseline energy usage for both gas and electric consumption. The impacts could be either

[2] Whole Building Approach: Uses computer simulations to consider integrated, optimized energy solutions, and provides reliable comparisons of various efficiency alternatives and quantifies the effects of improving the building's systems.

positive or negative; negative impacts are a result of measures with interactive affects such as higher efficiency lighting which can lead to increased heating load;

- Conducted decision maker surveys to determine the net to gross (NTG) ratios[3] for each sampled site; and
- Used the measure NTG ratios to create "net savings models" in order to calculate site level NTG ratios; and
- Expanded the sample results to the corresponding utility populations.

Using the March 31, 2009 utility tracking data (fourth quarter of 2008 IOUs reported claimed savings), the Evaluation Team selected the participant sample shown in Table 1-2 by employing a stratified ratio estimation approach as detailed in Chapter 13 in the Evaluation Framework[4]. With the sample selected, the evaluation proceeded with recruiting the sites and conducted site specific evaluation work including decision maker surveys and building site specific models. The surveys combined with measurements taken at the site visits as well as data from the utility-supplied site files were used to identify participating buildings, estimated claimed savings, and incented measures. All of these resources were used to inform each site-specific model. The site specific results were combined into the overall results presented below by applying the case weights[5] used in the sample selection process.

Table 1-2 : NRNC (SBD) Sample Design Summary by IOU

Utility	Population	Sample
PG&E	279	57
SCE	312	70
SDG&E	93	48
SCG	28	16
Total	**712**	**191**

[3] Net-to-gross ratio is an adjustment factor used to compute net savings from gross savings accounting for free-ridership. It is otherwise known as "net of free-ridership."

[4] *The California Evaluation Framework* TecMarket Works Team for the CPUC June 2004

[5] A case-weight is the number of projects in the population that are represented by a sample point. For example, assume a utility had 50 projects that had annual kWh consumption between 0-300,000, and of those 50 projects 10 of them were sampled. The weight for each of these sites would then be 5, meaning that each of these 10 projects in the sample represent 5 projects in the population.

1.2 Overview of the NRNC Programs Evaluation Results

1.2.1 Gross Energy and Demand Savings

Table 1-3 shows the ex-ante and ex-post gross savings and realization rates for all Savings By Design programs. SCG had no claimed electricity savings. For the three remaining IOUs, the gross electricity energy savings ex-post results were quite close to their ex-ante estimates with gross realization rates ranging from 82% to 107% with a state wide average of 96%. The realization rate for SCE of 107% was driven largely by whole building sites where over two thirds of the sites had gross realization rates greater than 1.

The gross peak demand realization rates range from 57% to 112% with a state wide average of 80%. Realization rates for SDG&E and PG&E were driven down due to whole building sites which had an average realization rate of 42% and 48%, respectively. The relative precision ranges from 7.3% to 17.8% with a statewide average of 9.0%. In general, peak demand savings are more difficult to predict with whole building simulations than annual energy usage for a variety of reasons and these larger precision values for demand are consistent with historical trends.

The gas savings results were more variable than the electric energy savings results. Although over 74.4% of total statewide savings were sampled, the relative precision was high. This stems from the limited correlation between the IOUs' program tracking gas savings and the evaluated gas savings. This suggests the gas savings estimation techniques used by the utilities could be improved. Figure 1-1, Figure 1-2, and Figure 1-3 reflect the gross electric, demand, and gas reductions, respectively.

The statistical approach used to expand the gas sample results to the population was a weighted mean per unit estimation. This approach reweighted the sample based on therm savings to calculate a weighted average gas savings at project level by utility. Then, this average project savings were multiplied by the number of projects in the population to calculate the total gas savings of each utility.

SCE did not claim therms savings and had no therm specific measures in their population. The evaluated therm savings for SCE were a result of electric measures that had interactive effects which produced gas impacts, both positively and negatively. The majority of SCE gas savings in the sample came from a single large commercial site.

In general, SCG projects had very low realization rates with the exception of one site with five projects that accounted for 85% of the savings in the entire sample.

Similarly, PG&E natural gas savings realization rates were "buoyed up" by a couple large projects. The combined sample of PGE commercial projects had low gas realization rates; however PG&E had a realization rate greater than 100% because of two high-performing large industrial projects which offset the low realization rates associated with commercial sites.

Table 1-3 : Overall NRNC (SBD) Gross Savings and Realization Rates

Program Name	Category	Ex-Ante Gross Savings	Ex-Post Gross Savings	Realization Rates
Savings by Design Program SCE 2512	**Energy Savings (MWh)**	107,601	115,259	107.1%
	Demand Reduction (MW)	18.9	21.2	111.6%
	Gas Savings (Therms)	2,005	59,419	N/A[6]
Savings by Design Program SDG&E 3018	**Energy Savings (MWh)**	17,918	14,779	82.5%
	Demand Reduction (MW)	4.9	2.8	57.1%
	Gas Savings (Therms)	224,322	149,080	66.5%
Savings by Design Program SCG 3542	**Energy Savings (MWh)**	**-**	**-**	**-**
	Demand Reduction (kW)	-	-	-
	Gas Savings (Therms)	7,224,806	5,025,504	69.6%
Savings by Design Program PG&E "Virtual"	**Energy Savings (MWh)**	68,376	56,174	82.8%
	Demand Reduction (MW)	20.5	11.6	56.6%
	Gas Savings (Therms)	542,829	651,374	120.0%
Total Statewide	**Energy Savings (MWh)**	**193,895**	**180,211**	**96.0%**
	Demand Reduction (MW)	**44.3**	**35.5**	**80.2%**
	Gas Savings (Therms)	**7,993,962**	**5,885,378**	**73.6%**

[6] SCE claimed no therm savings for the SBD program although SCE did track interactive effects within their tracking database.

Figure 1-1 : Ex-Ante and Ex-Post Annual Gross Energy Savings (MWh)

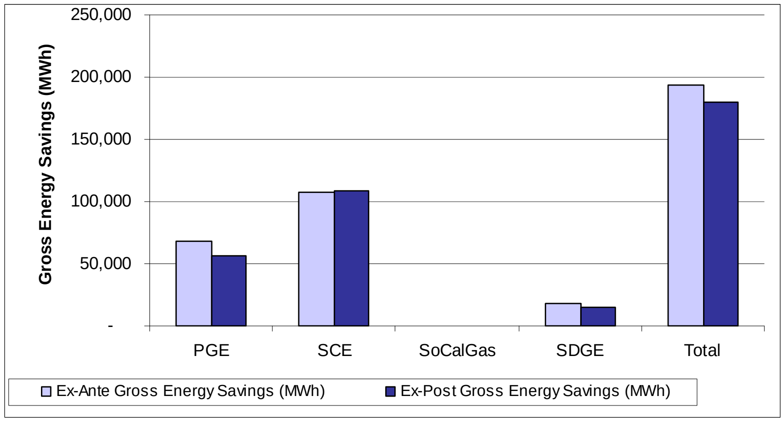


Figure 1-2 : Ex-Ante and Ex-Post Gross Peak Demand Reduction (MW)

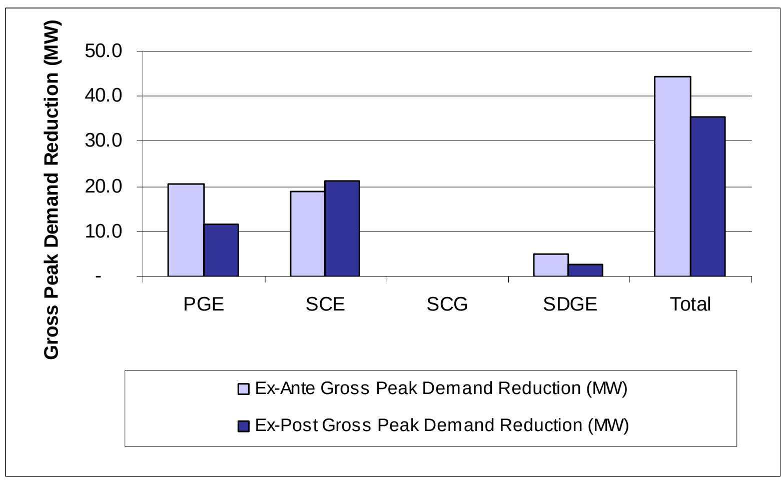
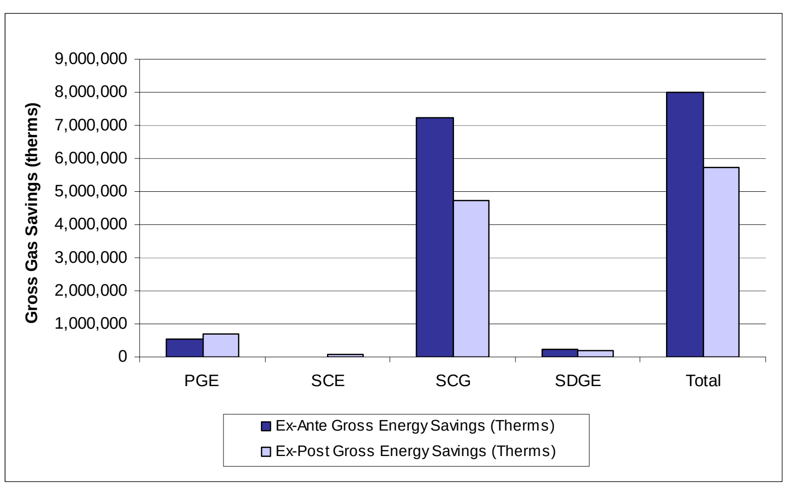


Figure 1-3 : Ex-Ante and Ex-Post Gross Gas Savings (Therms)



1.2.2 Net Energy and Demand Savings

Figure 1-4, Figure 1-5, and Figure 1-6 show ex-ante and ex-post net savings for electric, demand, and gas by utility and statewide. Table 1-4 shows the results of the net savings evaluation. The net realization rates are the comparison of the evaluated net savings against the IOU's net savings forecast, which is their ex ante estimates multiplied by an assumed net-to-gross rates. There were wide differences in the findings across the utilities and across electric energy savings, demand reduction and gas energy savings.

The gas savings values had the lowest net realization rates and the most variability which could be in large part due to the fact that the tracking savings and evaluated savings had almost zero correlation. Further research into the IOUs' modeling of gas savings is necessary to identify if the reason of the high ex-ante estimates especially in the case of SCG and SDG&E were due to data entry, incorrect modeling, or issues with the modeling software tools that were used to estimate therm savings.

For electric energy savings, the net realization rate results range from 59.7% to 92.9% and the electric demand reductions realization rates range from 38.9% to 98.8%. A detailed breakdown of savings by measure and fuel type is included in Chapter 3.

Table 1-4 : Overall NRNC (SBD) Programs Net Energy and Demand Savings

Program Name	Category	Ex-Ante Net Savings	Ex-Post Net Savings	Net Realization Rate
SBD Program PGE "Virtual"	Energy (MWh)	59,665	35,633	59.7%
	Demand (MW)	17.6	6.9	38.9%
	Gas (therms)	469,441	532,575	113.4%
SBD Program SCE 2512	Energy (MWh)	78,549	72,961	92.9%
	Demand (MW)	13.8	13.7	98.8%
	Gas (therms)	788	48,850	N/A[7]
SBD Program SCG 3542	Energy (MWh)	-	-	-
	Demand (MW)	-	-	-
	Gas (therms)	6,791,730	3,506,457	51.6%
SBD Program SDGE 3018	Energy (MWh)	14,692	9,435	64.2%
	Demand (MW)	4.0	1.6	40.4%
	Gas (therms)	183,944	182,498	99.2%
Total	Energy (MWh)	152,906	118,030	77.2%
	Demand (MW)	35.4	22.1	62.4%
	Gas (therms)	7,445,903	4,270,380	57.4%

[7] SCE did not claim any gas savings for their Savings By Design program though there were recorded interactive effects in the utility tracking database provided by SCE.

Figure 1-4 : Overall NRNC (SBD) Programs Net Energy Savings

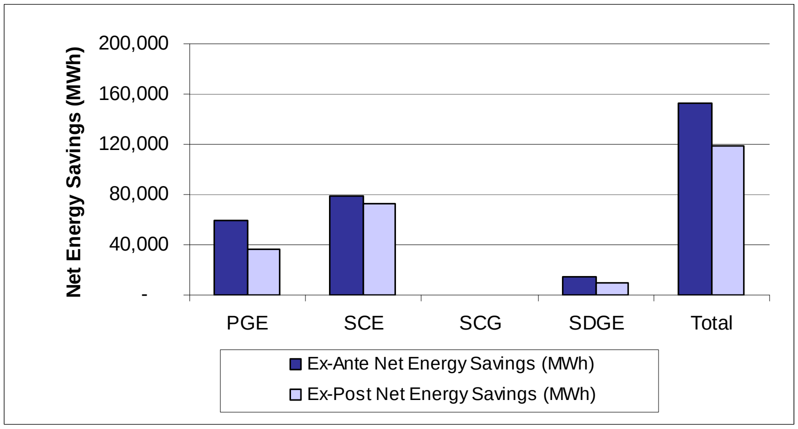


Figure 1-5 : Overall NRNC (SBD) Programs Net Demand Savings

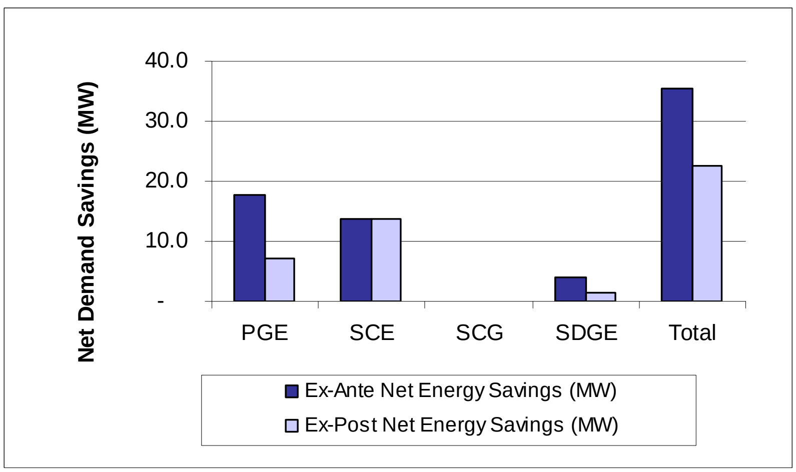
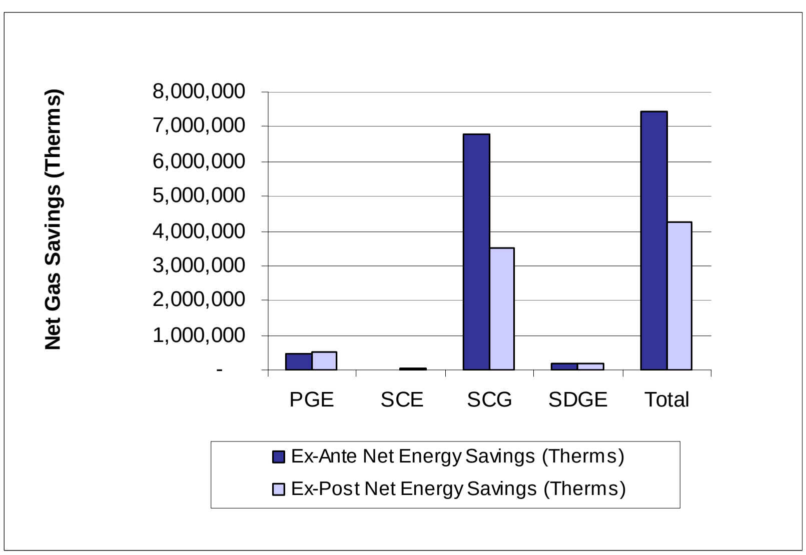


Figure 1-6 : Overall NRNC (SBD) Net Gas Savings



1.2.3 NTG Results

Table 1-5 shows the net and gross ex-post results for all NRNC SBD programs. The results show that MWh energy savings had a statewide NTG of 63.4%, demand reduction of 62.3%, and gas savings of 72.6%.

