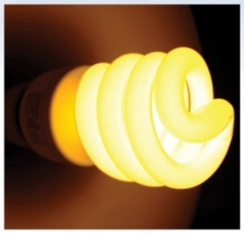

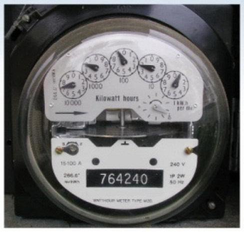

Home Energy Solutions Evaluation

Final Report

Submitted By Nexant

To Connecticut Energy Efficiency Board

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Nexant

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CONTENTS

In 2009, Nexant was retained by the Connecticut Energy Efficiency Board (EEB) to conduct an impact evaluation of the 2008 Home Energy Solutions (HES) program as provided by the United Illuminating Company (UI), Connecticut Light and Power Company (CL&P), Yankee Gas Services (Yankee), the Southern Connecticut Gas Company (SCG), and the Connecticut Natural Gas Company (CNG). This report contains findings regarding the program's impact, including electrical demand and energy savings, natural gas savings, and an assessment of the comprehensiveness of the program.

OVERVIEW OF HOME ENERGY SOLUTIONS PROGRAM

The HES program is designed to reduce total energy use and electric system peak demand in existing homes, in addition to reducing natural gas usage in participant's homes utilizing fossil fuels. Phase 1 of the program provides direct installation of efficiency measures in residences, while Phase 2 offers participants rebates for implementation of additional high efficiency measures. The 2008 program year had 9,107 Phase 1 participants, resulting in calculated gross energy savings of 10,936,625 kWh and 39,649 MMBtu, along with summer and winter peak demand reductions of 2,859 kW and 2,003 kW, respectively. 2008 HES Phase 2 participation included 1,182 customers who took advantage of appliance and home insulation rebates resulting in a calculated gross energy savings of 415,238 kWh and 1,526 MMBtu.

EVALUATION OBJECTIVES

The specific goals of this evaluation are:

- Estimate the program's gross energy savings for electric and gas measures
- Estimate total, peak seasonal, and extreme seasonal demand savings
- Estimate Net Savings
- Affirm or improve the 2010 Program Savings Document (PSD) as informed by the results of this study
- Assess program comprehensiveness

This evaluation is based on (1) detailed on-site examination of a sample of forty-two (42) Phase 1 projects that were selected using statistical sampling techniques and expanded to represent the 2008 population of HES projects, (2) statistical analysis of the monthly utility bills of 300 participants and a pre-program consumption-matched sample of 300 non-participants to isolate program from non-program impacts, and (3) results of surveys conducted with both participants and installers. Excluding central air conditioning rebates, which were not part of this study, Phase 2 measures account for less than 5% of the 2008 HES program claimed savings. No identified Phase 2 customers agreed to participate in this study; therefore, Phase 2 impacts are not included. The methodology used to accomplish each evaluation objective can be found in Section 2 and a summary of all evaluation methodologies can be found in Table 2-2.

RATIONALE FOR EVALUATION METHODOLOGY

This study employs an Engineering-Adjusted Billing Analysis (EABA) to assess net savings. The EABA incorporates the results of two other processes – site visits with metering and engineering modeling (Engineering) – along with a statistical analysis of billing-measured usage into a unified construct that provides estimates of net program savings. The results of the interim steps are also provided.

The Gross Savings Engineering assessment is the most comparable measure to the savings estimated by the Companies through the PSD. It therefore allows for a side-by-side comparison about expected gross savings with what was found and measured in the participant homes. Similar comparison can be made across various programs. The gross impacts study describes the savings associated with the *measures* installed. These are the savings that the participating customers see reflected in their energy bills. However, it cannot fully represent the savings caused by the program, because it doesn't include measurements of what participating customers would have consumed/saved even without the HES program (due to free-ridership or other cost-reducing behaviors). Without the program, they may still have installed CFLs or purchased new appliances, or lowered their thermostats, and so on. In fact many of their neighbors did so without participating in and perhaps without knowing about the existence of HES.

The Engineering adjusted Billing Analysis was conducted to measure program impacts net of these other influences. The results of the study reflect the savings that the *program* caused. For this study, the Sponsors decided to use existing free-ridership and persistence figures and thereby created a shortcoming to the Engineering Adjusted Billing Analysis. The final results do not reflect any influence the program had on non-participants. Some of the neighbors discussed above made some of their decisions because they had heard about CFLs, caulking, etc from the HES program. Their decisions might reflect all kinds of other things such as national promotions or advertising unrelated to Connecticut's programs. The existing data on free-ridership and persistence does not include any measure of the program impacts on non-participants the relative size of program vs non-program impacts in the Control Group is unknowable within the context of this study. All we know is that net savings may be somewhat understated if there is more spillover than free ridership. None-the-less, the EABA approach does produce a reasonable net savings estimate.

Throughout this document, results of the EABA net impact study and the Engineering gross impact study are presented. Neither piece supplies a full picture of the savings associated with the HES program. Separately each has its strengths. Together, reliable results to estimate the impacts of both measure installations and program intervention can be assessed.[1]

[1] Engineering Adjusted Billing Analysis is not always appropriate. The selection of this methodology for the HES study makes sense because HES program participants are fairly homogenous and the types of measures installed are likewise homogenous. These two characteristics are prerequisite for any whole-program use of EABA. For other programs, one participant facility and the measures incorporated in it may have little if any similarity to those of any other participant. In these cases statistical approaches may be far less efficient.

KEY FINDINGS

Gross Program Impact

Table E.1-1 summarizes the HES Phase 1 gross calculated savings and the Phase 1 gross measured savings determined through this evaluation. Results are presented for the program as a whole with accompanying realization rates. Details on the contributions of specific measures to the total program impact are described in Section 3.

Table E.1-1 2008 HES Program Phase 1 Gross Impacts Summary

Metric	kWh	MMBtu	Summer Peak kW	Winter Peak kW
HES Claimed Savings	10,936,625	39,649	2,859	2,003[1]
Realization Rate	97.6%	107.5%	83.4%	91.9%
Relative Precision (80% Confidence)	±5.1%	± 45.4%[2]	±16.7%	± 5.6%
Gross Measured Savings	10,679,399	42,614	2,385	1,841[1]

1 Savings only for CL&P. No values reported by other utilities.

2 The sample for this study was based on electric savings only; as a result the 42 samples did not include adequate gas savings measures to achieve a high relative precision at 80% confidence.

The evaluation study concluded that Phase 1 of the 2008 HES program resulted in 10,679,399 kWh gross annual energy savings and 2,385 kW gross summer peak demand savings compared to 10,936,625 kWh annual energy savings and 2,859 kW summer peak demand savings claimed by the program. These results do not incorporate the influences of factors such as spillover, free ridership or other general conditions affecting the residential customers as a whole, such as the declining economy. The respective gross realization rates for electrical energy (kWh) and summer peak demand are 97.6% and 83.4% with relative statistical precision of ±5.1% and ±16.7% at 80% confidence. Phase 1 of the 2008 HES program also resulted in 42,614 MMBtu of gross natural gas savings compared to 39,649 MMBtu claimed by the program. Finally, 1,841 kW of winter peak demand savings were achieved by CL&P Phase 1 HES participants in 2008 compared to 2,003 kW winter peak demand savings claimed by the program. UI did not claim winter peak kW savings for the measures installed in 2008.

Engineering Adjusted Billing Analysis Study

An Engineering Adjusted Billing Analysis was conducted to quantify program savings net of the effects of non program impacts, such as economic conditions, load changes and market effects. The results of the billing study were used to understand the effects of non program impacts and have no influence on the gross measured program impacts or gross realization rates. In Section 2.2: Billing Analysis Study, further details on the engineering adjusted billing analysis methodology can be found. Figure 2.1 presents a schematic of the billing analysis study parameters.

The billing analysis showed that both participants and non-participants reduced their energy usage from 2007 to 2009, evidenced in Table 4-1 and Table 4-2. Results show that homeowners in general have become more energy conscious and have reduced their energy consumption. However, participants in the HES program achieved a higher level of energy savings as compared to their non-participant peers.

The billing analysis study was used to calculate a metric called the Control Group Ratio (CGR) which is used to represent the portion of change in energy use for participants between the baseline and retrofit years that is attributable to measure installations by the program. The CGR was calculated by home heating fuel type and the results can be found in Table E.1-2.

Table E.1-2 Billing Analysis Control Group Ratio

	Control Group Savings (CGS) (average per home)		Control Group Ratio (CGR)	
Heating Fuel	kWh	MMBtu	%	%
Gas	572	3.0	66.8%	51.8%
Electric	1,108		57.6%	
Oil & Other	403		32.4%	

The results present CGR's ranging from 32.4% (Oil &Other heated homes) to 66.8% (Gas heated homes). Note that the CGR quantifies non program impacts including customer behavior, effects of economic conditions, load changes and other market effects like spillover and snapback. The market effects including inside spillover and snapback are collectively included in the CGR results and cannot be disaggregated from the non-program. The disaggregation would be necessary to use these results to calculate net savings; otherwise positive changes in non-participant behavior that were caused by the program (e.g. spillover effects) would inappropriately reduce savings estimates.

In order to calculate the Engineering Adjusted Billing Analysis net realization rates, the home heat fuel specific CGR's presented in Table E.1-2 were applied to the gross realization rates shown in Table E.1-1 (or by specific measure in Table 4-4). The results are shown in Table E.1-3 with the associated program net savings.

Table E.1-3 Engineering Adjusted Billing Analysis Net Program Level Savings

Unit	HES Claimed Savings	CGR Adjusted Net Realization Rate	CGR Adjusted Net Savings
MMBtu	39,649	55.6%	22,058
kWh	10,936,625	57.4%	6,272,195

A complete description of the Engineering Adjusted Billing Analysis and discussion of how it relates to the Gross Impacts study is presented in Section 4.

Program Savings Document (PSD) Review

The PSD calculation approach for all Phase 1 measures (CFLs, pipe insulation, water measures, infiltration reduction testing) studied in association with this evaluation was examined. The calculation methodologies, as presented in the PSD for CFLs and infiltration measures, are appropriate as presented. However, changes in calculation methodologies for other measures are recommended. For pipe insulation, Nexant recommends an alternative method for calculating pipe insulation savings. For water measures, Nexant recommends incorporating water usage metrics from industry-accepted sources. Details are presented in Section 5.

Program Comprehensiveness and Participant Satisfaction

The on-site inspections revealed that measures indicated in project documents generally matched what was found in the field, and that contractor execution was comprehensive and thorough. However, information gathered during on-site inspections and contractor interviews indicated that program constraints (caps) prevented cost-effective savings from being attained. In general, most customers reported a high level of satisfaction with the HES program. On a scale of one to five, with one representing ‘not satisfied’ and five representing ‘completely satisfied’, the average response was 3.9. Details can be found in Section 6.

Contractor Surveys

Telephone surveys were administered to a total of seven contractors that agreed to have a discussion regarding their HES participation. The general opinion of the contractors was that the HES program does a good job of achieving savings through cost-effective measures, but they all agreed that more opportunities to save energy exist at all homes. Contractors had constructive comments on how program improvements could be achieved, including feedback regarding program measures, non-program measures, program-imposed limits, and compensation structure. Details can be found in Section 6.

Recommendations

Based on the general findings presented above, Nexant recommends the following changes to the HES program:

- Develop a well-organized enterprise relational database system at CL&P and Yankee Gas that more cleanly links gas and electric account data.
- Create a consistent database system for all HES program administrators that allow the HES participant records from multiple companies to be compiled easily.
- Marketing of the HES program should be redirected to attract a greater quantity of casual, less energy-conscious participants. HES marketing material should include more non-energy benefits such as better air quality, greater occupant comfort and more even temperature distribution. This would result in greater savings per home and more cost effective site-visits.
- Estimates of recommended Phase 2 energy savings (in dollars) per measure should be included in marketing literature.

- The program caps placed on CFLs in the UI HES program should be removed in order to capture the missed savings opportunities observed during home inspections.
- The program caps placed on air sealing should be removed and replaced with a cap that considers both CFM improvement and ACH50. Contractors should be incentivized for CFM improvement on a $/CFM basis, without limit, up to an ACH50 value of 10 which corresponds to LBL[2] leakage Class F. Details can be found in Section 6.1.2.
- An incentive premium should be offered to contractors for self-generated leads.
- To promote greater participation in Phase 2 offerings, contractors should be encouraged to follow up with homeowners approximately one month following the on-site assessment.
- The application deadlines on Phase 2 offerings should be extended, to allow homeowners additional time to plan for large expenditures in their budgets.
- The PSD savings calculations for pipe insulation and water measures should be revised according to the suggestions in Section 5.2 and 5.3.
- Measures that achieve natural gas savings should be evaluated separately using an on-site inspection sample based on gas savings so that their impacts can be reported with better statistical precision.
- Future evaluation studies should include a Net-to-Gross study to quantify market effects including free-ridership, spillover and snapback to better isolate the effects of non program impacts like economic price fluctuations and load changes.
- Phase 2 measures should be studied using an independent, statistically valid, home inspection sample.

[2] http://epb.lbl.gov/publications/lbl-35173.pdf: Lawrence Berkeley Laboratory, “The Use of Blower Door Data”, March, 1998.

This report evaluates the performance of the HES program for Program Year (PY) 2008. This section provides background information on the HES program and the specific objectives of the evaluation.

1.1 HES PROGRAM

The HES program is designed to reduce both electric and natural gas energy use in existing homes through direct measure installation and rebates for additional equipment. Direct-install measures include lighting retrofits, water fixture retrofits, and weatherization measures. Measures for which customer rebates are offered include appliance replacement and building envelope upgrades, particularly insulation, doors, and windows.

1.1.1 Overview

The two phases of the HES program are described below:

FIRST PHASE: Assessment and Direct Installation

- On-site opportunity assessment
- Customer-specific energy recommendations
- Direct installation of identified opportunities
    - Air leak sealing and duct sealing
    - Lighting retrofits
    - Water fixture retrofits
    - Pipe insulation
- Recommendations for additional measures and appliance replacements for which rebates are available

SECOND PHASE: Customer Rebates for Purchases of Capital Items

- Appliance replacement
    - Refrigerators
    - Dishwashers
    - Clothes washers
    - Water heaters
- Insulation upgrades
- Door and window replacement
- Power Cost Monitors and TOU Education

In the first phase of the HES program, an energy assessment is performed at each house, including a blower-door test to identify drafts and air leaks. Some opportunities for energy savings identified during the assessment are installed directly with the homeowner's consent. Incandescent light bulbs are replaced with compact fluorescent (CFL) bulbs. Low-flow water fixtures are installed on sink faucets and shower heads. Air leaks are eliminated by direct installation of caulking, weather-stripping and other air sealing techniques. Duct passages are also assessed using duct blasting tests, and sealed.

During the energy assessment, the customer is also informed of additional opportunities for which rebates are available under the second phase of the HES program. Phase 2 seeks to promote and inform customers about rebates for heating, cooling, and appliance upgrades and to provide education to reduce energy consumption.

1.1.2 Delivery

CL&P and UI provide the framework and funding for the program, while "implementation contractors" execute the program's two phases. Local energy services companies and fuel oil dealers act as implementation contractors.

In general, the program is conducted as follows:

- **Customer contact.** Customers are enlisted in the program through letters, utility bill inserts, cold calling, or door-to-door marketing. In many cases, customers directly contact either the utility or implementation contractor after learning about the program through word-of-mouth. Utilities also distribute leads to HES implementation contractors.
- **On-site assessment.** The implementation contractor performs an assessment, installs appropriate Phase 1 measures, and introduces and suggests appropriate Phase 2 energy savings opportunities. The customer is educated about the potential upgrades and the associated energy benefits.
- **Work order form.** All installed Phase 1 measures are recorded on HES work order forms. The customer provides a signature to verify that all information is accurate, and a copy is distributed to utilities for program tracking.
- **Phase 2 participation.** If the customer decides to install suggested Phase 2 measures, he or she may arrange installation with the implementation contractor or use rebates to make the equipment purchase from another vendor.

HES program staff interacts with implementation contractors through regular meetings and letters outlining program updates or changes.

1.1.3 2008 Participation

In 2008, the HES program was delivered by numerous implementation contractors. The efforts of these contractors resulted in Phase 1 upgrades in a total of 9,107homes. The projects were primarily CFL lighting retrofits and air sealing upgrades, though water conservation and pipe insulation measures were also installed. Table 1-1 shows the number of Phase 1 and Phase 2 participants in the 2008 program year.

Table 1-1 2008 HES Quantity of Participants

	CL&P	UI
Phase 1 Participants	6,768	2,339
Phase 2 Participants: *Appliance Rebates*	830	137
Phase 2 Participants: *Insulation*	141	74

The first phase had significantly higher participation than the second phase and therefore provides a large portion of the energy savings of the program. The 2008 program year had 9,107 Phase 1 participants, resulting in calculated gross energy savings of 10,936,625 kWh and 39,649 MMBtu. 2008 HES Phase 2 participation included 1,182 customers who took advantage of appliance and home insulation rebates resulting in a calculated gross energy savings of 415,238 kWh and 1,526 MMBtu.

1.2 EVALUATION GOALS AND OBJECTIVES

The goals of this evaluation are as follows:

- Estimate the program's gross energy and demand savings
  - Estimate annual electric and gas savings
  - Estimate savings occurring during peak consumption periods
  - Estimate savings associated with individual program measures and groups thereof
- Estimate total, peak season and extreme seasonal demand savings
- Examine participant savings net of temporal effects (such as economic changes or overall market effects).
- Affirm or improve the 2010 Program Savings Document (PSD) as informed by the results of this study
- Assess the degree to which the program realized all available savings opportunities.
- Assess Participant satisfaction

1.2.1 Estimation of Gross Savings

Gross impacts are the energy and demand savings that are found at a customer site as the result of measure implementation. Data collected during on-site assessments were used as inputs to engineering analyses to calculate gross impacts of HES-installed measures. The results of these analyses are compared to the savings attributed to each measure by the HES program using assumptions found in the PSD.

1.2.2 Engineering Adjusted Billing Analysis Study

When programs are implemented using rate payer funding, it is important to assess to what degree the savings or peak reduction result from the program efforts, isolated from the outside influences like changing economic conditions, increase in energy price values and general energy cost awareness among customers. For example, if a customer would have installed measures to reduce energy consumption without any assistance from the program, or the customer would have reduced annual energy use due to economic conditions and increased awareness, those savings should not be counted towards the savings achieved as a result of the direct intervention of the program. Net impacts can add to or subtract from a program's direct results.

The current study did not examine free-ridership, spillover or persistence explicitly. Instead, a statistical billing analysis study was conducted to provide a composite comparison between energy usage of program participants and similar non-participants before, during and after program participation.

1.2.3 PSD Review

The objectives of the PSD review are to assess all developed assumptions for each measure in the program and to make recommendations for revisions where appropriate. This review encompassed both results from this evaluation and vetted results from other studies in other jurisdictions.

1.2.4 Program Comprehensiveness Evaluation

This evaluation focuses on understanding and evaluating the level of completeness of measure installation. Possible reasons for incomplete installations include:

- The contractor may not have informed the customer of, recommended, or installed all eligible measures.
- The contractor may have reached program limits on the amount of sealing or CFLs allowed under program guidelines.
- The customer may have declined recommended measures for a variety of reasons.

Surveys of program participants were conducted to assess program comprehensiveness. Separate surveys were also conducted of installers. The surveys for both groups include questions to gauge satisfaction and gather general feedback.

The evaluation of the HES program involved two separate analyses: 1) A building inspection and measure metering impact evaluation to determine gross program realization rates by measure and 2) A billing analysis evaluation to determine net savings by comparing changes in energy use between program participants and non-participants. Gross impacts are the energy and demand savings that are found at a customer site as the direct result of a measure implementation. The billing analysis study sought to net out the effects of external behavioral influences like economic conditions and load changes.

2.1 GROSS SAVINGS ESTIMATION

Nexant engineers examined measure installations and conducted blower door tests to collect information on individual, installed program measures. These data became inputs in eQUEST® models and other engineering analyses. The results of the analyses were combined to produce savings estimations by measure, home heating fuel type, and Company providing the program.

2.1.1 Site Inspection and Data Validation

2.1.1.1 Sampling

ISO NE requires saving estimates at an 80% confidence interval with a 10% margin of error at the portfolio level. Nexant agreed that level of precision is a reasonable goal for an accurate and defensible evaluation of the HES program. These confidence and precision levels offer a balance between cost and rigor for a program of this size and the budget allocated to this study. The HES program is designed so that the energy measures to be implemented and/or recommended are limited and discrete, which minimizes variability among installations. Assuming a coefficient of variation of 0.5, a sample size of 41 homes was determined to meet the desired precision. The sample population was split between the utilities based on a ratio estimation approach, by using the weighted proportion of the program-estimated electrical demand savings in each Company's territory (32homes for CL&P, 9 homes for UI).