Table 1-5: Overall NRNC (SBD) Programs Net-to-Gross Results

Program Name	Category	Ex-Post Net Savings	Ex-Post Gross Savings	Net-to-Gross Ratio
SBD Program PGE "Virtual"	Energy (MWh)	35,633	56,174	63.4%
	Demand (MW)	6.9	11.6	59.1%
	Gas (therms)	532,575	651,374	81.8%
SBD Program SCE 2512	Energy (MWh)	72,961	115,259	63.3%
	Demand (MW)	13.7	21.2	64.6%
	Gas (therms)	48,850	59,419	82.2%
SBD Program SCG 3542	Energy (MWh)	-	-	-
	Demand (MW)	-	-	-
	Gas (therms)	3,506,457	5,025,504	69.8%
SBD Program SDGE 3018	Energy (MWh)	9,435	14,779	63.8%
	Demand (MW)	1.6	2.8	58.0%
	Gas (therms)	182,498	149,080	122.4%
Total	Energy (MWh)	118,030	186,211	63.4%
	Demand (MW)	22.1	35.5	62.3%
	Gas (therms)	4,270,380	5,885,378	72.6%

1.2.4 Gross and Net Energy and Demand Savings by Measure Category

Although it was not an objective of the evaluation, in the course of the evaluation it was found that splitting the savings into categories of Whole Building, Lighting, HVAC, Industrial and Other provided good insights into the make-up the participating projects. The total savings are broken into commercial and industrial project savings. The commercial sector is further broken down by approach, either a system (prescriptive) approach or whole building approach. The system approach is further divided into major end uses. Whole Building sites (as well as the industrial sites) may include measures such as shell, lighting, HVAC + motors and/or refrigeration. Whereas, the prescriptive system measures are strictly incented for a particular measure such as lighting. The combined commercial total represents the sum of the system approach sites and the whole building approach sites

The savings shown in Table 1-6 are the gross energy savings by measure category at the statewide level. About 69% of the total ex-post gross electric savings statewide resulted from the combined commercial sector and about 31% from the industrial sector. Almost all the electric savings in the combined commercial sector statewide were from whole building (more than 50%) and system approach lighting measure category (more than 40%).

The ex-post gross demand reduction statewide followed the same trend as the electric saving; about 73.5% of the demand reduction resulted from the combined commercial sector and about 26.5% from the industrial sector. About 50% of the demand reduction in the combined commercial sector statewide was from whole building and about 47% was from the lighting measure category.

On the other hand, the majority of the ex-post gross gas savings statewide resulted from the industrial sector (about 90%); the combined commercial totaled to about 10% where most of the gas savings was due to the whole building (about 89%) and the remaining impact was due to HVAC + Motors and shell systems.

Table 1-6 : Statewide Ex-Post Gross Energy Savings and Demand Reduction

Measure Category	Ex-Post Gross Energy Savings (MWh)	Ex-Post Gross Demand Reduction (MW)	Ex-Post Gross Gas Savings (Therms)
System Shell	196	0.1	22,793
System Lighting	54,686	12.2	-5,501
System HVAC + Motors	1,574	0.8	49,441
System Refrigeration	-	-	8
Whole Building	72,140	13.0	529,763
Combined Commercial Total	**128,596**	**26.1**	596,504
Industrial	57,615	9.4	5,288,874
Total (combined Commercial + industrial)	**186211**	**35.5**	**5,885,378**

The savings shown in Table 1-7 are the net energy savings by measure category at the statewide level. Similar to the trends shown in the ex-post gross analysis, about 76% of the total ex-post net electric savings statewide resulted from the combined commercial sector and about 24% from the industrial sector. Almost all the electric savings in the combined commercial sector statewide were from whole building (about 52%) and system approach lighting measure category (about 45%).

The ex-post net demand reduction statewide followed the same trend as the electric saving; about 79% of the demand reduction resulted from the combined commercial sector and about 21% from the industrial sector. About 46% of the demand reduction in the combined commercial sector statewide was from whole building and about 40% was from the lighting measure category.

On the other hand, the majority of the ex-post net gas savings statewide resulted from the industrial sector (about 83%); the combined commercial totaled to about 17% where most of the gas savings was due to whole building (91%) and the remaining impact was mainly due to HVAC + Motors and shell systems.

Refer to chapter 3 for more details on these findings.

Table 1-7: Statewide Ex-Post Net Energy Savings and Demand Reduction

Measure Category	Ex-Post Net Energy Savings (MWh)	Ex-Post Net Demand Reduction (MW)	Ex-Post Net Gas Savings (Therms)
System Shell	496	0.1	22,584
System Lighting	40,591	8.9	3,294
System HVAC + Motors	1,596	0.4	37,476
System Refrigeration	-	-	30
Whole Building	46,529	8.1	663,729
Combined Commercial Total	**89,213**	**17.5**	**727,113**
Industrial	**28,817**	**4.6**	**3,543,267**
Total (combined commercial + industrial)	**118,030**	**22.1**	**4,270,380**

1.3 NRNC (SBD) Finding and Recommendations

1.3.1 NRNC Key Findings

The non residential new construction population consisted of 712 projects of which the evaluation team sampled 191 projects or approximately 27% of the population. The detailed findings for energy, demand, and therm savings can be found in Chapter 3 of this report. The following represents an overview of the ex-post gross and ex-post net evaluated savings. For all program participants, the combined total annual ex-post gross energy savings were estimated in this evaluation to be 186,211 MWh. The gross energy realization rates ranged from 82.2% to 107.1% with an overall gross realization rate of 96.0% for the program statewide. For all program participants, the combined total peak ex-post gross demand reduction is estimated to be 35.5 MW. The gross demand realization rates varied by utility from low of 56.6% to high of 111.6% with an overall gross realization rate of 80.2% for the programs statewide. The combined total annual ex-post gross gas savings for the program is 5,885,378 therms. The gross gas realization rate ranged from 66.5% to 120% with an overall realization rate of 73.6%.

The ex-post net evaluated energy savings for all program participants is 118,920 MWh yielding a statewide realization rate for energy of 77.8%. The net energy savings realization rate varied by utility from a low of 60.9% to a high of 93.1%. The ex-post net evaluated peak demand savings for all program participants is 22.1 MW yielding a statewide realization rate for peak demand of 62.4%. The ex-post peak demand savings realization rate varied by utility from a low of 38.7% to a high of 98.9%. The ex-post net evaluated gas savings for all program participants is 4,270,380 therms yielding a statewide realization rate of 57.4%. The ex-post net gas savings realization rate varied by utility from a low of 51.6% to a high of 113.4%.

1.3.2 NRNC Key Recommendations

This evaluation has shown that the IOUs non-residential new construction programs continue to provide large gross savings, with a substantial fraction being net savings despite changing codes and baselines. The positive performance was especially true for SBD applied to whole buildings. However, when the program was provided to industrial sites, which offer significant opportunities for gross savings, the progam seemed to present opportunities for significant free-ridership. This evaluation illustrated that the net-to-gross ratios for industrial site participants were low. From our decision maker surveys, it appeared that in their enthusiasm to identify opportunities for improved energy efficiency, the program implementers may be pushing into areas that the industry already viewed as standard practice. However, the statewide NTG ratio for SBD, which was dominated by commercial new construction, showed NTG rates quite close to the IOU's ex-ante assumptions. For specific projects, gross savings realization rates can vary widely, especially if they involve gas measures, but on average many shortfalls were off-set by overachievements in other projects which resulted in overall positive results. We sampled a significant fraction of the program participants, and relatively high precision statistics give us confidence in these findings.

Gross savings can vary widely due to many issues, but several of them were within control of the utilities: baselines can be set erroneously and many assumptions and calculations are undocumented in the IOUs' files, leaving unexplainable differences with ex-post results. For instance, some measures were listed in the tracking system with significant savings but were never installed; and some measures were installed but did not perform properly. This evaluation has also illustrated that for gas measures, the ex-ante estimation were either difficult to estimate or not estimated correctly.

In this evaluation we had a particular challenge in dealing with the "virtual" PG&E SBD program in a manner consistent with the SBD programs in the other utilities. As a result of this work, we fundamentally believe that virtual programs cannot be evaluated in a consistent fashion with real programs.

We recommend that the Utilities continue the SBD program since it is providing value to customers and providing significant energy savings. We believe the utilities need to improve the tools they are using to determine natural gas savings estimates. We also recommend that the utility implementers exercise more care and due diligence in assuring that they are really pushing the standard practice efficiency envelope when SBD is applied to industrial facilities. Finally, we recommend that all four utilities implement similar SBD programs.

2. Introduction and Purpose of Study

The New Construction, Codes and Standards Evaluation group consists of twenty-one[8] 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 groups their programs under market segments, but for this non-residential new construction evaluation they have created a "virtual" Savings by Design program for the commercial sector as a whole. Finally, the group includes a sub-group of several smaller programs that are aimed at testing new applications or improving efficiency among a relatively small target population.

The Programs evaluated by this contract group are broken down into five clusters: Residential New Construction, Non-Residential New Construction, Codes and Standards, Verification-Guided Evaluations and Tracking Only Programs. This document presents the results for the statewide Non-Residential New Construction (NRNC) program area for 2006-2008. Results for the other segments of the Group can be found in other volumes. The Codes and Standards evaluation is included in Volume III and all the residential new construction, verification-guided evaluation and tracking only program evaluation are included in the Residential New Construction Volume I.

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

2.1 Non-Residential New Construction Evaluation Overview

Evaluation Objectives

The key objectives of the NRNC (SBD) study are to:

- Develop gross and net electricity and gas energy and electricity demand impact estimates for the Savings By Design program, for each Utility;
- Develop estimates of free-ridership, for each utility; and
- Develop gross and net whole building electricity and gas energy and electricity demand impact estimates for the Savings By Design program, for each Utility.

Although it was not a primary objective of the evaluation, splitting the savings into measure categories provides more insight into program activities. Therefore, the distribution of savings between industrial and commercial projects is reported along with the distribution of commercial project savings by approach, Whole Building or Systems approach.

The SBD program has included industrial projects participating at varying levels at each utility. From Program Year 2002 onward, all four utilities allowed industrial projects to participate in their program and to receive incentive payments. The industrial results have been reported separately from the whole building segment due to the unique considerations of these process specific measures, but this distinction was not the basis of the sampling plan.

The 2006-2008 SBD Evaluation Study is an evaluation of Savings By Design projects that were completed and claimed by the IOUs in the calendar years 2006-2008. SBD is an ongoing multi-IOU program that began in 1999 and is expected to continue into the future. Each program cycle evaluation of SBD is a snapshot of a segment of the total SBD site population that is active during that particular program cycle. The selection criteria for inclusion in a particular evaluation cycle are payment of the final incentive in the evaluation cycle which is tied to project completion. Though this study is restricted to projects completed in 2006-2008, the evaluated projects may have initially signed onto the program as far back as several years previous. There are also projects that received design assistance and analysis from SBD during this program cycle that will be included in future evaluation cycles when the savings associated with the project is claimed by the utility and the final incentive paid to the participant.

Sample Design

The mix of whole building and industrial participants that will be included in any specific evaluation is not known until the sample is selected. Whole building sites are subjected to a common systems approach that entails full DOE-2 simulation, while industrial sites are subjected to site specific evaluation techniques. The range of industrial sites expected to be encountered results in a wide range different engineering models. Each model is appropriate to the specifics of the industrial site being evaluated.

The sample was not stratified by project type (i.e. commercial, industrial); instead an overall evaluation sample for PG&E, SDG&E, and SCE programs was selected using electric energy savings as the stratification variable. The SCG sample was based on gas savings, the aggregate savings of the sample accounted for over 70% of the population therm savings for SCG's SBD program. The sampling plan was designed to over-sample the large customers, increasing the variance captured by the sample and improving the overall precision.

The sample design used Model Based Statistical Sampling (MBSS) to optimally select a sample that would minimize sample size and maximize precision. An explanation of the theoretical foundation of MBSS is included in Appendix D. Samples were initially designed by utility with a target of achieving ±10% relative precision at the 90% confidence level. Results are reported by measure category to give additional insight into the breakdown of savings from the various components. However, the goal of the evaluation was to calculate utility level estimates of savings at the specified level of confidence and precision. Samples were selected and weights were assigned at the utility level and not at the measure category level. The targeted precision goal of 10% precision at the 90% confidence level was achieved for all utilities for MWh savings. To achieve ±10% precision at the 90% confidence level for each measure category by utility would require sample sizes far beyond the budgets available for the evaluations of these programs.

Table 2-1 shows the utility specific populations and samples selected for the 2006-08 SBD program. The target precision estimate of ±10% precision at the 90% confidence level had to be modified from the initial sample design due to reductions in sample sizes that resulted from budgetary constraints.

Table 2-1 : Sample Design Summary By Utility

Utility	Population	Tracking kWh	Sample
PG&E	279	68,376,077	57
SCE	312	107,601,035	70
SDG&E	93	17,917,590	48
SCG	28	-	16
Total	**712**	**193,894,702**	**191**

The sample was selected from the utility databases and the program files for these sampled projects were requested from the utilities. The files were each carefully evaluated, and a determination was made to subject the project to a standard commercial whole building or custom evaluation process. The projects were then recruited for site visits via telephone. Whenever possible, which in practice turns out to be in most cases, the decision-maker survey was combined with the recruitment call. A field engineer was assigned the project and that individual performed a detailed survey during the on-site visit. Spot measurements and sometimes with the installation of metering equipment was completed during the site visit. Another visit was conducted to retrieve data loggers from sites where short-term monitoring was performed.

The basis of the project-level gross energy and demand savings estimated via engineering analysis informed by detailed onsite surveys and some cases, end-use metered data. In most cases, DOE-2 simulation models were used to evaluate commercial projects and engineering calculations were used for industrial projects. The site-level estimates were statistically projected to the program population to show program impacts at the 90% confidence level. The study was further informed by in-depth telephone decision maker surveys conducted with the building owners and/or designers regarding the energy design choices made for these buildings. The results of the decision-maker data not only produced the net-to-gross (NTG) findings, they were also used to adjust the engineering models for estimating the program's net energy impacts.

A decision maker survey was conducted for each project in the sample. The person or persons in charge of each measure-specific energy design decision was asked a series of questions with weighted scores to determine a net-to-gross ratio, or more specifically a net-of-free ridership ratio by measure. These values were then applied to the models and engineering calculations to come up with net savings values for each measure for each site in the sample.

Gross Whole Building Analysis

DOE-2 simulation models were built for every standard commercial project in the sample using a combination of project file and field collected data. Team engineers made modifications to each of the DOE-2 models to be certain that all claimed measures were considered for all projects. Once the DOE-2 modeling adjustments were made reflect the as-built conditions, the building was re-simulated using applicable code characteristics. The difference between these two runs was the gross savings for the building.

The Team next ran the gross savings parametric for all DOE-2 modeled whole buildings. Utilizing the output from the parametric runs, team analysts conducted the gross savings analysis for therm, kWh and kW savings. Using the case weights developed for the sample design, site level measures only and all measures gross savings estimates were expanded to the program population. The Team calculated realization rates for the program overall for therms, kWh and kW.

Gross Industrial Site Analysis

Engineering calculations were performed to evaluate industrial projects in the sample. The calculations focused on the incented measures and were informed with field collected data and measurements. The output of these models reflected the as-built conditions. Baselines for the measures were established by the team based on a combination of activities. The gross savings baselines for the evaluated savings are a similar but minimally-compliant construct capable of performing the same operations. For non-code baselines an assessment of the feasibility and legality of ex-ante baselines is integral to the measure evaluation. Likewise, a more appropriate baseline is used if the ex-ante is assessed to be non-compliant, infeasible or highly unlikely. Using the case weights developed for the sample design, site level measures only and all measures gross savings estimates were expanded to the program population. The team calculated realization rates for the program overall, for therms, kWh and kW.

Net Analysis Methodology

Using self-reported participant decision maker data, the team assessed the level of program free-ridership. Once the gross savings data was finalized, the net savings analysis was conducted. Using the case weights developed for the sample design, site level measures only and all measures net savings estimates were expanded to the program population. The team calculated net realization rates for the program overall for therms, kWh and kW. The net analysis provided many different ways for post-stratifying the findings, such as by utility, commercial vs. industrial, by measure, etc. For each analysis performed, key statistics (e.g., relative precision, error bounds, sample sizes, etc.) were calculated. Table 2-2 shows an overview of the evaluation approach employed for SBD programs.

Table 2-2 : Overview of NRNC SBD Program Evaluation Approach

	Gross Savings				***Net Savings***
Evaluation Methods	*Field measurement*	*Engineering Models*	*End-use metering*	*Calibrated Simulation*	*Participant Self Report*
Non-Residential New Construction	Onsite Visits, Surveys, Short-term metering on a sub sample of sites	Whole building simulation models using DOE2.2 engine with an access based front end.	End uses with greatest uncertainty such as variable speed drives (VSDs), lighting controls, chiller loads	Adjust simulation models informed by end--use metering data	Decision Maker Survey

2.2 Non-Residential New Construction Programs Description

Table 2-3 : NRNC Savings By Design (SBD) Programs Description

Program Name	Program ID	Program Description	Key Program Elements
SBD	*SCE 2512, SDGE 3018, SCG 3542*	*The Savings by Design programs offered by California's Investor Owned Utilities includes design assistance and financial incentives to improve the energy efficiency of commercial new construction.*	*The Savings by Design program has two principal approaches to program participation: systems approach and whole building approach. The program offers owners and design teams a wide range of services including design assistance, design resources, owner incentives, and design team incentives.*
SBD	*PGE Multiple; "virtual" program**	*PGE does not track savings under a single program ID However, the Savings by Design program is a state wide program and the program description is the same. The Savings by Design programs offered by California's Investor Owned Utilities includes design assistance and financial incentives to improve the energy efficiency of commercial new construction.*	*The Savings by Design program has two principal approaches to program participation: systems approach and whole building approach. The program offers owners and design teams a wide range of services including design assistance, design resources, owner incentives, and design team incentives.*

* PGE currently reports SBD program savings across various market sectors making it very difficult to track program

2.3 Program Accomplishments to Date

This section presents the accomplishments claimed for each of the NRNC Programs by IOU and compares these accomplishments to what was originally projected by the IOUs for each program and to total IOU portfolio accomplishments (as reported by each IOU on March 31, 2009 representing accomplishments through the fourth quarter (December) of program implementation in 2008 (Q4 2008).

2.3.1 IOUs' Tracking Data

The Evaluation Team received tracking data from the IOUs through Q4 2008 in March 31, 2009. The Team reviewed the data and coordinated with the utilities to resolve database discrepancies and clarification requests. The program enrollment summary statistics for the tracking data through the fourth quarter (Q4) of 2008 as finalized on 3/31/09 are shown in Table 2-4.

Table 2-4: NRNC (SBD) IOU Enrollment Summary Statistics (Q4 of 2008)

Utility	2006/2007	2008	Total
PG&E	117	162	279[9]
SCE	172	140	312[10]
SDG&E	86	7	93
SCG	10	18	28
Total	385	327	712

[9] The PG&E population decreased from the prior version of the report due to sites not being properly collapsed in the population. The site savings were collapsed to a single site though but the total program savings remained the same.

[10] The SCE population increased from the prior version of the report due to an error brought up during the comment period. The database used in the analysis for the prior report was missing data for the last quarter of the 2008 program year, the numbers in this report reflect the correct population and savings claims.

Figure 2-1 : NRNC IOU Program Enrollment (Q4 2008)

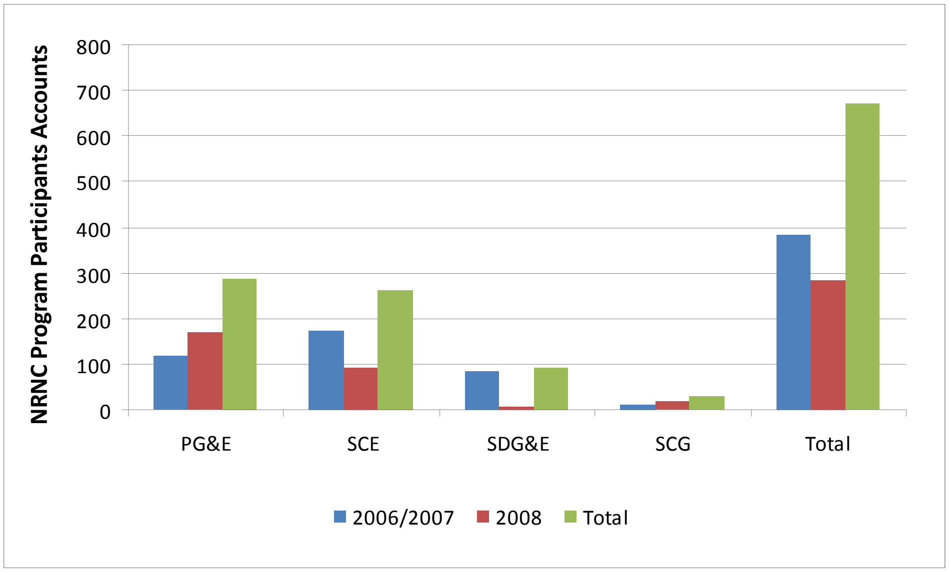


Figure 2-2, Figure 2-3, and Figure 2-4 contain claimed savings estimates by utility through Q4 2008. For the 2006-08 Savings by Design programs SCE is not claiming therm savings and SCG is not claiming electric savings.

SCG accounted for over 90% of the ex-ante therm savings for the 2006-08 SBD program cycle. SCE did not claim any therm savings though SCE did track the therm savings that resulted from interactive affects of electric measures.

Figure 2-2 : Ex-Ante Gross Energy Savings (MWh) by Utility

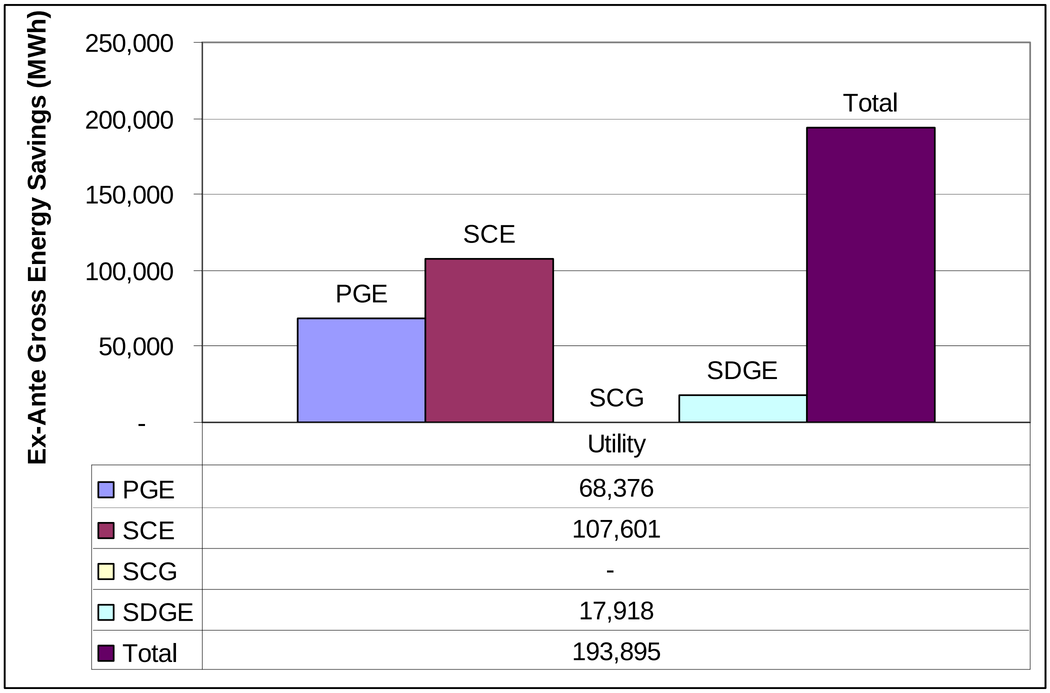


Figure 2-3 : Ex-Ante Gross Demand Reduction (MW) by Utility

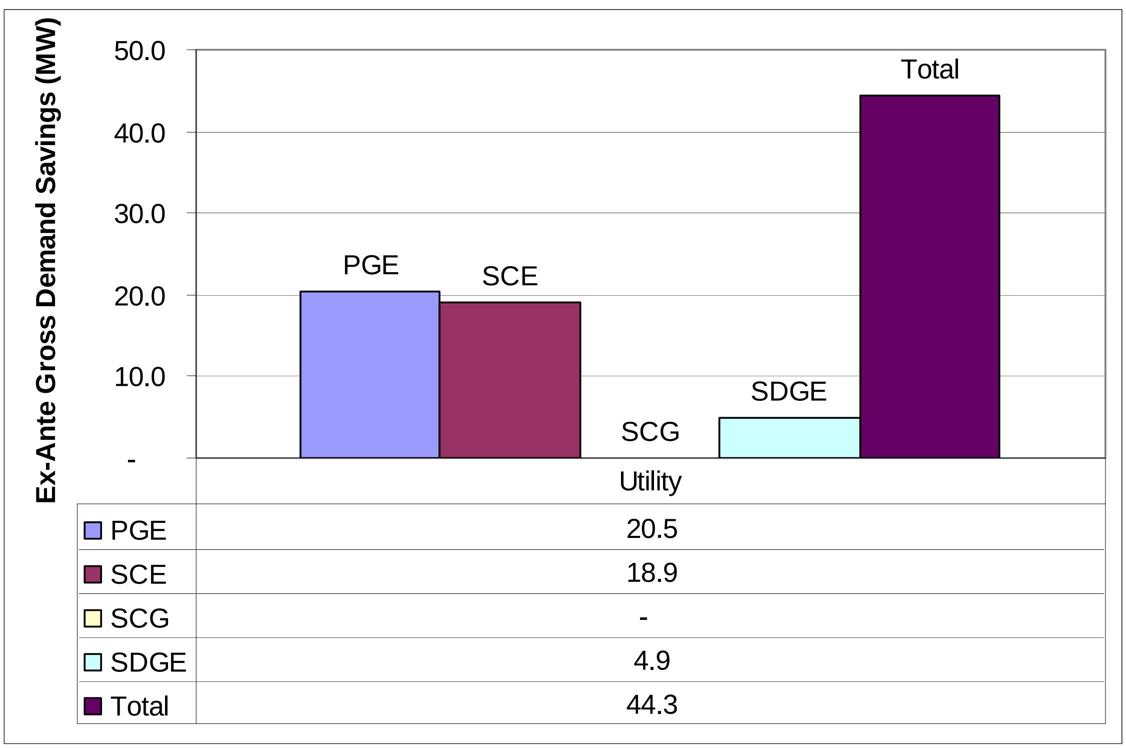
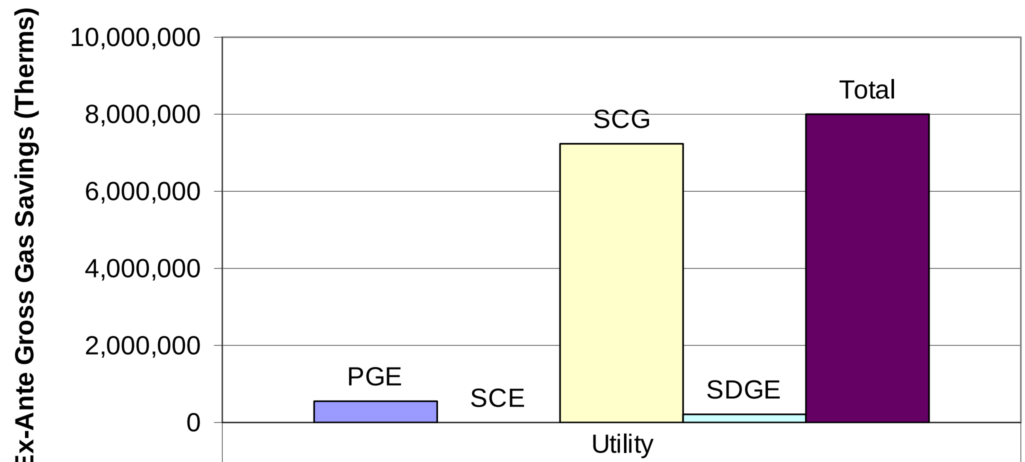


Figure 2-4 : Ex-Ante Gross Gas Savings (Therms) by Utility



PGE	542,829
SCE	2,005
SCG	7,224,806
SDGE	224,322
Total	7,993,962

The rest of this document is organized as follows:

Chapter 3 includes a discussion on the Savings By Design (SBD) program, including methodology, free-ridership estimates, and net and gross energy and demand impact estimates.