A total sample of 160 program participants was drawn from the project database, to account for potential obstacles in performing site visits, such as unwilling participants and scheduling difficulties. Also, for a home to remain in the evaluation, its energy consumption profile must have remained relatively stable since participation in the HES program (e.g. installation of solar panels would eliminate the home). This was only found in two of the sampled participants.

Contact letters were mailed to 160 program participants, including 17 Phase 2 participants. However, Nexant was unable to recruit any Phase 2 participants. The contact letter noted that the visit would take up to 2 hours to investigate all measures and would include a blower door test. Fifty dollar incentive checks were offered to any homeowner agreeing to the on-site inspection. Follow-up phone calls were made to schedule appointments.

2.1.1.2 Gross Savings Data

For the calculation of gross savings, site inspectors gathered information on baseline and retrofit equipment, as well as actual operating conditions. Data gathered at all residences for the measures installed under HES is described in Table 2-1. A complete copy of the data collection tool is provided in Appendix B.

Table 2-1 On-site Inspection Information

Measure	Baseline Information	Retrofit Information
Lighting Measures	Baseline Lamp Type # of Lamps per Fixture Wattage per Lamp[1] Location of Lamp Fixture Quantity # of Operating Hours	Retrofit Lamp Type # of Lamps per Fixture Wattage per Lamp Location of Lamp Fixture Quantity # of Operating Hours
Pipe Insulation	Baseline Tank Size Confirm No Jacket/Pipe Water Heater Fuel Type Heater Setpoint Length of Un-insulated Pipe Pipe Diameter Basement Ambient Temperature (assumed)	Retrofit Tank Size Jacket/Pipe Insulation and Type Water Heater Fuel Type Heater Setpoint Length of Insulated Pipe Pipe Diameter Basement Ambient Temperature
Water Fixture Measures – Showerhead Retrofit	# of Showers per Day Length of Showers Showerhead flow rate (GPM) [2]	# of Showers per Day Length of Showers Showerhead rated flow rate (GPM)
Water Fixture Measures – Faucet Aerator Retrofit	Frequency of sink usage Duration of sink usage Faucet flow rate (GPM)[3]	Frequency of sink usage Duration of sink usage Faucet flow rate (GPM)
Infiltration Measures	Infiltration rate (CFM)[4] HVAC equipment Water heating equipment Occupancy schedules Internal loads (electric stoves, clothes dryers, televisions, other electronic devices)	Infiltration rate (CFM)[5] HVAC equipment Water heating equipment Occupancy schedules Internal loads (electric stoves, clothes dryers, televisions, other electronic devices)

[1]This baseline bulb wattages could not be gathered on a consistent basis, so the HES program savings document wattage ratio of 3.4 to 1 (look-up table) was used for the baseline wattage for all homes
[2]Baseline flowrate assumed to be 3.5 GPM if pre-retrofit showerhead was not available.
[3]Baseline flowrate assumed to be 2.2 GPM (federal standard) if pre-retrofit aerator was not available.
[4]Taken from blower-door test administered during the initial on-site assessment
[5]Taken from blower-door test administered during the evaluation on-site inspection

2.1.2 Data Analysis

For less complex measures such as lighting, pipe insulation, and water measures, stipulated engineering algorithms were used to calculate the measure-specific gross savings. The algorithms produced demand and energy savings by utilizing site-specific data collected during the site visits, project documentation, and industry literature. The data gathered during home inspections allowed accurate inputs to be used for measure specific, home-by-home engineering calculations. For less complex measures, gross electrical peak demand savings and typical gas peak day (and extreme peak day) savings were calculated by applying coincidence factors to connected electrical demand reduction, annual electric energy savings, or gas savings. For summer and winter electrical demand savings, the seasonal peak is determined by the NE-ISO definition as follows:

- The seasonal peak is defined as non-holiday week days when the Real-Time System Hourly Load is equal to or greater than 90% of the most recent "50/50" System Peak Load Forecast for the summer season. The summer on-peak period is defined as 1:00PM – 5:00PM non-holiday weekdays in June, July and August. The winter on-peak period is defined as 5:00 – 7:00PM non-holiday weekdays in December and January.

The typical gas peak day and extreme gas peak day are defined as follows:

- Typical Peak Day – 30 year average coldest day
- Extreme Peak Day – coldest day over the last 30 years

A more complex engineering analysis was performed for energy savings from reduced infiltration, using eQUEST building energy simulation models.

Gross electrical peak demand savings due to infiltration measures were extracted directly from the hourly simulation results produced by eQUEST. Typical peak day and extreme peak day gross gas savings due to infiltration measures were calculated by applying space heating-specific gas peak factors (typical peak day and extreme peak day) to annual gas savings predicted by the simulation.

The following subsections explain the engineering algorithms used to calculate gross savings for the lighting, pipe insulation and water measures. Detailed explanation of the eQUEST modeling used for infiltration measures in available in Appendix D.

2.1.2.1 Lighting

The summer and winter on-peak demand savings calculation algorithm is shown in Equation **2-1**.

Equation 2-1 $$Seasonal\ Peak\ kW\ savings = \Delta Watts * CF$$

Where:

ΔWatts = Wattage reduction from retrofitting incandescent bulbs with CFL. Baseline Wattage taken from incandescent-to-CFL ratio of 3.4[3]

[3] 2008 HES PSD

CF = Summer or Winter on-peak coincident factor[4]

The annual energy savings for lighting measures were calculated using Equation 2-2.

Equation 2-2 $$Annual\ kWh\ savings = \Delta Watts * 2.6 \frac{\boldsymbol{hours}}{\boldsymbol{day}} * 365 \frac{\boldsymbol{days}}{\boldsymbol{year}}$$

Where:

ΔWatts = Same definition as Equation 2-1

2.6 hours/day = Average hours per day operation across all room types in residential homes[5]

2.1.2.2 Pipe Insulation

Pipe insulation measure savings were calculated using the *3E Plus* insulation thickness model[6]. Equation 2-3 was used to calculate pipe insulation savings.

Equation 2-3 $$\boldsymbol{Btu\ savings} = \frac{\boldsymbol{Btu\ savings\ per\ time\ per\ length}\left(\frac{\boldsymbol{btu}}{\boldsymbol{hr*ft}}\right)*\boldsymbol{length(ft)}*\boldsymbol{time(hr)}}{\boldsymbol{Efficiency\ of\ hot\ water\ production\ unit}\ (\boldsymbol{\eta})}$$

Where:

Btu savings per time per length = the heat loss rate difference between a bare pipe and an insulated pipe predicted by the *3E Plus* software using home-specific inputs (pipe diameter, pipe material, pipe orientation, insulation type, insulation thickness, hot water set-point and ambient temperature in the basement). A custom jacket material was created with zero emittance to simulate no jacket material so the effect of the obligatory jacket material that 3E Plus requires can be considered negligible.

Time (hr) = 8,760 hours

length (ft) = length of pipe insulation verified on-site

The energy savings rate (Btu/hr/ft) produced by the *3E Plus* software was calculated using a specified hot water temperature of 90°F which is the average between the hot water tank set-point (120°F) and the ambient unconditioned basement air temperature of 60°F. This average hot water temperature used in conjunction with 8,760 hours was used as an approximation rather than attempting to model the quantity of instances where hot water is requested and the savings associated with distance from the hot water heater over time.

The calculation in Equation 2-3 was applied to both natural gas and electric hot water heaters using the conversion 3,412 Btu/kWh and also using the appropriate efficiency of the hot water heater.

[4]Coincidence Factor Study Residential and Commercial Industrial Lighting Measures by RLW, Spring 2007

[5]Northeast Utilities and United Illuminating Retail/Point of Purchase Lighting Program Impact Evaluation, RLW Analytics, April 2003 (2008 HES PSD)

[6]*3E Plus Insulation Thickness Computer Program*. North American Insulation Manufacturers Association.<http://www.pipeinsulation.org>

Typical peak day gas savings were calculated using Equation 2-4.

Equation 2-4 $$\textbf{Peak Gas Savings} = \textbf{Annual Btu savings} * \textbf{Peak gas factor}$$

Where:

Peak gas factor = 0.00310[7] for typical peak day

For pipe insulation measures, extreme peak day savings will be equivalent to typical peak day savings because the supply water (ground water or city water) temperature is equivalent on a typical peak day and extreme peak day.

Electrical peak demand savings for pipe insulation measures were calculated using Equation 2-5.

Equation 2-5 $$\textbf{Peak demand savings} = \textbf{Annual kWh savings} * \textbf{Seasonal Peak CF}$$

Where:

Seasonal Peak CF = 0.0944 W/kWh Summer; 0.1389 W/kWh Winter[8]

2.1.2.3 Water Measures

Water measures consisted of low-flow showerheads and faucet aerators. Equation 2-6 was used to calculate energy savings due to installation of low flow showerheads:

Equation 2-6 $$\textbf{Btu savings} = \frac{\left(\frac{min}{day}\right)\left(\frac{days}{year}\right)\left(\Delta\frac{gal}{min}\right)\left(\frac{lb}{gal}\right)\left(\frac{Btu}{lb*°F}\right)(\Delta°F)}{\textbf{Efficiency of hot water production unit }(\eta)}$$

Where:

$\frac{min}{day}$ = minutes per day usage[9]

$\Delta\frac{gal}{min}$ = difference between baseline showerhead flowrate and low-flow showerhead flow rate

$\frac{lb}{gal}$ = 8.31; density of water

$\frac{Btu}{lb*°F}$ = 1.0; specific heat of water

$\Delta°F$ = difference in temperature of domestic hot water tank set-point and cold water supply

Although minutes per day usage was gathered through interview with participants, the results are not extrapolated across all participants since the data was based on subjective responses (opinion) and not metered data. Also, the 22 homes in this evaluation that contained water measures were

[7] 2010 PSD Table 1.1.3
[8] 2010 PSD Section 6.2.3 : Pipe Insulation
[9] Table 3, LBNL-35475, "The effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detailed End-use Treatment", May 1994

not sampled to be representative of the entire HES population. The literature source from the 2008 PSD[9] is used to specify the minutes per day use in Equation 2-6.

Typical peak day (and extreme peak day) gross gas savings and electrical demand peak savings for low flow water measures were calculated in the same manner as for pipe insulation seen in Equation 2-4 and Equation 2-5.