Chapter 4 includes an overview of the C&I Whole Building measure, which is contained within the subgroup of non-residential new construction programs. The section includes discussion of net and gross energy and demand impact

Chapter 5 includes a discussion of findings, lessons learned, and recommendations for the Savings By Design program.

3. SBD Program Evaluation Findings

KEMA conducted an evaluation of the 2006-2008 Savings By Design (SBD) Program, California's statewide non-residential new construction (NRNC) energy efficiency program administered by PG&E (various; aggregated as a "virtual, multiple" program), SCE (SCE2512), SCG (SCG3542), and SDG&E (SDGE3018). Table 3-1 shows the summary statistics for these programs as reported the March 31, 2009 version of the Utilities' tracking data bases.

This section presents the evaluation activities for the Savings by Design (SBD) New Construction Program Cluster. This evaluation cluster addresses the following programs: SCE 2512, SCG 3542, SDGE 3018, and PG&E (Multiple; "virtual" program). Each program is separate but they are delivered and marketed in a similar fashion and for this reason the evaluation approach is consistent across all four programs. Evaluating these programs consistently provides a better means of comparison.

As stated earlier the key objectives of the NRNC (SBD) evaluation are to:

- Develop gross and net electricity and gas energy and electricity demand impact estimates for the Savings By Design program, for each Utility;
- Develop estimates of free-ridership for each Utility; and
- Develop gross and net whole building electricity and gas energy and electricity demand impact estimates for the SBD, for each Utility.

3.1 Methodology and Specific Methods Used

The evaluation methodology consists of the following steps; the more critical elements will be described in greater detail within this chapter:

- **Acquire population data**: The initial step in program evaluation is the acquisition of data for the program population sufficient to perform a sample design. In this case we acquired the ex-ante energy and demand (savings, kWh, kW and therms) for the population and a unique project identifier from the IOUs databases. Since the first phase of the evaluation was concurrent with the program implementation, two separate data analyses were required, one for program years 2006 and 2007, and another for 2008.
- **Develop and select a representative sample:** The evaluation team designed two samples (first sample for PY 2006-07, and second sample for PY 2008). The samples were targeted to optimize the precision of the final evaluated savings estimates. The initial sample design incorporated forecasted program activity for the program year 2008. A random sample of the 2006-07 projects was selected for site visits in 2008. In 2009, after the final population data were acquired for program year 2008, the sample design was "trued-up" based upon actual program achievements. The sample design used a stratified model-based statistical sampling approach where electrical energy savings were used as the stratification variable.
- **Conduct project file review:** The project files for every project selected in the sample underwent a thorough review. The evaluation team reviewed the files to confirm the site classification as systems[11] or whole building approach[12] project, and as a commercial or industrial site. Furthermore, the team determined the level of rigor that should be implemented in evaluating the project. Thus, the evaluation team was able to determine from the file reviews the evaluation approach, whether to employ whole building simulation models for commercial building and/or a spreadsheet approach for industrial and "custom" measures. Examples of spreadsheet approaches include AirMaster+, MotorMaster+, Phast, etc.
- **Recruit and schedule participants for evaluation:** After the Team completed the file reviews, telephone calls were made to the listed project site contacts to schedule on-site-visits. If the

[11] System Approach: An approach that looks at the systems of the building rather than the individual equipment or fixtures. Systems include: daylighting, interior lighting, HVAC, service hot water, etc.

[12] Whole Building Approach: Uses computer simulations to consider integrated, optimized energy solutions. Provides reliable comparisons of various efficiency alternatives and quantifies the effects of improving the building's systems.

site contact also happened to be a decision maker, the decision-maker survey was conducted during the calls.

- **Conduct detailed on-site surveys**: Once the appointments were made, a site-surveyor was dispatched to the location to conduct a comprehensive and detailed site survey. The task of the site surveyor was to collect all relevant data in order to evaluate the project savings. In cases of typical commercial buildings, a standardized site survey instrument (survey form) was used to record all equipment specifications, building characteristics, operational schedules, and control strategies necessary. The Team used this information to construct energy simulation models. In the case of custom sites, the skill and the experience of the site surveyor was relied upon to make certain all of the applicable and available data were collected to reliably evaluate measure savings.
- **Perform end-use metering**: The Team selected a subset of the program sample for end-use metering to better inform the project evaluations. The goal of the end-use metering was to reduce the uncertainty of the final savings estimates. The impact of the savings was considered in choosing the metering subsample, i.e. the projects chosen for end-use metering were the projects where the metering would have the greatest impacts on reducing uncertainty. Metered end-uses included central plant equipment, packaged HVAC units, lighting systems, and industrial process and refrigeration equipment.
- **Evaluate project savings**: The Team took a variety of approaches to evaluate the project-level savings based on the data collected from the site visits. Each project was assessed with an as-built versus baseline where the energy consumption and coincident peak demand of the project constructed was compared against the energy consumption and coincident peak demand hypothetical baseline operating under similar conditions. The following analysis techniques were used for the relevant projects:
    - Whole Building Projects: The Team evaluated the majority of the sites using DOE-2 whole-building energy simulation models. The models were constructed using KEMA's front end to DOE2.2, Survey-IT, and MS Access database. Then, a subset of models was calibrated to end-use metered data.
    - Industrial Projects: The Team evaluated many industrial projects using spreadsheet analysis, in many cases using short-term data[13] from the end-use metering.

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13 Short-term data. Short-term was comprised of installing battery power data loggers on the incented end users for a period of 3 weeks. True power of the end users was calculated based on this measurement.

- Refrigerated Warehouse Projects: The Team evaluated refrigerated warehouse projects using the implementer's DOE 2.2R simulation models; these models were modified to reflect surveyors' on-site observations.
- Compressed Air Projects: The Team evaluated compressed air projects using DOE's Air Master++ application; the tool was developed to quantify savings from compressed air energy savings measures.

- **Baseline Assessment:** The gross savings baselines are determined by code or citable industry standards. For non-code baselines, an assessment of the feasibility and legality of an ex-ante baseline is integral to the measure evaluation. Asserted baselines that are not realistically available in the market or not allowable for environmental, health, or safety reasons are not used in ex-post evaluations. Evaluators made reasonable efforts to ensure that the baselines were appropriate. The baseline for whole building sites is the code under which the site was permitted.
- **Administer Decision-Maker surveys**: The Team assessed the net savings or, more appropriately, net-of-free-ridership savings at the measure using the self-report method in the decision-maker survey. The responses to the "influence of the program" and "in the absence of the program" questions were used to generate measures' net-savings scores which were translated into measures' net-to-gross ratio.
- **Calculate net savings**: The Team calculated the net savings for simulation model-type projects by adjusting measures inputs to create gross-savings that accounts for the measures' interactive effects. This sometimes led to sufficient decreases in fuel interactions to the extent that net savings for some fuels could be over 100% due to the low NTG for other fuels in the building. For projects without interactive measures effects, net savings were built-up by applying the measures' net-to-gross ratios to gross results and summing up the savings.
- **Expand gross and net project results to the population**: The Team generated the final gross and net savings for the program population by applying case-weight to project-level results. After applying the case-weights to the sample and extrapolating those results to the population, the Team was able to obtain program-level and utility-level energy and demand savings, realization rates, and net-to-gross ratios.

3.1.1 Data Sources

KEMA used several primary and secondary data sources to complete this project. The primary data sources include:

- New construction decision-makers, and
- Newly constructed buildings.

The Team obtained the primary data from the primary sources through quantitative interviews and surveys of buildings. The new construction decision-makers include building owners/managers, architects, and engineers who design and specify the relevant equipment. The secondary data sources include:

- Statewide IOUs' SBD program databases and files,
- Engineering and manufacturers' reference material, and
- California Energy Commission weather data.

The Team used the IOUs' databases, Title-24 compliance certificates, and program files to identify participating buildings, estimated claimed savings, and incented measures. The other secondary sources listed above were used to support the modeling and calibration effort.

3.1.2 Sampling Plan

The Evaluation Team employed the model-based statistical sampling plan (MBSS) to select the project samples. Model-based sampling methods were also used to analyze the data, i.e. to extrapolate the findings from the sample projects to the target population of all program participants and to evaluate the statistical precision of the results.

Given that the Team used MBSS in the previous studies (1994-96 evaluation studies, the 1998 baseline study, and the 1999-2001, 2002, 2003, and 2004-05 SBD studies), it was possible to use the statistical parameters from those studies to establish the expected precision parameters for the current evaluation. The Team combined information from the program tracking data with findings from prior studies – the error ratio and gamma parameter[14]. Using these data, the expected statistical precision for gross annual energy savings was calculated from the planned sample size for the participant sample. Once the sample size had been determined, a sample design was selected that was efficiently stratified

[14] Error ratio and gamma parameter describe the relationship between the x and y variables of the MBSS model. These parameters are used in conjunction to inform the sample design. Both of these parameters are explained in detail in the Theoretical Foundation section below.

by the tracking estimate of annual energy savings, with a proportional representation of each utility in the combined participant population.

Sample Design

This section outlines the 2006-08 sample design which was conducted in two phases. During Phase I, the Team selected a sample from projects that were completed during 2006-07. During Phase II, the Team selected a sample from projects completed in the program during 2008. The reason for a two -phase sample design was to ensure that there would be enough time to recruit and perform field work on a sufficient number of sites for the entire three years. By separating the sample design into two phases, it was possible to perform field work on the majority of the sites during the 2008 program year, leaving only one year's worth of sites to field during the 2009 calendar year.

Halfway into the evaluation period, ED decided to focus on measures that constituted large percentages of the total portfolio savings explicitly; these measures were labeled "High Impact Measures" or HIMs. For SBD the only HIMs that were identified were projects that used the Whole Building (WB) approach. Because the sample had already been designed and selected without regard to HIMs, a sensitivity analysis was conducted to estimate the expected precision for the HIMs by utility. In consultation with ED, it was decided that the existing whole building subset of the NRNC sample would provide results satisfying the HIM requirement.

One complication, unfortunately, was that PG&E does not maintain a Savings By Design-specific tracking system, so it was necessary to create a virtual program from which to select the PG&E portion of the sample. During the second phase sample design, when quality control checks were performed across the different evaluation contracts, it was discovered that there were projects that existed in the population for PG&E NRNC that other evaluators were including in their program populations. Resolving the samples across contract groups delayed the selection of the PG&E sample until after the sample had been completed for the other Utilities. A more detailed explanation of the overlapping projects issues and resolutions is included in the Phase II sample design section.

Phase I Sample Design

During the first phase sample design, the Team used program tracking data from 2006-07 to estimate an overall population and draw samples by utility to target a relative precision of 10% at the 90% level of confidence (90/10). The sample was then stratified by tracking energy savings (kWh) for each utility with the exception of SCG (which did not claiming kWh savings in the 2006-08 program years). The SCG sample design was stratified by tracking therms. In the analysis of the 2004-05 NRNC program it was discovered that tracking and evaluated therms had virtually no correlation and therefore had extremely poor precision. The reasons for the lack of correlation had not been determined, but one possible reason may be that the assumptions and tools that the utilities used to estimate gas savings simply had not reached a level of maturity to produce reliable enough estimates. More focused gas savings analysis may be necessary to develop improved estimating techniques.

The Team assembled the Phase I population by taking the tracking data for the four IOUs and separating out only those projects that were a part of the SBD programs, with the exception of SCE (SCE provided a separate listing of projects by program). These projects were then examined by street address to identify sites where multiple project identification numbers (IDs) were present, or multiple buildings for the same company at the same location. Evaluation analysts and engineers determined if these projects could be collapsed into a single site for sample design, verification and analysis purposes. The summary statistics for the tracking data with collapsed sites are shown in Table 3-1.

Table 3-1: Summary Statistics of Data from IOUs' SBD Tracking Database

Utility	Sites	kWh	Mean (kWh)	Minimum (kWh)	Maximum (kWh)	StdDev	CV
PG&E	117	28,596,795	244,417	0	3,108,518	385,402	1.58
SCE	172	56,543,095	328,739	955	2,874,748	400,137	1.22
SDG&E	86	16,443,282	191,201	3,869	1,047,190	242,463	1.27
SCG	10	-	-	-	-	-	-

To estimate the overall program population for the three year cycle, the Team assumed that the final year of the program would continue along the same trend as the prior two years. Therefore, the 2006-07 tracking data that was obtained would represent two thirds of the three year population. The estimated three year populations and corresponding error ratios are listed below in Table 3-2.

With model-based statistical sampling (MBSS), the Team used a model to predict the error variance for each element in the population. The model was then used to develop the sample design. For this study, the error ratio was taken from the Savings By Design 2004-05 study. Based on prior studies and current tracking data, an estimate was made for the maximum population for each utility given a possible upswing in program participation for each utility. This field is labeled as the Ceiling Population.

Table 3-2: Estimated Three Year Population for Phase I SBD Programs by Utility

Utility	Predicted Sites	Error Ratio	Ceiling Population
PG&E	176	0.59	250
SCE	258	0.78	350
SDG&E	129	0.72	200
SCG	15	0.57	60
Total	**578**	**N/A**	**860**

Based on the estimated number of accounts for the three year evaluation, the estimated error ratio, and the targeted level of precision of 90/10, the team calculated a sample size for each utility. The sample listed in Table 3-3 represents the entire three year program evaluation, as well as the PY2006-07 sample which is two thirds of the overall sample. The remaining third of the sample was allocated to projects from the 2008 program year.

Table 3-3: IOUs' SBD Specific Phase I Sample Sizes

Utility	Original 2006-08 Sample	Original PY 2006-07 Sample	Planned PY2008 Sample	Revised 2006-08 Sample
PG&E	61	41	20	65
SCE	101	67	34	67
SDG&E	68	45	23	50
SCG	13	10	3	18
Total	**243**	**163**	**80**	**200**

KEMA conducted a census of all 10 of the 2006-07 SCG projects and sampled the majority of the 2008 projects (if program enrollment continued to be low) due to the low number of projects in the SCG NRNC program and poor correlation of tracking to evaluated therms savings. The sample design for the estimated 2006-08 population is shown in Table 3-4. The analysis showed that a sample of 243 projects was needed across the four utilities to achieve the desired relative precision. Two thirds of the sample was allocated to the 2006-07 samples.

Table 3-4: Estimated Precision for the SBD Phase I Sample by Utility for 2006-08

Utility	Predicted Projects	Error Ratio	Sample	Expected Relative Precision
PG&E	176	0.59	61	10%
SCE	258	0.78	101	10%
SDG&E	129	0.72	68	10%
SCG	15	1.50	13	25%

As shown in Table 3-5, the team selected one recruitment backup for each sample point in the population with the exception of SCG, where all projects in the population were selected to be in the sample.

Table 3-5: Number of Backup Sites for SBD in Phase I Sample

Utility	Planned Sample	Phase I Ceiling Sample	Backups Surveyed
PG&E	41	45	5
SCE	67	75	7
SDG&E	45	55	10
SCG	10	23	0
Total	**163**	**199**	**22**

KEMA contacted representatives from the four IOUs during the first quarter of 2008 to find out if there was any reason to believe that the number of projects would vary greatly for the last year of the program. Utility representatives from each utility felt that there was no reason to believe that there would be any great swing in the number of projects for the upcoming year, with the exception that there might possibly be a slight decrease in projects due to the downturn in the economy and businesses becoming slightly more conservative in their spending.

Based on the ceiling population, the Team created a ceiling sample size for each utility, which represented how many projects would need to be selected if the population reached the estimated maximum. KEMA conducted the net-to-gross survey (see Appendix E) with additional projects for each utility, with the exception of SCG which had all project decision makers interviewed, for the difference between the current planned sample size and the sample size that would be needed if the ceiling population ends up being the true population.

The reasons for interviewing additional 2006-07 project decision-makers were two-fold. The first was that there was a chance that the decision maker had not left the company, making it substantially easier to locate the decision maker. Second, the decision maker might have greater recollection of how and why decisions were made then versus later, assuming the survey was administered a year later to the 2006-07 sample.

Due to project complications, in the 4th quarter of 2008 KEMA and ED decided to reduce the number of sample points for the evaluation in order to meet budgeting constraints. KEMA attempted to maximize the balance of precision and breadth of coverage in response to developments that reduced the sample size from the originally planned size of 243 projects to 200 projects as shown in Table 3-6.

As of Q4 2000, the remainder of the 2006-07 sample yet to be fielded was put on hold until the final program population were available for the final sample design. At that time, a total of 24 2006-07 projects had not yet been visited across the four utilities, giving a total of 139 projects completed for the 2006-07 sample and leaving 61 projects for the 2008 sample. The final utility tracking data was not received until March 31, 2009 and the reconciliation of the virtual PG&E sample did not occur until late summer 2009, leaving very little time to complete the evaluation. To meet the reporting deadline for ED (November 15, 2009), it was necessary to stop site visits after finsihing the field work on 191 projects.

Table 3-6: Final Phase I Sample Design

Utility	Overall Sample	PY 2006-07 Sample	Revised Sample	Final Sample
PG&E	61	41	65	57
SCE	101	67	67	70
SDG&E	68	45	50	48
SCG	13	10	18	16
Total	**243**	**163**	**200**	**191**

Phase II Sample Design

The first step that the Team took in the second phase sample design was to look at the final 2006-08 tracking data and compare this with our prediction of program enrollment. The optimum allocation of sample points between the two phases was analyzed to maximize overall precision by utility based on the final tracking data provided by each utility. Next, the number of projects per stratum by utility in the optimal sample design was compared to the actual number of projects that had been evaluated for the 2006-07 sample design by stratum. The Team checked if any stratum was under-sampled and if it was necessary to visit any of the 2006-07 projects that had been put on hold.

During the second phase sample design, KEMA discovered that there were projects that existed in the population for PG&E NRNC that other evaluators were including in their program populations. These programs included: PGE2004, PGE2005, and PGE2007.An ad hoc group consisting prime evaluation contractors from the affected contract groups (KEMA, Itron and ADM), ED decided that projects within the PGE2004 and PGE2007 programs that were also part of the NRNC program would remain a part of the NRNC evaluation. The group also decided that all projects that were enrolled in the PGE2005 Hi-Tech facilities programs[15] were to be evaluated separately as opposed to a portion of those projects being included in the NRNC evaluation. This reduced the population for the PG&E NRNC by approximately 11% of projects and 43% of tracking kWh savings as these were larger projects.

Table 3-7 shows the program enrollment statistics for each utility by phase. There was an unanticipated increase in the number of projects enrolled in PG&E's program in 2008 compared to 2006-07 that needed to be taken into account in the Phase II sample design. It was originally expected that 2008 would represent approximately one third of the overall projects.

[15] The high-tech facilities for PG&E were handed to ADM under major facilitates evaluation contract.

Table 3-7: IOUs' SBD Phase II Enrollment Summary Statistics

Utility	2006/2007	2008[16]	Total
PG&E	117	162	279
SCE	172	140	312
SDG&E	86	7	93
SCG	10	18	28
Total	385	327	712

Per their original program estimate SDG&E was predicted to have approximately 43 projects enrolled during the 2008 program year for a total of 129 projects. However, the actual enrollment for 2008 was 7 projects, indicating that fewer sample points needed to be allocated to SDG&E than originally designed. Conversely, 129 projects enrolled with PG&E during the 2008 year, which was not only greater than expected, but was greater than the first two years combined. As a result, samples that were originally allocated to SDG&E were reallocated to PG&E without sacrificing the precision of the SDG&E evaluation, since SDG&E had such a small enrollment in the 2008 year period. SCG also saw an increase in program enrollment; however, SCG's program was already being oversampled to account for the poor correlation of therm savings so the increase did not compromise the sample design or goal of 90/10 precision at the statewide level.

Both SDG&E and SCG have small populations with high variances such that the finite population correction factor (FPC) comes into play. The FPC measures how much extra precision is achieved when the sample size is a large percentage of the population size, which is the case for these two utilities. Even though both of these utilities have small sample sizes, we still expected to achieve ±10% precision at the 90% confidence for SDG&E due to the fact that the sample was a large portion of the population. Since therms tracking data appeared to be virtually uncorrelated to the evaluated estimates of savings in the 2004-05 program, we were not able to provide a useful estimate for SCG therms precision.

The results of the sample design in Phase II are shown in Table 3-8. The final allocation of projects in the Phase II sample design was selected prior to the decision to remove all projects from the PGE2005 program from the SBD population. Over 43% of the total kWh savings of the PG&E SBD program were

[16] Population counts for PG&E and SCE changed from the draft version of the report, for an explanation see section 2.3.1 on page 34.

from PGE2005. Dropping these projects led to a slight over sampling of PG&E projects compared to an optimal statewide allocation.

Table 3-8: Summary of Final Phase I and Phase II SBD Sample Design

Utility	Phase	Projects	Ex-Ante Gross kWh	Sample	Expected Relative Precision
PG&E	Phase 1	117	27,108,361	33	12.40%
PG&E	Phase 2	162	41,267,716	24	12.00%
PG&E[17]	Total	279	68,376,077	57	8.75%
SCE	Phase 1	172	57,820,026	50	16.80%
SCE	Phase 2	140	49,781,009	20	19.80%
SCE	Total	312[18]	107,601,035	70	13.10%
SDG&E	Phase 1	86	16,449,335	42	9.60%
SDG&E	Phase 2	7	1,468,255	6	24.80%
SDG&E	Total	93	17,917,590	48	9.10%
SCG	Phase 1	10	-	10	
SCG	Phase 2	18	-	6	
SCG	Total	28	-	16[19]	

[17] The PG&E population decreased from the reported number in the draft evaluation report because during the QC period, KEMA found that some of the sites were not collapsed properly. The collapsed sites' reflected the savings for multiple sites from single locations but the total savings remained the same. Site P45415, P45416, P45417, P45418, and P45175 were collapsed either because they were all in the same building with different uses, or were located in campus of buildings in the same location.

[18] SCE population was adjusted from the number included in the draft evaluation report due to a comment made by SCE during the public comment period, who pointed out that the ex-ante numbers were missing data from the last quarter of 2008 claims. KEMA adjusted these numbers and the report reflects the correct population and savings claims. Both SCE's gross and net savings results increased due to this correction.

[19] Two sites (G120006 and G20526) in SCG samples were revised as a result of a comment made during the public comment period. In the analysis that was made previously in the draft report, realization rates from the evaluated measures were applied to non-evaluated measure where the sites did not provide complete data for the analysis. The revised analysis separated the sites in the population into two separate sites, realization rates from the analysis were applied to the site that was evaluated and the other site received the utility overall realization rate.

Final Sample Design

The following tables show the final sample weights and strata cut points by utility. The samples were designed by kWh savings with the exception of SCG, who did not claim electric savings, where the sample was designed by therm savings. Table 3-9 lists the final weights for the electric analysis by utility.

Table 3-9: Final kWh Sample Sizes and Weights by Utility

Utility	Stratum	Max kWh Savings	# of Projects	Sample Size	Weight	Sample Fraction
PGE	1	150,928	173	21	8.24	0.12
	2	370,308	49	10	4.90	0.20
	3	574,712	29	9	3.22	0.31
	4	1,052,365	19	11	1.73	0.58
	5	3,719,449	9	6	1.50	0.67
	PGE Subtotal		279	57	4.89	0.20
SDGE	6	133,062	55	18	3.06	0.33
	7	277,687	15	9	1.67	0.60
	8	416,605	11	9	1.22	0.82
	9	676,295	7	7	1.00	1.00
	10	1,047,190	5	5	1.00	1.00
	SDGE Subtotal		93	48	1.94	0.52
SCE	11	301,870	194	24	8.08	0.12
	12	536,182	48	22	2.18	0.46
	13	745,471	35	11	3.18	0.31
	14	1,308,480	22	6	3.67	0.27
	15	4,351,133	13	7	1.86	0.54
	SCE Subtotal		312	70	4.46	0.22

The gas analysis was conducted using a weighted mean per unit approach. Weights were calculated for each utility based on the therm savings of that site. For utilities other than SCG which claimed only gas savings, separate weights were calculated for both the electric and gas analysis, in this way to accurately reflect the gas contribution each site made to the population and not base the weighting on the kWh savings which have no bearing on gas savings other than some interactive affects for whole building sites. Table 3-10 shows the final weights for the gas analysis by utility.

Table 3-10: Final Therm Sample Sizes and Weights by Utility

Utility	Stratum	Max therms Savings	# of Projects	Sample Size	Weight	Sample Fraction
PGE	1	5,536	258	48	5.38	0.19
	2	14,393	11	5	2.20	0.45
	3	75,892	8	3	2.67	0.38
	4	101,796	2	1	2.00	0.50
	PGE Subtotal		279	57	4.89	0.20
SDGE	6	6,330	88	43	2.05	0.49
	7	24,654	1	1	1.00	1.00
	8	40,326	1	1	1.00	1.00
	9	52,159	2	2	1.00	1.00
	10	58,319	1	1	1.00	1.00
	SDGE Subtotal		93	48	1.94	0.52
SCE	11	1,302	299	67	4.46	0.22
	12	3,090	7	1	7.00	0.14
	14	11,833	5	1	5.00	0.20
	15	37,926	1	1	1.00	1.00
	SCE Subtotal		312	70	4.46	0.22
SCG	16	240,007	25	14	1.79	0.56
	17	1,616,734	2	1	2.00	0.50
	18	3,233,460	1	1	1.00	1.00
	SoCalGas Subtotal		28	16	1.75	0.57

3.1.3 Decision Maker's Implementation

Decision-maker (DM) surveys were attempted for all sites (191) in the planned sample however, decision maker surveys for 12 projects could not be completed. Final counts of completed DM survey are listed below in Table 3-11. The primary reasons include were that the decision-maker was no longer at the company, lack of response to calls and inquiries, the business had closed, and refusal/terminated survey. A more in-depth assessment of the incomplete DM surveys can be found in Appendix D.

Table 3-11: Summary of Sample for Decision Maker's Surveys Completed by Utility

Utility	Planned Sample	Final Sample	Final Num. of NTG Surveys
PG&E	65	57	51
SCE	70	70	69
SDG&E	47	48	44
SoCalGas	18	16	15
Subtotal Sample Size	200	191	179

Table 3-12 contains the final sample of completed projects and NTG DM Surveys by the various approaches implemented: whole building, systems and industrial.

Table 3-12: Final Sample for Decision Maker's Surveys by Utility and by Approach

Final Sample of Completed Projects by Approach					
Utility		Industrial	Whole Building	Systems	Subtotal Sample Size
PGE	Projects Complete	18	30	9	57
	NTG Survey	14	28	9	51
SCE	Projects Complete	23	21	26	70
	NTG Survey	23	21	25	69
SDGE	Projects Complete	5	19	24	48
	NTG Survey	5	17	22	44
SCG	Projects Complete	13	3	0	16
	NTG Survey	12	3	0	15

Table 3-13 contains an estimate of the total number of contacts attempted during the recruitment and on-site audits for both complete and incomplete projects in addition to the average number of contacts per completed site. Typically utilities provide one point of contact, but the average is at least two contacts to complete an on-site audit and decision-maker survey. Reoccurring program participants help to keep the average low along with KEMA's previous interaction with these customers.

Table 3-13 : Contacts Intercepted to Complete Audits and Decision Maker's Surveys

Total Number of Contacts to Complete Project	
Number of Contacts for Complete & Incomplete Projects	440
Sum of Contacts to Recruit Final Sample (191)	408
Average Num. of Contacts Per Completed Project	2.2

Table 3-14 contains an estimate on the number of telephone calls made during the recruitment of the on-site audit and decision-maker survey. However, there is significantly more communication with the customers to coordinate the audit as customers often prefer communication by email. Emails are not necessarily accounted for within the counts reflected in the table.

Table 3-14: Recruitment Call Summary

Telephone Recruitment Call Summary	
Total Number of Calls Performed	742
Sum of Calls to Recruit Final Sample (191)	728
Average Num. of Calls Per Completed Project	3.8
Average Num. of Calls Per Incomplete Survey	5.3

3.2 Confidence and Precision of Key Findings

The results showed that the sample variances for the 2006-08 were very close to the previous year's projected results. Although there was some deviation in each utility from the estimated three year program population, on the whole the predictions were very close and the target goal of ±10% precision at the 90% confidence level for each utility was met.

3.3 Validity and Reliability

This study approach built on prior cycles of Non-Residential New Construction evaluations as a foundation. Those prior analyses produced results within the desired confidence and precision levels of 10% precision at the 90% confidence level. The approach relied on a combination of leveraging the known precisions from prior cycles to help design the sample. Then, specific evaluations were focused on individual projects building complete engineering models for each project. For measures with the largest uncertainty, field energy consumption measurements were performed and the models calibrated to the field measurements. The calibrated simulations were further checked through a set of sensitivity analyses designed to identify and correct errors and inconsistencies in the engineering models. Teams of skilled engineers provided peer-review for the intermediate steps of the analysis.

The Team treated the industrial projects individually with custom designed evaluations, site surveys, monitoring and specific engineering models. Peer review and team meetings were critical to ensure that these often unique projects were dealt with as thoroughly and completely as possible. Appendix C includes full write-ups of the individual site reports. In this cycle of evaluations, efforts were made to ensure that the rigor of individual industrial evaluations for specific measures were reasonably consistent with similar measures found in other evaluation groups.

KEMA made sure that all field measurement devices received required maintenance and calibration to reduce field measurement error with improved instrumentation and measurement techniques. Some of the greatest uncertainties lay in data collected from site personnel interviews. While the evaluation team made every effort to cross-verify data collected in the interview during the evaluation, certain parameters such operating hours, and fan and lighting schedules could not be truly verified without metering. Greater uncertainties might have arisen when full as-built plans were not available on site. In these instances, verification of wall insulation, window U-value and SHGC, and similarly unverifiable parameters were left as their default values when modeling the site.