2.1.2.4 Modeling analysis – Infiltration measures

Models were developed for each inspected home using eQUEST to calculate savings due to the infiltration measures. A generic model was created with consistent universal characteristics (wall construction, roof construction, window U-factors, window to wall area, etc.) across all customer types. Baseline and post-retrofit models were tailored to each specific home, based on observations from the site visit as outlined in Table 2-1. Baseline models were calibrated to within 5% of 2007 utility records for annual electric and gas (if applicable) consumption of each home, using lighting W/ft^2, appliance loads, home electronics loads, and occupancy loads. Other HES sponsored equipment installations (i.e. lighting, pipe insulation, etc) were not modeled in order for the model to capture only the energy savings due to the infiltration measures. For the retrofit simulation, only the infiltration CFM was adjusted. Model details can be found in Appendix D.1.

The annual gross energy savings and annual gas savings associated with the infiltration measures were calculated as the difference between the baseline and retrofit simulation results for each home. Gross electric peak demand savings due to infiltration measures were extracted directly from the peak period of eQUEST hourly simulation results.

Typical peak day and extreme peak day gross gas savings due to infiltration measures were calculated by applying space heating-specific gas peak factors (typical peak day and extreme peak day) to annual gas savings predicted by the simulation. For the typical peak day, a gas factor of 0.00977[10] was used. For extreme peak day savings, Nexant calculated an extreme gas peak factor by dividing the heating degree days (68) associated with the coldest day (-21°F low, 15°F high, -3°F average) over the last 30 years by the average heating degree days (5,990) over that same time period for Bradley Airport in Windsor Locks, CT. The resulting extreme peak day gas factor is 0.0114. The methodology used is consistent with the 2010 PSD for calculation of the typical peak day factor.

2.1.3 Realization Rate

The gross realization rate reflects the portion of program claimed savings that are actually achieved by the customer, as measured by the evaluation study. As described above, Nexant sampled a portion of the 2008 projects and independently calculated the savings for each project, based on information gathered during on-site inspections. The realization rate was calculated by dividing Nexant's measured gross savings value by the respective project savings as reported by the Company. Note that the realization rate is a function of the engineering analysis only and does not

[10] 2010 PSD Table 1.1.3

take in to account any findings obtained from the billing analysis study. Gross realization rates are calculated for specific measures, as well as for the program as a whole.

The overall program realization rate (calculated as a weighted average of all projects and measures) was then applied to the entire population of savings. Equation 2-7 shows the basic formula for calculating gross measured savings.

Equation 2-7 $Savings_{meas} = Savings_{calc} \times Realization\ Rate$

Where:

Savings$_{meas}$	=	Gross savings measured by Nexant for the program
Savings$_{calc}$	=	Gross savings calculated for the program, as calculated using PSD data
Realization Rate	=	Averaged $Savings_{meas}$/$Savings_{calc}$ for each sample project

A realization rate of 1.0 occurs when the measured savings were equivalent to the savings calculated by the program. Realization rates greater or less than 1.0 indicates that actual operating conditions, equipment installation, and/or baseline conditions were greater than or less then (respectively) the assumptions in the PSD.

2.2 BILLING ANALYSIS STUDY

A billing analysis study was performed to estimate net savings from the program as a whole. The billing analysis compared billing trends between program participants and non-participants to draw conclusions about consumer behavior in the current energy market. The results of the billing analysis study do not affect the gross measured savings or reported realization rates. The gross measured savings calculated through engineering analyses represent the savings realized through measure installation at participant homes. Non-program influences, such as changes in the economy and energy costs, affect customer behavior. To quantify the effect of outside influences, utility billing data from program participants and non-participants, both before and after program installation, were collected and comparatively analyzed using a regression based billing analysis. The results of billing analyses were used to determine the percentage of the impact that can be attributed to the HES program.

2.2.1 Control Group Ratio

Results from the billing analysis were used to calculate a control group ratio (CGR).The CGR can be used to isolate non program influences and study the effect of economic conditions on participant behavior. The methodology is presented below and the results can be found in Section 4.2.

While program participants are expected to display reduced energy consumption, non-participants may also adjust their energy consumption because of influences such as changes in the economy, employment status, the price of energy, or other factors. Comparing the energy consumption of a group of non-program participants during the same time periods shows the effects of conditions outside of the influence of the program. Program participants are equally likely to have been influenced by these external factors. Thus, if the change in energy consumption of participants is compared to changes in non-participants' energy consumption, the effects of non-program external influences can be separated from the effects of the program itself. Figure 2.1 is a schematic illustrating the control group ratio analysis method, using the non-participant data as a "control group". The calculation for the Impact Rate (IR), Control Group Savings (CGS) and the Control Group Ratio (CGR) can also be seen in Figure 2.1.

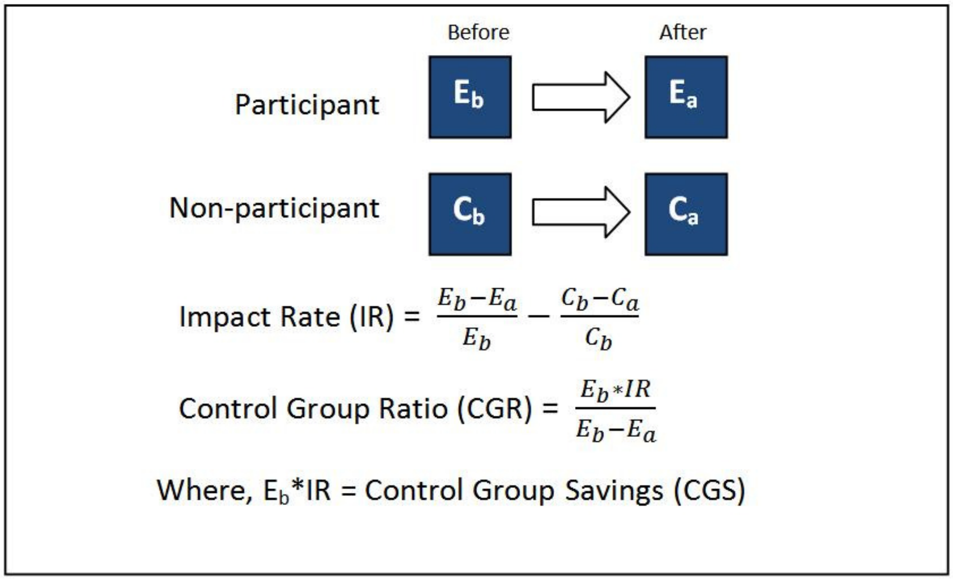


Figure 2.1 Control Group Impact Analysis Schematic

As noted in the figure, the Impact Rate (IR) of the program is equal to the energy savings rate of participants less the energy savings rate of non-participant. The Control Group Savings (CGS) is equal to the Impact Rate (IR) multiplied by the participant baseline energy consumption (E_b). Finally, the Control Group Ratio (CGR) is equal to the Control Group Savings (CGS) divided by the difference between pre and post program annual energy consumption (E_b-E_a). If savings are attributable to the program, then the value of the IR is positive. For instance, if the non-participant's consumption of electricity decreased by 3% and the participant's decreased by 9%, the net savings attributable to the program would be 6% of the sum of the participant's baseline year consumption. The resulting CGR would be 6% multiplied by the baseline year's consumption (E_b) divided by the difference between pre and post program annual energy consumption (E_b-E_a).

An assessment of the general energy climate was performed using the described billing analysis method. The billing analysis was conducted using a regression model to compare twelve months of pre and post-retrofit energy use for participants and non-participants, based on a control group method. A control group (non-participant group) of homes in the same area, experiencing the same weather and with similar pre-program energy consumption characteristics is a very robust and appropriate baseline. It reflects both the behavior and the market changes in a very similar group of homes.

The energy consumption from utility billing records for program participants and non-participants in the baseline year of 2007 and the post-retrofit year of 2009, across all three home heating fuel types was analyzed. The 2009 electricity and gas consumptions were normalized based on a weather regression of the 2007 electricity and gas consumptions. Cooling degree days or heating degree days were used as the independent variable, depending on the season, to calculate the relationship used to normalize the 2009 energy consumption. Details on the weather adjustments are described in Appendix E.

2.2.2 Utility Data Sampling

Assistance and input from CL&P and UI allowed the samples for participants and non-participants to be drawn using a single, uniform method. Both utilities were able to identify the home heating fuel type of non-participants, using billing rate identifiers and seasonal consumption thresholds. The goal was to have 100 participant homes and 100 non-participant homes in each of the 3 home heating fuel categories (600 homes total) from which to calculate savings. Out of the 100 homes in each home heating fuel category, 78 were from CL&P and 22 from UI, which was based on the weighted proportion of the program's estimated electrical demand savings in each Company's territory. A summary of actual account energy consumption quantities for the sampled homes can be found in Appendix E.

Twelve months of utility bills were collected for each home in the same zip code area, from each of the 2007 (pre-retrofit) and 2009 (post-retrofit) time periods. There were some challenges involved in determining the heating fuel type for non-participants since this characteristic is not tracked explicitly in the Company billing databases. The procedures used to identify home heating fuel type for non-participants can be found in Appendix E.

The gas billing analysis was conducted only for Yankee gas customer accounts since the utility billing records from SCG and CNG could not be obtained. The Yankee gas customer account profiles were assumed to be representative of all gas customers who participated in the HES program. The shortcoming did not affect the engineering impact analysis since the measure level gas savings for the HES participants in the on-site sample were available in the project records.

2.2.3 Company Monthly Billing Records

The companies provided electronic spreadsheets that contained monthly billing records of the sampled accounts during the 2007 to 2009 time period. CL&P provided monthly electric billing records as well as corresponding Yankee Gas monthly billing records for its customers and UI provided monthly electric billing records for its customers.

The CL&P and Yankee Gas billing database underwent a major overhaul in 2008 that required billing data to be combined from two different database systems. The earlier system, named C2, included data through March 2008 for Yankee Gas accounts and through September 2008 for CL&P electric accounts. Billing records more recent than the database system conversion dates were stored in the new database system, named Report Mart. Billing data was delivered to Nexant in separate spreadsheet files by year (2007, 2008, 2009) and energy type (kWh, CCF). An additional file was delivered that contained two unique identifiers, derived from meter numbers, to link data provided in one database system to the other and also between gas and electric accounts. The following protocol was used to assemble a single consumer bill usable for the billing analysis:

1. Obtain monthly electric data from 2007 legacy data system spreadsheet file. Ensure that consumption records exist for each month and that “bill from” and “bill to” dates span one month. Check for multiple meter readings within a single month or meter readings that span multiple months. Collapse or split these types of meter readings accordingly. Split percentages can be obtained using ratios in the corresponding months in 2008 or 2009 billing data, if available. Missing month’s meter readings can be accommodated with scaled 2008 data if available and can only be obtained for a maximum of one missing month. Accounts with more than one missing month in 2007 were eliminated from the billing analysis.
2. Use unique identifier provided to link 2007 legacy C2 electric data to 2008 and 2009 Report Mart electric data for the same account. Obtain monthly electric data from 2009 Report Mart data system spreadsheet file. Repeat step 1. Make adjustments as necessary.
3. Use unique identifier provided to link CL&P electric account to Yankee Gas account.
4. Obtain monthly gas data from 2007 legacy data system spreadsheet file. Repeat step 1. Make adjustments as necessary.
5. Obtain monthly gas data from the 2009 data system spreadsheet file. Repeat step 1. Make adjustments as necessary.
6. Billing records are now in suitable format for billing analysis.