Another contribution of uncertainty was simulation model data entry errors. Given the complexity of the projects, some instances of random errors in the data entry process were inevitable. The errors were identified and by a series of quality control checks performed throughout the process.

First the surveyor completed a checklist of items that might have created random errors in the model inputs. The checklist, developed from our experiences, included checks of lighting power density at the space level and comparison of the sum modeled areas versus the reported area for the site. Next, the whole building and measure energy and demand savings had to conform to reasonable ranges or have an explanation why any values were out of range for the site. The next check was the analysis of quality control (QC), which looked at end-use realization rates for individual sites. If any site failed the analysis, the model was "kicked back" to the surveyor for revisions or justification of why any end-use realization was out of range.

Decision maker surveys (found in Appendix G) were only conducted by skilled evaluation staff familiar with the technologies being deployed as well as the required background information regarding the nature of the decision to implement the specific energy efficiency measures. The survey employed built-in checks for consistency and the surveyor explored inconsistent responses whenever feasible. The Team staff is well trained, with several members having considerable experience conducting energy efficiency related surveys and recruiting participants for on-site surveys. Since decision maker surveys incorporate collection of specific building energy information conducted in concert with the recruiting effort, only knowledgeable surveyors were used for this task. The decision maker survey required informed discussion regarding esoteric energy efficiency measures best achieved with highly skilled staff. The surveyors selected for this task were the antidote to non-response and self-selection bias due to persistence and determination.

Sample Bias

Selection bias is the systematic tendency to exclude one kind of unit or another from the sample. The Evaluation Team avoided most selection bias through random and stratified sample designs. The obstacles we encountered and our approach to maintaining our sample integrity are described below.

Self-selection bias allows respondents to be "self-chosen" ("volunteerism"), rather than using a pre-designated sample. Bias is introduced because these individuals may be more opinionated or be more interested in the topic of the survey than non-volunteers. For example, non-Participants who self-select into a sample may be more interested in energy; therefore, they may build more efficiently than other Non-Participants.

Response bias can derive from several sources including interviewer attitudes, the precise wording of the questions, or even the juxtaposition of one question with another. In our case, some respondents might have claimed to be "energy efficient" or "energy conscious" because they believed the surveyor was energy conscious. To help avoid response bias, the evaluation surveyors were trained to remain objective while administering the survey instrument. In addition, the survey specialists adhered to a standardized interviewing procedure with each respondent.

Non-response bias is introduced when there are low response rates (i.e. large number of hang ups, refusals, or no contacts). When response rates fall low enough, questions about the representativeness of the respondents were raised. The telephone as the contact instrument allowed for numerous contact attempts and variation in the times contacts were attempted. Patience and persistence could help circumvent issues with non-response bias, and for this reason, the team had set a minimum call attempt standard of 7 calls per individual.

Cultural bias affected who we ended up sampling. Of course, we did not have control over language barriers, and we made an honest attempt to contact every name in the sample by priority whether or not we believed a language barrier will exist.

3.4 SBD Statewide Detailed Findings

Projects that were incented under the Whole Building approach are reported under the measure group labeled "Whole Building." The combined total energy savings and demand reduction are defined to be the difference between the energy use or demand for the entire building under the T-24 baseline and as-built simulations. The Evaluation Team determined the results for each sample site both on a whole building basis as well as within each end use. Positive savings indicate that the building was more efficient – used less energy or demanded less – than its baseline case. We reported industrial measures in a separate category named "Industrial" due to the unique nature of industrial measures such as those installed in waste water facilities and dairies. Some commercial projects included industrial measures, for example labs with fume hoods. As mentioned in the previous section, the modeling results for these sites were disaggregated into commercial and industrial measures for the analysis, and the resulting industrial findings were included within the industrial results tables.

The Team used two different approaches in analyzing the energy savings and demand reduction results, an "Incented Measure" approach and an "All Measures" approach. The results focused on the "All Measures" approach as explained below.

In the "All Measures" approach, listed below, the Team aggregated savings from all measure categories regardless of the specific measures for which a site received an incentive. For example, if a site received an incentive for HVAC but also achieved savings due to decreased Lighting Power Density (LPD), the total savings for that site would be the sum of both HVAC and LPD savings. The reason that this approach was adopted was to prevent trade-offs where sites could receive incentives for increased efficiency in one measure category while having sub-code efficiency in other measure categories.

The "Incented Measure" approach, listed in Appendix B, only considers savings for each measure category for which a site received an incentive. In the "All Measures" example where both HVAC and LPD measures were better than baseline, the savings for that site would only consist of the HVAC measure for which the site received a rebate. These estimates of savings can be useful to show how cost effective certain measures were, but in order to prevent trade-off between measures the SBD program had established the "All Measures" approach to report savings for the program.

The refrigeration measure listed under the systems approach represent any refrigeration savings that were calculated from the building simulation tool. All *refrigerated warehouses* were considered industrial measures and used engineering calculations not the building simulation tool to calculate savings. The savings from these measures were included in the industrial measure savings. All of the grocery stores enrolled in the SBD program applied under the Whole Building approach and therefore all refrigeration savings for that category are included in the Whole Building savings.

3.4.1 Statewide SBD Gross Energy Savings Findings

Table 3-15 shows the estimated combined total gross energy savings relative to the energy savings from the program tracking databases, calculated at the utility level. For all program participants, the combined total annual gross energy savings were estimated in this evaluation to be 186,211 MWh, representing a gross realization rate of 96%.

Table 3-15 : 2006-2008 SBD Ex-Ante and Ex-Post Gross Electric Energy Savings (MWh)

Utility	Ex-Ante Gross Energy Savings (MWh)	Sampled Energy Savings (MWh)	% Sampled Energy Savings	Ex-Post Gross Energy Savings (MWh)	Error Bound	Relative Precision	Gross Realization Rate
PG&E	68,376	29,312	42.9%	56,174	5,594	10.0%	82.2%
SCE	107,601	41,284	38.4%	115,259	9,673	8.4%	107.1%
SCG	-	-	-	-	-	-	-
SDG&E	17,918	14,693	82.0%	14,779	612	4.1%	82.5%
Total	**193,895**	**85,288**	**44.0%**	**186,211**	**11,191**	**6.0%**	**96.0%**

The total savings are broken into commercial and industrial project savings. The commercial sector is further broken down by approach, either a system (prescriptive) approach or whole building approach. The system approach is further divided into major end uses. Whole Building sites (as well as the industrial sites) may include measures such as shell, lighting, HVAC + motors and/or refrigeration. Whereas, the prescriptive system measures are strictly incented for a particular measure such as lighting. The "measure categories" in this report refer to the measures that define each of the DOE-2 parameters.

Table 3-16 shows total statewide energy savings broken down by measure category. The combined commercial total energy savings were 128,596 MWh for the three utilities combined. An additional 57,615 MWh in savings came from the industrial sites bringing the total statewide ex-post gross energy savings to 186,211 MWh.

Figure 3-1 shows the composition of gross energy savings for the commercial sector by measure type at the statewide level. Almost all of the savings are from whole building and system approach lighting measures with 56.1% of the savings from whole building measure category, while system approach lighting made up 42.5% of savings. The combined commercial total represents the sum of the system approach sites and the whole building approach sites. The total program savings is the sum of the combined total savings from the commercial sector and the industrial savings.

Table 3-16 : Total Statewide SBD Ex-Post Gross Energy Savings (MWh) by Measure Type

Measure Category	Ex-Post Gross Energy Savings (MWh)
System Shell	196
System Lighting	54,686
System HVAC + Motors	1,574
System Refrigeration	-
Whole Building	72,140
Combined Commercial Total	**128,596**
Industrial	57,615

Figure 3-1 : Composition of SBD Annual Ex-Post Gross Energy Savings by Measure Category for the Total Commercial Sector

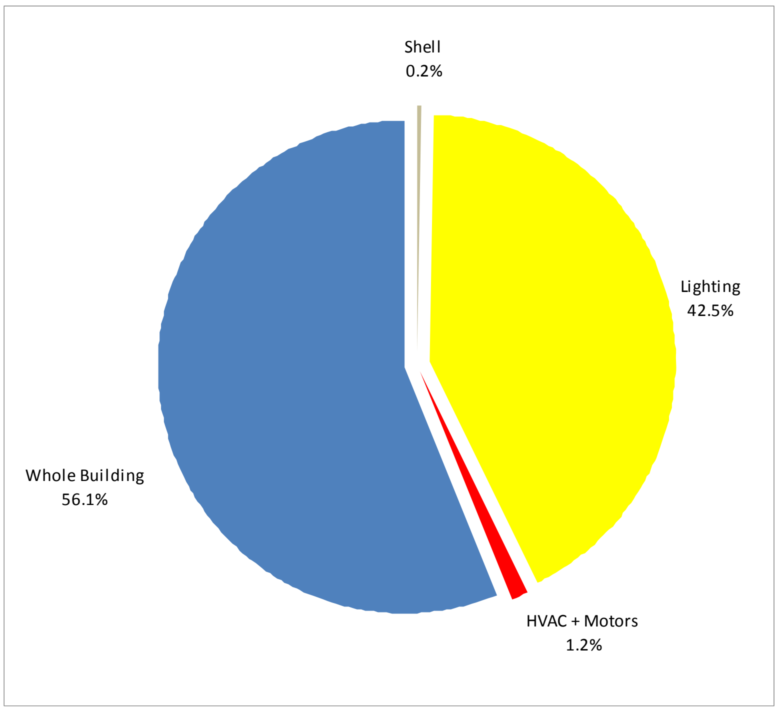

Table 3-17, Table 3-18, and Table 3-19 show the estimated ex-post gross energy savings including error bound by measure category for PG&E, SDG&E and SCE, respectively. SCG claimed no electricity savings for the program period.

Table 3-17: Ex-post Gross Energy Savings (MWh) by Measure, PG&E

Measure Category	Ex-Post Gross Energy Savings (MWh)	Error Bound	Relative Precision
System Shell	0	0	-
System Lighting	7,896	3,442.5	43.6%
System HVAC + Motors	57	63.1	110.9%
System Refrigeration	0	0.0	-
Whole Building	33,755	2,553.4	7.6%
Combined Commercial Total	**41,708**	**4,304.7**	**10.3%**
Industrial	14,466	5,709.2	39.5%

Table 3-18: Ex-post Gross Energy Savings (MWh) by Measure, SDG&E

Measure Category	Ex-Post Gross Energy Savings (MWh)	Error Bound	Relative Precision
System Shell	-27	18	67.3%
System Lighting	6,930	506	7.3%
System HVAC + Motors	370	230	2.1%
System Refrigeration	0	0	-
Whole Building	6,861	482	7.0%
Combined Commercial Total	**14,134**	**612**	**4.1%**
Industrial	645	143	22.2%

Table 3-19: Ex-post Gross Energy Savings (MWh) by Measure, SCE

Measure Category	Ex-Post Gross Energy Savings (MWh)	Error Bound	Relative Precision
System Shell	222	226	101.9%
System Lighting	39,860	14,260	35.8%
System HVAC + Motors	1,148	710	61.9%
System Refrigeration	0	0	-
Whole Building	31,525	4,015	12.7%
Combined Commercial Total	**72,755**	**14,784**	**20.3%**
Industrial	42,504	10,209	24.0%

3.4.2 Statewide SBD Demand Reduction Findings

This section presents the gross peak demand reduction for the SBD program participants. For all program participants, the combined total peak gross demand reduction is estimated to be 35.5 MW, representing a gross realization rate of 80.2%, as seen in Table 3-20.

Table 3-20: 2006-2008 SBD Ex-Ante and Ex-Post Gross Peak Demand Reduction (MW)

Utility	Ex-Ante Gross Peak Demand Reduction (MW)	Sampled Peak Demand Reduction (MW)	% Sampled Energy Savings	Ex-Post Gross Peak Demand Reduction (MW)	Error Bound	Relative Precision	Gross Realization Rate
PGE	20.5	8.2	40.0%	11.6	2.1	18.1%	56.6%
SCE	18.9	6.2	33.0%	21.2	2.3	10.8%	111.6%
SCG	-	-	-	-	-	-	-
SDGE	4.9	3.7	76.9%	2.8	0.2	7.1%	57.1%
Total	**44.3**	**18.2**	**41.0%**	**35.5**	**3.1**	**8.8%**	**80.2%**

Table **3-21** shows the breakdown of peak demand reduction by measure category at the statewide level. The combined commercial total gross peak demand reduction was 26.1 MW for the three utilities combined. An additional 9.4 MW in demand reduction came from the industrial sites bringing the total statewide ex-post gross demand reduction to 35.5 MW. As with the energy savings results, it is shown in Figure 3-2 that Whole Building Approach projects account for just less than 50% of the peak demand reduction among program participants. About 47% of the reduction was due to system lighting measure category (i.e. lighting power density, day-lighting controls, and other lighting controls), while HVAC + Motors measure category comprise an additional 3% of the reduction of the total commercial sector; savings for shell measure category were negligible.

Table 3-21 : Total Statewide SBD Ex-Post Energy Demand Savings by Measure Category

Measure Category	Ex-Post Gross Energy Savings (MW)
System Shell	0.1
System Lighting	12.2
System HVAC + Motors	0.8
System Refrigeration	-
Whole Building	13.0
Combined Commercial Total	**26.1**
Industrial	9.4

Figure 3-2 : Composition of SBD Ex-Post Gross Peak Demand Reduction for the Total Commercial Sector

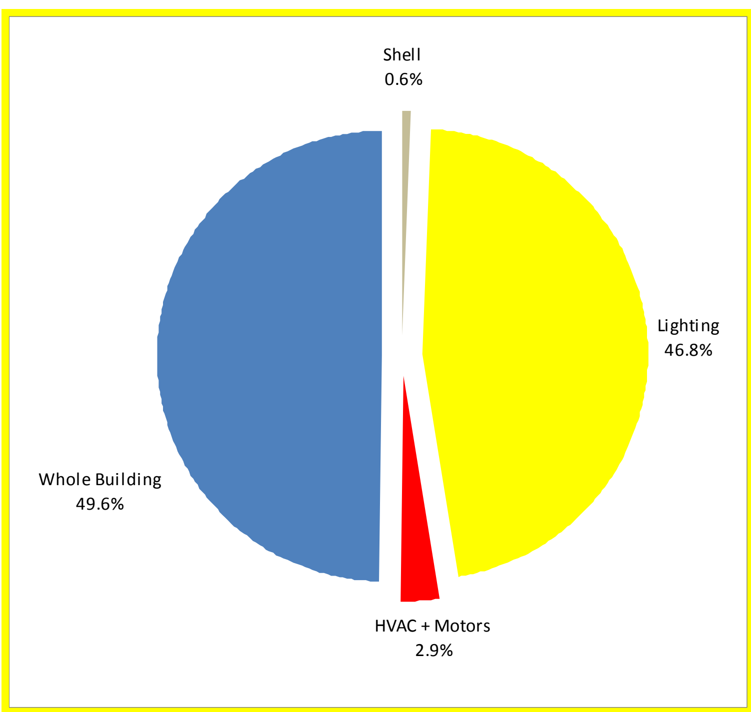

Table **3-22**, Table **3-22**, Table 3-23 and Table 3-234 show the estimated ex-post gross peak demand reduction and error bound by measure category for PG&E, SDG&E and SCE, respectively. SCG claimed no electricity savings for the program period.