Organizing the billing records for CL&P and Yankee Gas data presented several challenges that required each account’s monthly meter readings to be manually inspected. The three largest issues encountered were 1) Missing monthly readings, 2) Single months with multiple readings and 3) Meter readings that spanned multiple months. Each issue is discussed in greater detail below along with Nexant’s resolution strategy.

Meter readings for early 2007 months were missing for several accounts. In order to provide an estimate of the missing records, 2008 data was used and scaled if available.

Another issue was a single month that contained multiple meter readings. The most common month to experience this issue was December 2007. There was often a portion of December 2007 data recorded in the January 2008 data file, usually labeled “system derived usage”. For example, the 2007 data file would contain a December reading from 12/2/2007 to 12/23/2007 while all other months contained readings through the end of the month. Inspection of the 2008 monthly data file would reveal a reading from the missing portion of December 2007 which would need to be manually added to the meter reading in 2007 to obtain an accurate energy consumption value.

Meter readings that spanned multiple months was another issue encountered, although less frequent than the two previous issues. In all such cases, the meter readings spanned two months. In order to split the meter reading in to its monthly components, the ratio of the energy consumption in the corresponding 2008 monthly data was used.

In addition to the issues encountered in the monthly data, the unique identifiers that linked the old and new database systems introduced another level of complexity. Significant additional time and effort was needed to assemble monthly billing records. Specifically for gas heated homes, certain accounts had complete electric billing records, but their corresponding gas billing records were incomplete. These issues significantly increased the level of effort needed to assemble billing records of all accounts (over 600 accounts total).

Several difficulties associated with organizing the CL&P and Yankee Gas data in to a suitable format for billing analysis were due to the conversion of database systems that occurred in 2008. However, the billing data of several accounts in both systems contained inconsistencies.

The electric monthly billing data provided by UI was delivered in a consistent and clean format readily usable for billing analysis. A single spreadsheet was provided that contained well organized information.

Southern Connecticut Gas and Connecticut Natural Gas companies were unable to provide billing data.

2.2.4 HES Participation Databases

CL&P and UI delivered HES participation databases (Microsoft Excel files) to Nexant that included Phase 1 measure specific participation data itemized by account number (homeowner name and address). Separate databases were also provided for Phase 2 participation data for appliance and insulation rebates. Although the HES application used by vendors to administer home assessments is uniform across the Companies, CL&P and UI use drastically different electronic databases to store the participation information.

Structurally, the HES participation database used by CL&P contained one row per account (participant) and each column represented a Phase 1 measure parameter or home characteristic parameter (name, address, account number, square footage, home heat fuel type, etc). Parameters specific to HES energy conservation measures included details on installed measures such as quantity and type of lights installed, CFM reduction, quantity (in feet) of pipe insulation and associated energy savings (kWh, seasonal kW and MMBtu), etc. The database was logically organized and allowed participation details to be easily exported and studied.

The HES participation database used by UI was structured differently from that of CL&P and contained multiple rows per account (participant). A column labeled “proddesc” (product description) was used to itemize installed HES measures and several other columns were used to specify associated electric energy savings. This database structure contained several redundant rows for many columns that are common to the participant (name, address, account number, etc) and made analyzing the data difficult. UI also provided a completely separate file titled “non-electric benefit report” that included natual gas savings in addition to fuel oil and water savings. Combining the information available in both databases required significant additional time and effort.

The CL&P HES participant database was more convenient to work with and allowed analysis to be performed easier and faster. The Companies should consider standardizing the HES participant database to a format currently used by CL&P.

2.3 PROGRAM COMPREHENSIVENESS EVALUATION

Program comprehensiveness was evaluated through interviews with program participants during inspection visits and observation of how thorough each installation was when completed. A survey was developed and administered to a sample of participants to determine the reasons why some measures may not have been implemented despite their technical feasibility.

Separate interviews were conducted with program implementers and installers via telephone. Both utilities provided lists of program implementers and contact information. A questionnaire was developed as a guide to investigate program comprehensiveness with installers.

Both groups were surveyed for satisfaction levels and for any additional program feedback. The survey used with participant homeowners is included in Appendix B.1. The survey used with vendors is included in Appendix B.2.

2.4 SUMMARY OF EVALUATION METHODOLOGIES

To recap, Table 2-2 summarizes the methodologies used for each component of this evaluation.

Table 2-2 Summary of Evaluation Methodologies Used

Method / Objective	On-Site Inspection and Measurement	Vendor Interviews	Participant Interviews	Engineering Models	Statistical Analysis of Utility Bills	Secondary Research
Annual Gross Electric and Gas Savings	✓		✓	✓		
Peak Period(s) Gross Savings	✓		✓	✓		
Net Savings Study	✓			✓	✓	
Comprehensiveness and Program Satisfaction	✓	✓	✓			
PSD Review	✓			✓		✓

2.5 VALIDITY AND RELIABILITY

Energy efficiency evaluations are subject to several sources of potential bias. A short description of potential biases for the HES evaluation and a brief explanation of how each potential bias was minimized follows.

Participant Recruitment for the Inspection Visit

Letters were sent to 160 HES participants, under Company letterhead and signed by HES program staff, offering a $50 rebate for agreeing to allow an inspector to visit the home, with a target of inspecting 41 homes. A potential bias exists that some homeowners were willing to agree to the inspection visit simply to receive the monetary incentive. Some homeowners were motivated enough to volunteer for inspection by searching online for Nexant's contact information, despite it not being provided in the contact letter. In order to avoid selecting an inordinate quantity of these fast-responders, a protocol was instituted to pool all homeowners who volunteered for inspection by calling Nexant directly. Only a few of these homeowners were selected for inspections. Enthusiastic homeowners who voluntarily contacted Nexant were kept to a minimum, so as to not bias the evaluation. Most homeowners were recruited for inspection by receiving a phone call directly from Nexant scheduling staff. Care was also taken to select a broad range of homeowners: retirees, families, couples, stay-at-home moms, work from home, etc.

Infiltration Measurement

Since Nexant performed the blower door test to measure home envelope infiltration at a later date than the initial assessment, there is potential for several parameters to have an effect on the results. Outdoor temperature and other natural conditions (wind levels, time of day) would change the blower door test results. The state of the home envelope would also have a significant impact on the infiltration rates if envelope changes occurred after the initial assessment was completed by the contractor. The effect of natural conditions is not as critical as the state of the home's envelope. In order to minimize any potential bias and error due to changes in the home envelope, Nexant inspectors interviewed homeowners to ensure the home was in the same configuration as when the initial assessment was conducted. The blower door testing equipment was well calibrated and all on-site inspectors were trained to ensure that the test was administered correctly and to minimize bias and error.

Choosing an appropriate comparison group for billing analysis

Care was taken in selecting the participants and control groups (non-participants) for the billing analysis. Cooperation with the Companies was needed to identify the home heating fuel of non-participant accounts. Characteristics used to match participants and non-participants were annual baseline year consumption and basic geographic grouping by zip code. Appendix E provides further information.

Vendor Recruitment

Contact emails were sent out to participating HES vendors asking to arrange a time for an interview. Naturally, vendors who offered negative feedback of the program were motivated to respond quickly and to participate in the comprehensiveness survey, while vendors who were content with their involvement in the program were not as motivated about giving feedback. There is a potential for greater participation from vendors who had negative feedback. In order to minimize this effect, Nexant attempted to contact all vendors in a uniform fashion so as to achieve consistent results.

Slow to respond vendors were contacted multiple times so that negative feedback from fast responders did not bias overall results.

Billing Data Availability

The home heating fuel type of the non-participants was estimated using Company rate identifiers and/or seasonal consumption thresholds. The evaluators worked with Company staff to determine the most accurate means to identify home heating fuel type for the purposes of providing Company data for the billing analysis.

The gas billing analysis was conducted only for Yankee gas customer accounts since the utility billing records from SCG and CNG could not be obtained. The Yankee gas customer account profiles were assumed to be representative of all gas customers who participated in the HES program, although the loss of the SCG and CNG data had a strong negative impact on the precision of the results. As discussed in Section 2.2.2, this shortcoming did not affect the engineering impact analysis since the measure level gas savings for the HES participants in the on-site sample were available in the project records.

The gross impact evaluation investigates the energy and demand savings that result from measure implementation. The current evaluation study only includes Phase 1 measures. Although participants who installed Phase 2 measures were attempted to be included in the home inspection sample, Nexant was unable to recruit any Phase 2 participants. Phase 2 measures represent less than 5% of the program's claimed savings, excluding rebates for central air conditioning, so the net effect of variations in this population on the program realization rate are minimal.

3.1 SURVEY RESULTS

Nexant performed site visits for a total of 42 residences, split between the utilities based on the weighted proportions of the program-estimated electric demand savings in each Company's territory (33 homes for CL&P, 9 homes for UI). Two inspected homes (both CL&P) were removed from the realization rate calculation, because their energy consumption profiles changed significantly since HES participation (one installed solar panels, the other a pellet stove heater). The surveyed projects included a variety of installed measures. Table 3-1 shows the distribution of installed measures in the surveyed projects. None of the 42 homes inspected availed themselves of rebate measures.

Table 3-1 Quantity of Homes with Installed Measures in Surveyed Projects, by heating type

Measure	Natural Gas	Electric	Oil & Other	Total
Qty of Homes by Heat fuel	25	7	8	40
Lighting Measures	25	7	8	40
Pipe Insulation	8	2	0	10
Water Measures	16	6	0	22
Infiltration Measures	19	6	2	27

The entries in Table 3-1 are quantity of homes with each measures type. Table 3-2 summarizes measure installation in the entire sample.