Table 3-22: Ex-Post Peak Gross Demand Reduction By Measure Category, PG&E

Measure Category	Ex-Post Gross Energy Savings (MW)	Error Bound	Relative Precision
System Shell	0.0	0.0	-
System Lighting	2.0	1.2	58.6%
System HVAC + Motors	0.1	0.1	108.9%
System Refrigeration	0.0	0.0	-
Whole Building	6.2	1.3	21.0%
Combined Commercial Total	**8.3**	**1.8**	**21.4%**
Industrial	3.3	1.6	47.3%

Table 3-23: Ex-Post Peak Gross Demand Reduction By Measure Category, SDG&E

Measure Category	Ex-Post Gross Energy Savings (MW)	Error Bound	Relative Precision
System Shell	0.1	0.0	85.2%
System Lighting	1.1	0.1	8.7%
System HVAC + Motors	0.2	0.1	3.0%
System Refrigeration	0.0	0.0	-
Whole Building	1.4	0.2	12.1%
Combined Commercial Total	**2.6**	**0.2**	**7.1%**
Industrial	0.1	0.0	17.3%

Table 3-24: Ex-Post Peak Gross Demand Reduction By Measure Category, SCE

Measure Category	Ex-Post Gross Energy Savings (MW)	Error Bound	Relative Precision
System Shell	0.1	0.1	102.1%
System Lighting	9.2	2.4	26.5
System HVAC + Motors	0.6	0.3	54.2%
System Refrigeration	0.0	0.0	-
Whole Building	5.3	0.8	15.1%
Combined Commercial Total	**15.2**	**2.5**	**16.4%**
Industrial	6.0	2.0	33.3%

3.4.3 Statewide SBD Gas Savings Findings

As shown in Table 3-25, the total statewide ex-post gross gas savings from the programs is 5,885,378 therms with a total realization rate of 73.6%. The evaluation is based on a sample representing approximately 74.4% of the ex-ante gross gas savings.

Table 3-25: 2006-2008 SBD Ex-Ante and Ex-Post Annual Gross Gas Saving (therms)

Utility	Ex-Ante Gross Energy Savings (Therms)	Sampled Energy Savings (Therms)	% Sampled Energy Savings	Ex-Post Gross Energy Savings (Therms)	Error Bound	Relative Precision	Gross Realization Rate
PGE	542,829	158,920	29.3%	651,374	403,716	62.0%	120.0%
SCE	2,005	16,783	NA	59,419	54,476	91.7%	N/A
SCG	7,224,806	5,558,262	76.9%	5,025,504	4,174,785	83.1%	69.6%
SDGE	224,322	211,225	94.2%	149,080	70,396	47.2%	66.5%
Total	**7,993,962**	**5,945,190**	**74.4%**	**5,885,378**	**4,195,205**	**71.3%**	**73.6%**

The gas savings tracking estimates have little correlation to the evaluated gas savings. This result was similar to the gas savings finding in the previous SBD evaluation. As a result of this lack of correlation a weighted mean per unit (MPU) estimation technique was used to estimate savings.

For the MPU analysis of gas savings, the samples are re-weighted by utility by the evaluated gas savings estimate. The mean per unit estimate calculates a weighted average of the sampled gas savings and then multiplies this average by the number of sites in the population.

The MPU approach was the approach used for many program evaluations prior to the switch to the ratio model based approach, and is still being used by multiple evaluations for the 2006-08 program cycle. The advantage of using a ratio model approach is that it leverages information that is known about the population to inform the sample design to more efficiently select a sample and achieve better precision. Although the MPU approach is not as efficient it still provides a reliable estimate of savings provided that an adequate amount of the population savings is sampled. In the case of gas savings for SBD almost 70% of the population savings was sampled, which is well beyond what would be necessary to have a reliable estimate of gas savings.

The relative precision and error bounds for the MPU approach look at the variation of each site's weighted evaluated savings from the weighted mean of the sample. Therefore if you have a sample that has a wide range of evaluated savings, as is the case for SBD gas savings which range from -800,000 to 3,000,000 therms, the error bounds will be large and the relative precision will be high. This does not necessarily mean that the ex-post estimates of savings are inaccurate; it simply means that there is a great deal of variation in savings from site to site.

Table **3-21** shows the breakdown of ex-post gross gas savings by measure category at the statewide level. The total commercial total ex-post gross gas savings was 596,504 therms (10% of the total statewide gas savings) for the four utilities combined. An additional 5,288,873 therms in gas savings came from the industrial sites bringing the total statewide ex-post gross gas savings to 5,885,377 therms. As shown in Figure 3-2, for statewide, Whole Building projects accounted for about 89% of the total commercial gross gas savings. About 8% and 4% of the gas savings were due to system HVAC + Motors, and the shell measure categories, respectively. Lighting and refrigeration measure categories had negligible contribution to the statewide gas savings for the commercial sector.

Table **3-22**7, Table **3-22**8, Table 3-23 and Table 3-23 show the estimated ex-post gross gas savings and error bound by measure category for PG&E, SDG&E, SCE, and SCG, respectively.

Table 3-26 : Total Statewide Ex-Post Gross Gas Savings by Measure Type

Measure Category	**Ex-Post Gross Energy Savings (Therms)**
System Shell	22,793
System Lighting	-5,501
System HVAC + Motors	49,441
System Refrigeration	8
Whole Building	529,763
Combined Commercial Total	596,504
Industrial	5,288,874

Figure 3-3 : Composition of SBD Ex-Post Gross Gas Savings for the Total Commercial Sector

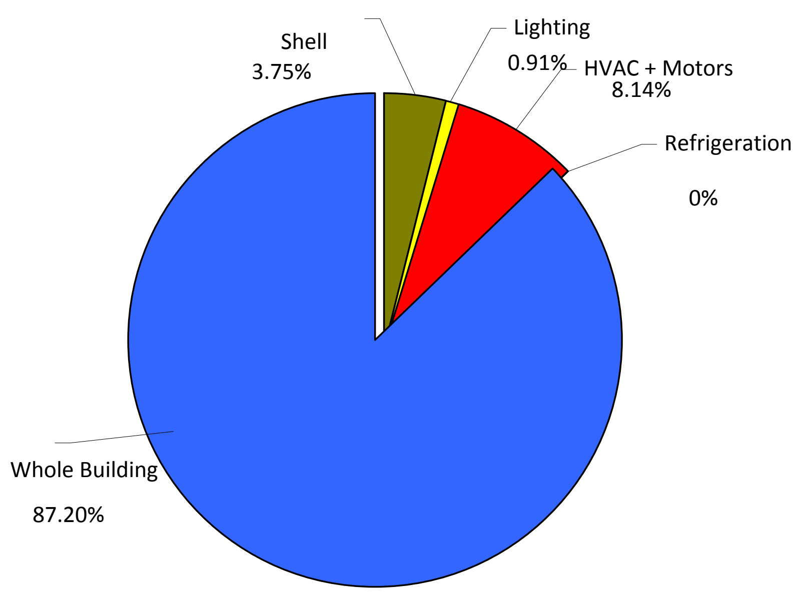

Table 3-27 : PG&E Ex-Post Gross Gas Savings by Measure Type

Measure Category	Ex-Post Gross Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	4,735	5,314	112.2%
System Lighting	-5,614	6,004	106.9%
System HVAC + Motors	1,050	1,362	129.8%
System Refrigeration	1	2	137.7%
Whole Building	413,002	301,459	73.0%
Combined Commercial Total	**413,174**	**301,569**	**73.0%**
Industrial	238,200	268,408	112.7%

Table 3-28 : SDGE Ex-Post Gross Gas Savings by Measure Type

Measure Category	Ex-Post Gross Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	688	1,089	158.2%
System Lighting	398	594	149.2%
System HVAC + Motors	17,879	18,048	100.9%
System Refrigeration	6	7	102.2%
Whole Building	105,505	64,230	60.9%
Combined Commercial Total	**124,477**	**66,729**	**53.6%**
Industrial	24,604	22,425	91.1%

Table 3-29 : SCE Ex-Post Gross Gas Savings by Measure Type

Measure Category	Ex-Post Gross Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	17,370	14,281	82.2%
System Lighting	-295	2,574	871.3%
System HVAC + Motors	30,513	47,400	155.3%
System Refrigeration	0	0	-
Whole Building	10,794	22,542	208.8%
Combined Commercial Total	**58,381**	**54,456**	**93.3%**
Industrial	1,037	1,455	140.3%

Table 3-30 : SCG Ex-Post Gross Gas Savings by Measure Type

Measure Category	Ex-Post Gross Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	-	-	-
System Lighting	10	12	114.0%
System HVAC + Motors	0	0	-
System Refrigeration	-	-	-
Whole Building	462	270	58.4%
Combined Commercial Total	**472**	**270**	**57.1%**
Industrial	5,025,032	4,174,785	83.1%

3.4.4 Statewide SBD Ex-Post Net Energy Findings

Table 3-31 : Total Statewide SBD Ex-Post Net Energy and Demand Savings by Measure

Measure Category	Ex-Post Net Energy Savings (MWh)	Ex-Post Net Energy Savings (MW)	Ex-Post Net Gas Savings (Therms)
Shell	496	0.1	22,584
Lighting	40,591	8.9	3,294
HVAC + Motors	1,596	0.4	37,476
Refrigeration	0	0.0	30
Whole Building	46,529	8.1	663,729
Combined Commercial Total	**89,213**	**17.5**	**727,113**
Industrial	28,817	4.6	3,543,267

As shown in

Table 3-32, from a statewide total perspective the realization rate for energy is 77.8%. The net realization rate varied by Utility from a high of 93.1% to a low of 60.9%. The statewide relative precision was 8.6%, with utility level precision ranging from 6.9% to 15.1%.

Table 3-32: SBD Net Energy Savings (MWh)

Utility	Ex-Ante Net Energy Savings (MWh)	Ex-Post Net Energy Savings (MWh)	Error Bound	Relative Precision	Net Realization Rate
PGE	59,665	36,324	5,477	15.1%	60.9%
SCE	78,549	73,161	8,618	11.8%	93.1%
SCG	-	-	-	-	-
SDGE	14,692	9,435	650	6.9%	64.2%
Total	**152,906**	**118,920**	**10,232**	**8.6%**	**77.8%**

The net demand reductions are shown in Table 3-33, with a Statewide realization rate ranging between 38.7% and 98.9% with a statewide average of 62.4%.

Table 3-33: SBD Ex-Post Net Demand Reduction

Utility	Ex-Ante Net Energy Savings (MW)	Ex-Post Net Energy Savings (MW)	Error Bound	Relative Precision	Net Realization Rate
PGE	17.6	6.9	1.4	20.4%	38.9%
SCE	13.8	13.7	2.1	15.2%	98.9%
SCG	-	-	-	-	-
SDGE	4.0	1.6	0.2	10.1%	40.4%
Total	**35.4**	**22.1**	**2.5**	**11.3%**	**62.4%**

Table 3-34: Ex-Post Annual Net Gas Savings

Utility	Ex-Ante Net Energy Savings (Therms)	Ex-Post Net Energy Savings (Therms)	Net Realization Rate
PGE	469,441	532,575	113.4%
SCE	788	48,850	N/A
SCG	6,791,730	3,506,457	51.6%
SDGE	183,944	182,498	99.2%
Total	7,445,903	4,270,380	57.4%

Table 3-35: PG&E Ex-Post Net Savings Energy Savings by Measure Type

Measure Category	Ex-Post Net Energy Savings (MWh)	Error Bound	Relative Precision
System Shell	0	0	-
System Lighting	6,894	2,879	41.8%
System HVAC + Motors	18	22	123.5%
System Refrigeration	-	-	-
Whole Building	20,805	3,721	17.9%
Combined Commercial Total	**27,716**	**4,708**	**17.0%**
Industrial	7,917	4,079	51.5%

Table 3-36: SDG&E Ex-Post Net Energy Savings By Measure Type

Measure Category	Ex-Post Net Energy Savings (MWh)	Error Bound	Relative Precision
System Shell	(22)	26	120.9%
System Lighting	4,236	421	9.9%
System HVAC + Motors	381	261	2.1%
System Refrigeration	-	-	-
Whole Building	4,349	544	12.5%
Combined Commercial Total	**8,945**	**650**	**6.9%**
Industrial	490	73	14.9%

Table 3-37: SCE Ex-Post Net Energy Savings By Measure Type

Measure Category	Ex-Post Net Energy Savings (MWh)	Error Bound	Relative Precision
System Shell	518	698	134.7%
System Lighting	29,461	10,404	35.3%
System HVAC + Motors	1,197	1,466	122.5%
System Refrigeration	-	-	-
Whole Building	**21,375**	**4,806**	**22.5%**
Combined Commercial Total	**52,551**	**11,458**	**21.8**
Industrial	20,410	7,375	36.1%

Table 3-38: PG&E Ex-Post Net Demand Reduction by Measure Type

Measure Category	Ex-Post Net Energy Savings (MW)	Error Bound	Relative Precision
System Shell	0.0	0.0	-
System Lighting	1.5	0.8	55.9%
System HVAC + Motors	0.0	0.0	-
System Refrigeration	-	-	-
Whole Building	3.8	0.8	20.1%
Combined Commercial Total	**5.3**	**1.1**	**21.4%**
Industrial	1.5	1.0	68.1%

Table 3-39: SDG&E Ex-Post Net Demand Reduction by Measure Type

Measure Category	Ex-Post Net Energy Savings (MW)	Error Bound	Relative Precision
System Shell	-	-	-
System Lighting	0.7	0.1	9.0%
System HVAC + Motors	0.1	0.0	1.6%
System Refrigeration	-	-	-
Whole Building	0.8	0.1	18.8%
Combined Commercial Total	**1.5**	**0.2**	**10.1%**
Industrial	0.1	0.0	15.2%

Table 3-40: SCE Ex-Post Net Demand Reduction by Measure Type

Measure Category	Ex-Post Net Energy Savings (MW)	Error Bound	Relative Precision
System Shell	0.1	0.1	102.2%
System Lighting	6.7	2.0	30.4%
System HVAC + Motors	0.3	0.2	75.2%
System Refrigeration	-	-	-
Whole Building	3.5	0.8	23.1%
Combined Commercial Total	**10.6**	**2.2**	**20.4%**
Industrial	3.0	1.4	45.1%

Table 3-41: PG&E Ex-Post Net Gas Savings by Measure Type

Measure Category	Ex-Post Net Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	4,344	5,302	122.1%
System Lighting	2,185	2,313	105.9%
System HVAC + Motors	1,014	1,361	134.2%
System Refrigeration	24	33	137.7%
Whole Building	508,822	341,801	67.2%
Combined Commercial Total	**516,388**	**341,852**	**66.2%**
Industrial	16,187	26,850	165.9%

Table 3-42: SDG&E Ex-Post Net Gas Savings by Measure Type

Measure Category	Ex-Post Net Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	868	986	113.6%
System Lighting	562	671	119.5%
System HVAC + Motors	17,263	18,039	104.5%
System Refrigeration	6	7	102.2%
Whole Building	142,419	69,410	48.7%
Combined Commercial Total	**161,118**	**71,726**	**44.5%**
Industrial	21,380	22,174	103.7%

Table 3-43: SCE Ex-Post Net Gas Savings by Measure Type

Measure Category	Ex-Post Net Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	17,372	14,279	82.2%
System Lighting	537	2,064	384.2%
System HVAC + Motors	18,320	30,173	164.7%
System Refrigeration	-	-	-
Whole Building	12,027	24,860	206.7%
Combined Commercial Total	**48,256**	**41,672**	**86.4%**
Industrial	594	833	140.3%

Table 3-44: SCG Ex-Post Net Gas Savings by Measure Type

Measure Category	Ex-Post Net Energy Savings (Therms)	Error Bound	Relative Precision
System Shell	0	0	-
System Lighting	10	12	114.0%
System HVAC + Motors	879	1,001	114.0%
System Refrigeration	-	-	-
Whole Building	462	270	58.4%
Combined Commercial Total	**1,351**	**1,037**	**76.8%**
Industrial	3,505,106	2,945,641	84.0%

4. Non-Residential New Construction Whole Building Evaluation (HIM)

The C&I Whole Building measure is contained within the subgroup of Non-Residential New Construction programs that KEMA is evaluating as part of the NCCS group. The Whole Building HIM assessment was requested after we had already completed our sample design and fielded several on-sites for the NRNC evaluation. Rather than do a new sample design we assessed the estimated precision for the 2006-08 program for Whole Building sites and determined that the evaluation sample design we had already completed would be sufficient. We evaluated the Whole Building HIM in a manner consistent with our methods described in Section 3.1.

All of the 2006-08 CPUC contract evaluators were instructed to identify measures that contributed more than 1% of a utility's portfolio savings. These measures were labeled as High Impact Measures (HIM). For the 2006-08 NRNC program the Whole Building (WB) measure was the only measure that qualified as an HIM based on the criteria of a measure accounting for greater than 1% of portfolio savings. Evaluators were asked to target +-10% relative precision at the 90% confidence levels for all measures that qualified as HIMs. Samples for the NRNC program were originally designed at the utility level and not at the measure level so a sensitivity analysis was done to ensure that the existing sample design would support the desired level of precision for the WB HIM. The sensitivity analysis showed that at the statewide level the existing sample design would support the desired precision target for the WB HIM. There are no specific results from the HIM reporting that is distinct from the overall NRNC evaluation. The tables below are presented to provide a clear reporting of the whole building HIM.

Whole Building is not a specific program rather it is an aspect of the Savings by Design (SBD) programs. The SBD programs offered by California's Investor Owned Utilities include design assistance and financial incentives to improve the energy efficiency of commercial new construction. The incentive program includes both a Systems Approach and a Whole-Building Approach. The Whole-Building Approach is not limited to any particular measures, but provides incentives based on reduced energy consumption relative to Title 24. This program component provides design assistance and building energy simulation modeling to help provide an optimized "whole-building" or integrated design. In addition to informing the design process, the simulation models are used to calculate the estimated total annual energy savings for the building compared to the Title 24 minimum requirements. The analysis can be prepared by the design team, or by an energy consultant provided by the utility, using an approved computer tool. DOE-2, eQUEST, Carrier HAP and Trane Trace are examples of computer tools approved for use by the program. The whole building results are illustrated in the following tables (see also Appendix L).

4.1 Savings Results

Table 4-1 below shows the calculated ex-post gross energy savings[20], error bound, and relative precision for the utilities PG&E, SDG&E, and SCE for the Whole Building High Impact Measure. SCG claimed no electric savings as part of its program.

Table 4-1 : Whole Building Ex-post Gross Energy Savings

	Ex-Post Gross Energy Savings (MWh)	Error Bound	Relative Precision
PGE	**33,755**	**2,553**	**7.6%**
SDGE	**6,861**	**482**	**7.0%**
SCE	**31,525**	**4,015**	**12.7%**
Total	**72,140**	**4.782**	**6.6%**

Table 4-2 below shows ex-post gross peak demand reduction as well as error bound and relative precision calculated at the utility level. Again SCG claimed no electric savings as part of its program.

Table 4-2 Whole Building Ex-post Gross Peak Demand Reduction

	Ex-Post Gross Energy Savings (MW)	Error Bound	Relative Precision
PGE	6.2	1.3	21.0%
SDGE	1.4	0.2	12.1%
SCE	5.3	0.8	15.1%
Total	13.0	1.5	11.9%

[20] During the QC period, KEMA discovered a problem with the Whole Building analysis software code that was causing the net results were overwritten with the gross building estimates. KEMA corrected the problem with the software and the ex-post net savings for all the utilities results presented in this report are updated from those included in the draft evaluation report.

Table 4-3 below shows the ex-post gross therm savings as well as error bound and relative precision calculated at the utility level.

Table 4-3 Whole Building Ex-post Gross Therm Savings

	Ex-Post Gross Energy Savings (therms)	Error Bound	Relative Precision
PGE	413,002	301,459	73.0%
SDGE	105,505	64,230	60.9%
SCE	10,794	22,542	208.8%
SCG	462	270	58.4%
Total	529,773	309,049	58.3%

Table 4-14 below shows the calculated ex-post net energy savings, error bound, and relative precision for the utilities PG&E, SDG&E, and SCE for the Whole Building High Impact Measure. High Impact Measures were not a separate analysis method but rather a subset of the already calculated results. In previous SBD studies results were reported for the Whole Building approach. The only difference is that for the 2006-08 program cycle, these results were labeled as a HIM. SCG claimed no electric savings as part of its program. The program influence for Whole Building projects was a big factor in the total net savings achievements.

Table 4-45 below shows ex-post net energy savings as well as error bound and relative precision calculated at the utility level. Again SCG claimed no electric savings as part of its program.

Table 4-4 : Whole Building Ex-post Net Energy Savings

	Ex-Post Net Energy Savings (MWh)	Error Bound	Relative Precision
PGE	20,805	3,721	17.9%
SDGE	4,349	544	12.5%
SCE	21,375	4,806	22.5%
Total	**46,529**	**6,102**	**13.1%**

Table 4-4 below shows ex-post net peak demand reduction as well as error bound and relative precision calculated at the utility level. Again SCG claimed no electric savings as part of its program.

Table 4-5 : Whole Building Ex-post Net Peak Demand Reduction

	Ex-Post Net Energy Savings (MW)	Error Bound	Relative Precision
PGE	3.8	0.8	20.1%
SDGE	0.8	0.1	18.8%
SCE	3.5	0.8	23.1%
Total	**8.1**	**1.1**	**13.9%**

Table 4-6 below shows ex-post net therm savings as well as error bound and relative precision calculated at the utility level.

Table 4-6 : Whole Building Ex-post Net Peak Therm Savings

	Ex-Post Net Energy Savings (therms)	Error Bound	Relative Precision
PGE	508,822	341,801	67.2%
SDGE	142,419	69,410	48.7%
SCE	12,027	24,860	206,7%
SCG	462	270	58.4%
Total	**663,729**	**528,514**	**79.6%**

5. Discussion of Findings and Recommendations: SBD

5.1 Judging Continuing Need for the Savings By Design Program

Many findings from this evaluation substantiate a continuing need for the Savings By Design Program. It continues to produce important gross savings, with a substantial portion of those savings being attributable to the program. The great majority of the measures promoted by the program were long-life, lost-opportunity measures that should continue to deliver energy savings for a long time to come. At the same time, many of the program's measures continue to be innovative and push the energy efficiency envelope, effectively preparing the NRNC market for future code changes. Nevertheless, there are measures that are now becoming standard practice, and the Evaluation Team would suggest that the utilities continue to refine the measures receiving incentives.

The Evaluation Team found that the net-to-gross ratios are in an acceptable range for most measures and for the SBD programs as a whole. However, the dominant role of the incentives in motivating the implementation of measures remains less certain. An emerging finding is that market actors participating in the program reported near-equal satisfaction with other aspects of the SBD program that were designed to increase energy savings at the project level and led to market transformation, such as the design analysis offerings.

The Evaluation Team also found that the participating building designers and owners gained valuable building science expertise through the program's design assistance and design analysis components, which might lead to future generations of energy efficiency infrastructure even without a NRNC program. Another significant finding was that the incentives offered by the program go further to encourage whole building design practice over 'systems' projects, aptly putting emphasis on the whole building integrated systems design philosophy.

5.2 Lessons Learned about Evaluating Programs that Employed Complex Building Models

The SBD sample frequently captured state-of-the-art buildings which had been designed based on complex building energy modeling. In these cases, the resources which were invested in this modeling far exceed the level of investment available for the evaluation model. Ideally, we would have used these ex ante models provided by the IOUs to save time and effort and provide comparisons, which would have transparent about the differences in the ex ante vs. ex post model results. Study resources would be more effectively utilized by accepting and revising the IOUs' design team model rather than creating a new energy model. However, in order to accomplish this task, the IOUs need to provide consistent models, or,at a minimum, complete documentation of the model inputs. We were faced with very different and often inadequate documentation to allow us to run the ex post, as built analysis on the same platform. Therefore, for future efficiencies and transparency, the IOUs should move toward a consistent modeling platform and clear documentation of inputs.

5.3 Lessons Learned about Evaluating Industrial Projects

Although the aggregate net-to-gross ratio of industrial projects improved since the previous program cycles, the Evaluation Team found that free-ridership was still prevalent in many industrial projects. Similar to previous years' evaluations, decision maker interviews uncovered industrial projects that would have been installed exactly the same absent program interaction including incentives. This was especially true of projects conceived "in-house" by the participants that were well developed before any interaction with SBD representatives and consultants, rather than being a result of interaction with Savings By Design. In many cases we found these particular participants to be highly aware of the trade-offs between energy efficient and baseline equipment, including the cost differences and payback between the two.

Ever since the beginning of Savings By Design, program representatives have been reluctant to claim peak demand reduction for VSD control measures for all applications, even in the case of non-weather dependent applications. Although this oversight is not as widespread as it was ten years ago, there are still some projects not claiming savings for VSD controls on non-weather dependent measures showing up in the evaluation sample. Depending on load shapes and schedules, non-weather dependent VSD measures reduce peak demand in most cases. We have also found that many weather dependent VSD measure actually do reduce peak demand in situations like those with oversized chillers. Consequently, the notion that VSD measures do not reduce peak demand should always be considered on a case by case basis.

5.4 Project File Information

In general, the project files that are submitted to the evaluation contractor are frequently deficient in one or more ways. There is large variation in the amount of information found in a project file, and there is little consistency across the utilities. A uniform checklist or a project file coversheet would be very helpful in the evaluation of these projects.

A project file may contain considerable detail about the initial set of calculations, but there is typically little or no detail for a savings for recalculations when utility field verification deviates from the project documentation. The evaluator is forced to "reverse engineer" the calculations to figure how the final savings were estimated, and this approach is not always successful. Likewise, the project files in general should be very clear about what design documents are actually referred to the completed project as-constructed, as opposed to documents that are only of historical interest due to project changes. An accompanying data CD with the savings models or spreadsheet calculations used by the utility would also be helpful.

The self-reported net savings methodology, more accurately net-of-free-ridership, relies upon interviews with participant decision-makers. The evaluators realized this was a critical component and went to great lengths to find the most qualified survey respondent, typically the owner or the owner's representative that was present and involved when the measure implementation decisions were made. However, determining and locating the decision-maker was not always easy. Often, the project file gave "site contact" contact information of an individual or individuals which might or might not have been the decision-maker. The evaluator had to determine whether this person was the best one to answer the questions, often through administration of the decision-maker survey.

Therefore, when site contacts presented themselves as decision-makers and answered the survey without hesitation, their answers to the survey were used to produce the net savings results. Additionally, in many cases, decision-makers were no longer with the company. By the time evaluators had come to assess the project within this program cycle, 31 decision-makers had left their respective companies. For these 31 projects, evaluators were faced with either locating an alternate owner-level decision-maker or attempting to find the primary decision-maker as referenced in the program file at their current place of employment (or in their retirement) or settling for the second best person to respond to the survey. None of these situations were desirable. Furthermore, chasing down a decision-maker that had moved on was quite onerous and, at times, impossible. Additional challenges that were present were the competing ideas among the design team members and the owner's representative respondents on the level of program influence. Design team members often dismissed the programs' impacts and assumed the customers would have adopted the measures regardless because they (design-team) recommended them or because of the long term savings associated with high efficiency measures as opposed to standard performance measures. Design team members were not always aware of the financial constraints of the project and whether or not the customers could afford the increased first costs regardless of the program incentive.

However, if project decision makers were clearly identified in the project file and/or project database, the effort of identifying project decision-makers could have been avoided. Within this program cycle there was even less contact information than from the prior program evaluations. It was unacceptable to not include the very contact information that program administrators relied on themselves. Additionally, the best respondent for the survey was approached first and the evaluation team was not be "duped" by anyone presenting themselves as more involved with the project than they actually were. Ideally, each project would have had all of the owner-side decision-makers identified, and they would have been ranked by their knowledge of the project. Furthermore, if a means of locating the decision-makers once they had moved on from their present positions were obtained, such as personal email and telephone numbers, evaluators reduced their need to rely on the "best person left" to complete the all-important survey. For instance, if the primary source of communication was via email, the tracking data included the customers email. At a minimum all decision-maker contacts should contain the name, position within the company, direct telephone number with extension, alternate telephone number, email, and company website when available.

Likewise, a short summary of utility and/or Program influence on the project in the project file would have been very helpful to evaluate Program free-ridership. The summary could be very brief and document the point of the project cycle where interaction began, who was engaged and the basic nature of the influence, such as the following:

- First suggested measure(s) under consideration
- Provided testimonial support of measure success/effectiveness of measure(s) under consideration
- Incentives made measure(s) cost-effective
- Other influences

This type of documentation forces some level of self-assessment on the part of the Program with regards to free-ridership to the representative level. With a big focus on program savings goals, there exists an incentive to pull projects that have little or no Program influence. In the documentation of Program influence, the representative will have to confront the issue head on and not let the distraction of project processing activities allow avoidance of the issue. The summary of Program influence could be a very important mnemonic device for projects where the decisions were made several years ago and memories have gone hazy. This summary could be referenced during the decision-maker survey to help remind the decision-maker of Program activities they may have forgotten in the interim period. With the long project cycles of non-residential new construction, any "bridge to the past" could assist the accuracy of the evaluation. The current decision-maker survey relies on warm-up questions to "bring the decision-maker's head back to the design table." The effect of bringing names, dates, locations, and conversations into the discussion should only help recall.