Table 3-2 Total Installed Measures in Surveyed Projects

Measure	Measures per Home
Lighting Measures	24 bulbs per residence, on average
Pipe Insulation	70 ft total across all 10 homes
Water Measures	3 total fixtures per residence, on average
Infiltration Measures	Varied by site

3.2 MEASURE-SPECIFIC SAVINGS RESULTS

Measure-specific analyses using standard engineering algorithms were conducted to calculate energy savings for lighting, pipe insulation, and water measures for all projects surveyed. All instances where gross measured savings differed from gross calculated savings were categorized in to the following adjustment categories:

Technology adjustment (TECH_ADJ) accounts for all discrepancies between the technology (equipment type, efficiency, system configuration, etc.) identified in the paperwork and that observed in the field. Adjustments to baseline assumptions are also contained in this technology adjustment factor.

Quantity adjustment (QTY_ADJ) reflects any discrepancies between the quantity or size of the documented equipment versus the measures observed in the field.

3.2.1 Lighting

Table 3-3 shows the evaluation measured gross savings and HES program calculated gross savings for lighting measures, incorporating all of the surveyed projects. Since the baseline in the PSD was assumed to be the best estimate of the baseline, all discrepancies are the result of differences in the type or quantity of lights installed.

Table 3-3 Lighting Measured Savings

Unit of Savings	Gross Measured Savings - Nexant	Gross Calculated Savings - Companies	Realization Rate
kWh	35,962	36,178	99%
Summer Peak kW	3.40	3.38	101%
Winter Peak kW	7.87	7.97	99%

Nexant examined each project to determine the cause of the discrepancy between the measured value and HES's reported value. The primary reasons include:

- **Inaccurate bulb quantities:** 11 homes contained bulb quantity deficiencies when compared to project records and can be seen in Table 3-4 under the column labeled "Qty_Adj". Two homes contained a slight surplus of bulbs as compared to project records. A negative quantity in column "Qty_Adj" indicates Nexant found fewer bulbs onsite than indicated in project records; a positive quantity estimate found more.
- **Bulb type discrepancies:** 16 homes contained discrepancies in bulb type when compared to project records and can be seen in Table 3-4 under the column labeled "Tech_Adj". In these cases, implementation contractors installed different wattage CFL's to replace the same type of incandescent bulb within the same home depending on the lighting demand of the space and what they had in stock.

Table 3-4 lists the project specific savings for all homes that contained lighting measures and their categorized adjustment factors.

Table 3-4 Project Specific Savings: Lighting

Home Identifier	Lighting kWh Nexant	Lighting kWh HES	Lighting Summer Peak kW Nexant	Lighting Summer Peak kW HES	Lighting Winter Peak kW Nexant	Lighting Winter Peak kW HES	Tech_Adj	Qty_Adj
1	872	877	0.083	0.082	0.239	0.244		
2	517	449	0.049	0.042	0.142	0.125	✓	
3	219	237	0.021	0.022	0.060	0.066	✓	
4	2,373	2,223	0.225	0.207	0.650	0.618	✓	✓ (-2)
5	481	601	0.043	0.056	0.125	0.167		✓ (-2)
6	273	262	0.026	0.024	0.075	0.073	✓	
7	1,146	1,282	0.109	0.119	0.314	0.356		✓ (-3)
8	1,196	1,127	0.113	0.105	0.328	0.313	✓	
9	526	526	0.050	0.049	0.144	0.146		
10	729	729	0.069	0.068	0.200	0.203		
11	1,929	2,029	0.174	0.189	0.502	0.564		✓ (-2)
12	408	378	0.039	0.035	0.112	0.105	✓	
13	654	544	0.062	0.051	0.179	0.151	✓	
14	957	957	0.091	0.089	0.262	0.266		
15	2,797	2,649	0.265	0.246	0.766	0.736	✓	✓ (+4)
16	1,455	1,640	0.138	0.153	0.399	0.456		✓ (-3)
17	102	102	0.010	0.010	0.028	0.028		
18	556	549	0.053	0.051	0.152	0.153	✓	
19	492	492	0.047	0.046	0.135	0.137		
20	312	346	0.030	0.032	0.085	0.096		✓ (-1)
21	633	688	0.060	0.064	0.173	0.191	✓	
22	610	645	0.058	0.060	0.167	0.179		✓ (-1)
23	620	483	0.059	0.045	0.170	0.134	✓	
24	330	330	0.031	0.031	0.090	0.092		
25	1,180	1,148	0.112	0.107	0.323	0.319	✓	
26	415	392	0.039	0.036	0.114	0.109	✓	
27	312	330	0.030	0.031	0.085	0.092	✓	
28	1,754	1,740	0.166	0.162	0.480	0.484		✓ (-3)
29	2,257	2,257	0.214	0.210	0.618	0.627		
30	1,326	1,228	0.126	0.114	0.363	0.341	✓	✓ (+1)
31	1,437	1,437	0.136	0.134	0.394	0.400		
32	1,772	1,721	0.168	0.163	0.486	N/A	✓	
33	831	831	0.079	0.079	0.228	N/A		
34	1,123	1,120	0.106	0.107	0.308	N/A		
35	306	313	0.029	0.030	0.084	N/A		✓ (-1)
36	745	744	0.071	0.071	0.204	N/A		
37	512	510	0.049	0.049	0.140	N/A		
38	148	148	0.014	0.014	0.041	N/A		
39	1,203	1,612	0.114	0.153	0.330	N/A		✓ (-8)
40	456	502	0.043	0.048	0.125	N/A		✓ (-1)
Sum	35,962	36,178	3.40	3.38	7.87	7.97		

3.2.2 Pipe Insulation

The gross measured savings are presented in Table 3-5 for pipe insulation measures installed at 8 homes with gas domestic hot water heaters and 2 homes with electric domestic hot water heaters.

Table 3-5 Pipe Insulation Measured Savings

Hot Water Heater Fuel Type	Unit	Gross Measured Savings	Gross CalculatedSavings	Realization Rate
Gas	MMBtu	2.646	0.768	345%
	MMBtu (typical peak day)	0.0086	N/A	
	MMBtu (extreme peak day)	0.0086	N/A	
Electric	kWh	50.5	54.6	92%
	Summer Peak kW	0.0048	0.0052	92%
	Winter Peak kW	0.0070	0.0076	92%

Nexant examined each project to determine the cause of the discrepancy between the measured value and HES's calculated value. The primary reason was:

- **Variation in savings calculation methodology:** The HES program savings document uses a look-up table to assign energy savings for pipe insulation measures, while the Nexant calculations used the *3E Plus* insulation software to calculate the Btu savings, with direct inputs to the software from conditions recorded on-site. Recommended savings for 10 linear feet of pipe and a comparison of the two methodologies can be found in Section 5.2, which presents a review of pipe insulation calculation of the PSD.

- **Length of pipe insulation:** The length of pipe insulation installed was found to match project records in all but two homes.

Table 3-6 shows the project specific savings for all homes that contained pipe insulation with associated gas domestic hot water (DHW) heaters and their categorized adjustment factors.

Table 3-6 Project Specific Savings: Pipe Insulation (Gas DHW Heater)

Home Identifier	Pipe Insulation MMBtu Nexant	Pipe Insulation MMBtu HES	Pipe Insulation Typical Peak Day MMBtu Nexant	Pipe Insulation Extreme Peak Day MMBtu HES	Qty_Adj
1	0.5814	0.1440	0.0019	0.0019	
9	0.3828	0.0960	0.0012	0.0012	
11	0.5743	0.1440	0.0019	0.0019	
14	0.2584	0.0480	0.0008	0.0008	
18	0.1075	0.0240	0.0003	0.0003	
22	0	0.0600	0	0	✓ (-9ft)
28	0.2584	0.1440	0.0009	0.0009	✓ (-6ft)
30	0.4836	0.1080	0.0016	0.0016	
Sum	2.6464	0.7680	0.0086	0.0086	

Home identifier 28 contained 3 feet of pipe insulation while project records indicated 9 feet, a deficiency of 6 feet. Home identifier 22 contained no pipe insulation, while project records specified 9 feet.

Table 3-7 shows the project specific savings for all homes that contained pipe insulation with associated electric domestic hot water (DHW) heaters and their categorized adjustment factors.

Table 3-7 Project Specific Savings: Pipe Insulation (Electric DHW Heater)

Home Identifier	Pipe Insulation kWh Nexant	Pipe Insulation kWh HES	Pipe Insulation Summer Peak kW Nexant	Pipe Insulation Summer Peak kW HES	Pipe Insulation Winter Peak kW Nexant	Pipe Insulation Winter Peak kW HES	Tech_Adj
17	50.5	21.6	0.00477	0.00204	0.00701	0.00300	
20	0	33.0	0	0.00312	0	0.00458	✓
Sum	50.5	54.6	0.00477	0.00515	0.00701	0.00758	

The home associated with Home Identifier 20, contained the correct length of pipe insulation (6 feet), however the domestic hot water was provided via propane gas therefore no electrical savings are achieved.

3.2.3 Water Measures

The evaluation measured gross savings and HES program calculated gross savings for homes with natural gas and electric hot water heaters are shown in Table 3-8.

Table 3-8 Water Measures Measured Savings

Hot Water Heater Fuel Type	Unit	Gross Measured Savings	Gross Calculated Savings	Realization Rate
Natural Gas	MMBtu	44.5	55.3	80%
	Typical Peak Day MMBtu	0.18	N/A	
	Extreme Peak Day MMBtu	0.18	N/A	
Electric	kWh	2,811.9	3,414.6	82%
	Summer Peak kW	0.27	0.32	82%
	Winter Peak kW	0.28	0.34	82%

Nexant examined each project to determine the cause of the discrepancy between the Nexant calculated value and HES's calculated value. The primary reasons include:

- **Missing equipment:** Project records specified that 62 low flow devices were installed in the sampled homes. However, Nexant found 52 measures still installed. Participants reported removing two of these measures. In both cases the participant removed a program-sponsored low flow showerhead and switched back to the standard flow showerhead due to dissatisfaction with the flow rate. The remaining 8 measures are included as Quantity Adjustments to the calculated savings.
- **Differences in water heater energy factor:** Where available, Nexant used the actual efficiency of the hot water heater found on-site, which sometimes differed from the efficiencies assumed in the 2008 PSD (90%, 60%, and 50%for electric, gas, and oil water heaters, respectively).
- **Water usage discrepancy:** For faucet aerators, Nexant used an annual water usage reduction of 256 gallons based on the source associated with the 2010 PSD[9], while the tracked savings used an annual water reduction of 2,730 gallons associated with the 2008 PSD.

The effects of quantity discrepancy and water usage discrepancy outweighed the effect of the differences in water heater energy factor, resulting in measured savings shown in Table 3-8. Project specific discrepancies in quantity (Qty_Adj) and water heater efficiency (Tech_Adj) are shown in Table 3-9 and Table 3-10 for gas and electric hot water heaters respectively.

Table 3-9 Project Specific Savings: Water Measures (Gas DHW Heater)

Home identifier	Water Measures MMBtu Nexant	Water Measures MMBtu HES	Water Measures Typical Peak MMBtu Nexant	Water Measures Extreme Peak MMBtu Nexant	Tech_Adj	Qty_Adj
5	2.399	1.954	0.0074	0.0074		
8	0.690	1.888	0.0021	0.0021		✓ (-1)
11	2.070	4.918	0.0064	0.0064		✓ (-2)
14	2.399	1.880	0.0074	0.0074		
18	1.380	2.898	0.0044	0.0044		✓ (-1)
21	0.690	0.944	0.0022	0.0022		
22	4.797	4.852	0.0539	0.0539		✓ (-1)
23	3.239	3.842	0.0102	0.0102	✓	✓ (-2)
28	4.797	5.796	0.0151	0.0151		✓ (-1)
30	3.779	3.842	0.0125	0.0125		
32	1.336	1.834	0.0043	0.0043	✓	
34	4.535	4.197	0.0147	0.0147		✓ (-1)
36	3.089	3.474	0.0100	0.0100		
37	3.417	3.280	0.0111	0.0111		
38	0.657	0.917	0.0021	0.0021	✓	
39	5.226	8.830	0.0170	0.0170	✓	
Sum	44.5	55.3	0.1810	0.1810		

Table 3-10 Project Specific Savings: (Electric DHW Heater)

Home Identifier	Water Measures kWh Nexant	Water Measures kWh HES	Water Measures Summer Peak kW Nexant	Water Measures Summer Peak kW HES	Water Measures Winter Peak kW Nexant	Water Measures Winter Peak kW HES	Tech_Adj	Qty_Adj
12	917	749	0.0866	0.0707	0.1274	0.1041	✓	
13	412	368	0.0389	0.0347	0.0572	0.0511	✓	
16	202	184	0.0191	0.0174	0.0281	0.0256		
25	469	368	0.0442	0.0347	0.0651	0.0511		
27	0	749	0	0.0707	0	0.1041	✓	
40	812	996	0.0767	0.0946				✓ (-1)
Sum	2,812	3,415	0.2654	0.3229	0.2778	0.3359		

The home associated with Home Identifier 27 in Table 3-10, contained the correct quantity of water reduction measures, however the domestic hot water was provided via fuel oil; therefore no electrical savings are achieved.

3.2.4 Infiltration measures

Infiltration (home envelope air sealing) measures were installed at 19 gas heated homes, 6 electric heated homes and 2 oil-heated homes as shown in Table 3-1. The details of each category are presented in Sections 3.2.4.1, 3.2.4.2 and 3.2.4.3 respectively.

3.2.4.1 Gas Heated Homes

The gross measured savings and gross calculated savings for the 19 gas-heated homes with central air are shown in Table 3-11.

Table 3-11 Infiltration Measured Savings (Gas Heated Homes)

Fuel Source	Unit	Gross Measured Savings	Gross Calculated Savings	Realization Rate
Natural Gas	MMBtu	73.98	54.49	136%
	Typical Peak Day MMBtu	0.63	N/A	
	Extreme Peak Day MMBtu	0.73	N/A	
Electric	kWh	3,050	2,870	106%
	Summer Peak kW	2.66	4.63	57%
	Winter Peak kW	0.15	N/A*	

* No winter demand savings claimed.

Table 3-11 shows that Nexant measured an average savings of 3.9 MMBtu per home and 160 kWh per home. Nexant examined each project to determine the cause of the discrepancy between the measured value and HES's calculated value. The primary reasons are:

- **CFM differences:** Nexant's CFM figures obtained through on-site blower door testing were lower than HES CFM baseline figures (CFM Pre HES) in 15 of 19 homes. For these homes Nexant calculated positive electric and gas savings. In cases where Nexant's CFM figures were greater than baseline HES CFM figures (i.e. infiltration was greater), Nexant calculated negative savings.
- **Seasonal differences:** The outside air temperature affects the CFM figures obtained during blower door tests. In many cases Nexant did not necessarily perform the blower door tests at the same outside air temperature conditions as the initial HES visits.
- **Variation in simulation models:** Nexant's eQUEST model relied on home-specific information gathered during on-site visits, as opposed to the HES program model, which used generic home characteristics to specify savings for an average home in Connecticut.

The impact of differences in CFM and variation in simulation models dominated any seasonal differences that may have occurred. Across all homes, the gross measured energy savings were slightly higher than the gross calculated savings while the summer peak demand savings showed the opposite trend. This can be explained by the homes in the sample achieving most of their energy (MMBtu) savings during non-peak periods. The simulations showed lower savings during the summer peak periods mainly due to lower equipment operating hours. A summary of CFM rates of infiltration and project specific savings are presented in Table 3-12 and Table 3-13 respectively.

Table 3-12 Project Specific Infiltration Summary (Gas Heated Homes)

Home Identifier	CFM Pre HES	CFM Post HES	CFM Post Nexant	Δ CFM HES	Δ CFM Nexant
1	2,025	1,872	1,920	153	105
3	4,523	3,934	5,340	589	-817
4	2,913	2,690	2,750	223	163
8	2,584	2,315	2,345	269	239
9	3,402	3,186	2,590	216	812
10	4,686	4,034	3,600	652	1,086
14	4,971	4,259	3,455	712	1,516
15	1,891	1,718	2,275	173	-384
18	4,413	4,115	3,640	298	773
21	2,296	2,073	2,765	223	-469
23	2,180	1,930	1,965	250	215
24	3,532	3,216	3,100	316	432
28	3,261	2,803	3,005	458	256
30	3,583	3,063	4,200	520	-617
33	7,120	6,548	4,115	572	3,005
34	3,150	2,942	2,030	208	1,120
36	4,001	3,757	3,210	244	791
37	3,904	3,727	3,730	177	174
38	2,025	1,910	1,950	115	75

The column in Table 3-12 labeled ΔCFM HES is the CFM reduction, measured with blower door equipment, that was recorded in project records by the implementation contractor that performed the initial HES assessment (CFM Pre HES – CFM Post HES). The column labeled ΔCFM Nexant is the difference between the baseline HES infiltration rate (CFM Pre HES) and the infiltration rate obtained by Nexant engineers during evaluation site inspection visits (CFM Post Nexant). A negative value for ΔCFM Nexant indicates that Nexant engineers measured a higher infiltration rate than the baseline infiltration rate (CFM Pre HES) obtained by HES implementation contractors. A complete examination of air sealing comprehensiveness and lost opportunity can be found in Section 6.1.2.

Table 3-13 Project Specific Savings: Infiltration (Gas Heated Homes)

Home Identifier	Blower Door MMBtu Nexant	Blower Door MMBtu HES	Blower Door Typical Peak MMBtu Nexant	Blower Door Extreme Peak MMBtu Nexant	Blower Door kWh Nexant	Blower Door kWh HES	Blower Door Summer Peak kW Nexant	Blower Door Summer Peak kW HES	Blower Door Winter Peak kW Nexant	Blower Door Winter Peak kW HES
1*	1.22	1.22			69	69	0.12	0.12	0.00	0.00
3	-16.72	4.71	-0.16	-0.19	-390	265	-0.37	0.45	-0.02	0.00
4	6.06	1.78	0.06	0.07	40	100	0.00	0.17	0.01	0.00
8	10.07	2.15	0.10	0.11	70	121	0.00	0.21	0.01	0.00
9	14.98	1.73	0.15	0.17	958	97	0.56	0.17	0.12	0.00
10	16.14	5.22	0.16	0.18	500	293	0.47	0.50	0.02	0.00
14	21.90	5.70	0.21	0.25	810	320	0.72	0.54	0.03	0.00
15	-15.76	1.38	-0.15	-0.18	-210	78	-0.18	0.13	-0.02	0.00
18	16.32	2.38	0.16	0.19	540	134	0.48	0.23	0.02	0.00
21	-15.34	1.78	-0.15	-0.17	-282	100	-0.04	0.17	-0.03	0.00
23*	2.00	2.00			113	113	0.19	0.19	0.19	0.00
24	9.58	2.53	0.09	0.11	300	142	0.27	0.24	0.01	0.00
28	5.49	3.66	0.05	0.06	120	206	0.12	0.35	0.01	0.00
30	-14.52	4.16	-0.14	-0.16	-530	234	-0.46	0.40	-0.02	0.00
33**	6.12	6.12			294	294	0.39	0.39	N/A	N/A
34	8.69	2.23	0.08	0.10	220	107	0.00	0.14	0.01	N/A

36	12.40	2.61	0.12	0.14	284	126	0.27	0.17	0.02	N/A
37	3.70	1.89	0.04	0.04	120	11	0.11	0.00	0.00	N/A
38	1.65	1.23	0.02	0.02	25	59	0.02	0.08	0.00	N/A
Sum	73.98	54.49	0.63	0.73	3,050	2,870	2.66	4.63	0.15	0.00

*Home Identifier 1 and 23 did not have eQUEST models created because billing records were not available to accurately calibrate the models. Program calculated savings were accepted for these accounts.
**The home associated with Home Identifier 33 had a significant renovation that occurred since the initial HES visit which changed the homes infiltration characteristics. Program calculated savings were accepted for this account.

Table 3-12 shows that Nexant measured CFM values for 8 homes (Home Identifier 9, 10, 14, 18, 24, 33, 34,36) that were less than the post CFM indicated in project records. For these homes, Table 3-13 shows that Nexant calculated greater electrical energy savings than program reported savings with the exception of one account (Home Identifier 33) where program reported savings were accepted due a change in the home's envelope characteristics since the HES assessment.

Table 3-12 also shows that Nexant measured CFM values for 7 homes (Home Identifier 1, 4, 8, 23, 28, 37, 38) that were greater than the post CFM indicated in project records. For these homes Table 3-13 shows the Nexant gross measured savings were lower compared to program calculated savings with the exception of Home Identifier 37 where program reported savings in the database appear to be unusually low and could be a reporting mistake.

Nexant measured a total of 4 homes (Home Identifier 3, 15, 21, 30) where CFM values were greater than the pre CFM indicated in project records. This indicates that when Nexant performed the blower door test, the home had more infiltration than the implementation contractor measured in the baseline case. For these homes Table 3-13 shows Nexant calculated negative energy savings. The lower savings represent a lost opportunity which should be captured during future program cycles.

The HES program did not assign winter demand savings for the 19 gas heated homes that were studied in this evaluation. Nexant calculated winter peak demand savings due to reduced fan run time associated with forced air heating systems that occurred during the winter peak period.

3.2.4.2 Electric Heated Homes

The evaluation measured gross savings and HES program calculated gross savings for the 6 electric heated homes are shown in Table 3-14.

Table 3-14 Infiltration Measured Savings (Electric Heated Homes)

Fuel Source	Unit	Gross Measured Savings	Gross Calculated Savings	Realization Rate
Electric	kWh	2,004	2,507	80%
	Summer Peak kW	0.95	0.61	157%
	Winter Peak kW	0.43	1.19	36%

Table 3-14 shows that Nexant measured an average savings of 334 kWh per home and 0.16 summer peak kW per home. Nexant examined each project to determine the cause of the discrepancy between the measured value and HES's calculated value. The primary reasons are:

- **CFM differences:** Nexant's CFM figures obtained through on-site blower door testing were lower than HES CFM baseline figures in 5 of 6 homes. For these homes Nexant calculated positive electric and gas savings.
- **Variation in simulation models:** Nexant's eQUEST model relied on home-specific information gathered during on-site visits, as opposed to the HES program model, which used generic home characteristics to specify savings for an average home in Connecticut.
- **Seasonal differences:** The outside air temperature affects the CFM figures obtained during blower door tests. In many cases Nexant did not necessarily perform the blower door tests at the same outside air temperature conditions as the initial HES visits.

Seasonal differences are less of a concern since the impact of differences in CFM and variation in simulation models dominated any seasonal differences that may have occurred. Across all homes, the gross measured energy savings and winter peak savings were lower than their gross calculated counterparts, while the summer peak demand savings showed the opposite trend. The summer demand difference in trend is mainly attributable to Home Identifier 13 that had a large summer demand savings due to a combination of the efficiency of the cooling equipment and set-point temperatures in the summer months. A summary of CFM rates of infiltration and project specific savings are presented in Table 3-15 and Table 3-16 respectively.

Table 3-15 Project Specific Infiltration Summary (Electric Heated Homes)

Home Identifier	CFM Pre HES	CFM Post HES	CFM Post Nexant	Δ CFM HES	Δ CFM Nexant
12	2,715	2,535	2,625	180	90
13	3,642	3,238	3,305	404	337
16	2,894	2,506	2,450	388	444
17	2,940	2,730	3,460	210	-520
20	1,875	1,661	1,600	214	275
25	1,169	1,082	1,125	87	44

Table 3-16 Project Specific Savings: Infiltration (Electric Heated Homes)

Home Identifier	Blower Door kWh Nexant	Blower Door kWh HES	Blower Door Summer Peak kW Nexant	Blower Door Summer Peak kW HES	Blower Door Winter Peak kW Nexant	Blower Door Winter Peak kW HES	Δ CFM HES	Δ CFM Nexant
12	150	362	0.114	0.138	1.07E-05	0.160	180	90
13	760	812	0.679	0.309	2.78E-05	0.349	404	337
16*	605	605			0.335	0.335	388	444
17*	258	258	0.161	0.161	0.091	0.091	210	-520
20	80	334			1.66E-05	0.185	214	275
25	150	136			1.20E-05	0.075	87	44
Sum	2,004	2,507	0.953	0.607	0.425	1.193		

* Home Identifiers 16 and 17did not have eQUEST models created because billing records were not available to accurately calibrate the models. Program calculated savings were accepted for these accounts.

Table 3-15 shows that Nexant measured 2 homes (Home Identifier 16, 20) whose CFM values were less than the post CFM indicated in project records. Table 3-16 shows Nexant calculated energy savings for Home Identifier 20 less than program calculated energy savings despite Nexant measured a greater reduction in CFM. This is because the resident supplements their home heating with a wood stove and keeps a very low set-point on the electrical heating system. This set-point behavior was built into the simulation for this account and is the reason why the Nexant calculated energy savings are lower than program calculated energy savings.

Table 3-15 shows that Nexant measured 3 homes (Home Identifier 12, 13, 25) whose CFM values were less than the pre CFM indicated in project records but greater than the post CFM indicated in project records. For these homes Table 3-16 shows Nexant calculated energy savings less than program calculated savings with the exception of Home Identifier 25 where the Nexant energy savings is approximately 9% higher than program calculated energy savings and can be attributed to the simulation model sensitivity and calibration noise.

Table 3-15 shows that Nexant measured 1 home (Home Identifier 17) whose CFM value was greater than the pre CFM indicated in project records. This indicates that when Nexant performed the blower door test, the home had more infiltration than the implementation contractor measured in the baseline case. Due to a lack of available billing records for this account, Nexant could not accurately calibrate an eQUEST model, therefore the program calculated savings were accepted.

The Nexant calculated winter peak kW savings were negligible for all homes in electric heat category compared to those assigned by the program. This can be attributed to the Nexant simulation models showing that the heating equipment operated at the same peak capacity during the winter peak period for the baseline and retrofit configurations.

3.2.4.3 Oil Heated Homes

The evaluation measured gross savings and HES program calculated gross savings for the two oil heated homes with central air conditioning are shown in Table 3-17. Oil savings were not examined as part of this evaluation. The electric savings shown below are due to savings associated with the electric central air system.

Table 3-17 Infiltration Measured Savings (Oil Heated Homes)

Fuel Source	Unit	Gross Measured Savings	Gross Calculated Savings	Realization Rate
Electric	kWh	328.5	273.6	120%
	Summer Peak kW	0.33	0.47	71%
	Winter Peak kW	0.0078	0.00	

Nexant examined each project to determine the cause of the discrepancy between the measured value and HES's calculated value. The primary reasons are:

- **CFM differences:** Nexant's CFM figures obtained through on-site blower door testing were lower than HES CFM baseline figures in both oil heated homes. For these homes Nexant calculated positive electric savings.
- **Seasonal differences:** The outside air temperature affects the CFM figures obtained during blower door tests. In many cases Nexant did not necessarily perform the blower door tests at the same outside air temperature conditions as the initial HES visits.
- **Variation in simulation models:** Nexant's eQUEST model relied on home-specific information gathered during on-site visits, as opposed to the HES program model, which used generic home characteristics to specify savings for an average home in Connecticut.

The impact of differences in CFM and variation in simulation models dominated any seasonal differences that may have occurred. Across all homes, the gross measured energy savings were slightly higher than the gross calculated savings while the summer peak demand savings showed the opposite trend. This can be explained by the homes in the sample achieving most of their energy savings (kWh) during non-peak periods. The simulations showed lower savings during the summer peak periods mainly due to lower equipment operating hours. A summary of CFM rates of infiltration and project specific savings are presented in Table 3-18 and Table 3-19 respectively.

Table 3-18 Project Specific Infiltration Summary (Oil Heated Homes)

Home Identifier	CFM Pre HES	CFM Post HES	CFM Post Nexant	CFM HES	CFM Nexant
2	3,373	2,895	2,840	478	533
27	2,426	2,296	1,985	130	441

Table 3-19 Project Specific Savings: Infiltration (Oil Heated Homes)

Home Identifier	Blower Door kWh Nexant	Blower Door kWh HES	Blower Door Summer Peak kW Nexant	Blower Door Summer Peak kW HES	Blower Door Winter Peak kWNexant	Blower Door Winter Peak kW HES	Δ CFM HES	Δ CFM Nexant
2	270	215.1	0.23	0.37	0.0078	0.00	478	533
27*	58.5	58.5	0.10	0.10	0.00	0.00	130	441
Sum	328.5	273.6	0.33	0.47	0.0078	0.00		

* Home Identifier 27 did not have an eQUEST model created because billing records were not available to accurately calibrate the model. Program calculated savings were accepted for this account.

Table 3-18 shows that Nexant measured 2 homes (Home Identifier 2, 27) whose CFM values were less than the post CFM indicated in project records. Home Identifier 27 could not be evaluated because billing records were not available to accurately calibrate an eQUEST model. Table 3-19 shows Nexant- calculated energy savings for Home Identifier 2 to be greater than program-calculated energy savings despite Nexant measuring a greater reduction in CFM. This result can be attributed to the simulation model sensitivity and calibration noise.

3.3 REALIZATION RATES

Table 3-20 presents a summary of the Nexant gross measured energy savings by measure for all inspected homes in the sample.

Table 3-20 Summary of Nexant Gross Measured Savings in Sample

	MMBtu		kWh		Summer kW		Winter kW	
Measure	Nexant	HES	Nexant	HES	Nexant	HES	Nexant	HES
Lighting			35,962.2	36,178.3	3.40	3.38	7.87	7.97
Pipe Insulation	2.65	0.77	50.5	54.6	0.00	0.01	0.01	0.01
Water Measures	44.50	55.35	2,811.9	3,414.6	0.27	0.32	0.28	0.34
Infiltration - Gas	73.98	54.49	3,050.4	2,870.4	2.66	4.63	0.15	0.00
Infiltration - Electric			2,003.6	2,507.0	0.95	0.61	0.43	1.19
Infiltration - Oil			328.5	273.6	0.33	0.47	0.01	0.00
Duct Blasting[1]	30.12	30.12	1,105.9	1,105.9	1.47	1.47	0.12	0.12
Total	151.25	140.72	45,312.9	46,404.3	9.08	10.88	8.86	9.63

[1] The Work Plan developed by Nexant and the Companies states that Duct Blaster testing would not be performed due to the specialized equipment, time and effort involved in conducting this type of test. Nexant reviewed the PSD's methodology for crediting duct sealing savings and found no inconsistencies. Savings due to duct sealing were achieved in 6 homes in the sample and accepted as claimed.

Table 3-21 presents the evaluation gross measured savings and program gross calculated savings by energy unit for all measures across all inspected homes with corresponding realization rates. The realization rates shown can be reported with a confidence interval of 80% at precision levels stated. The project specific saving summary table can be found in Appendix C.2.

Table 3-21 Overall HES Sample Realization Rates

Unit	Gross Measured Savings	Gross Calculated Savings	Realization Rate	Relative Precision (80% Confidence)
MMBtu	151.2	140.7	107.5%	±45.4%[1]
kWh	45,313	46,404	97.6%	±5.1%
Summer Peak kW	9.08	10.88	83.4%	±16.7%
Winter Peak kW	8.86	9.63	91.9%	±5.6%[2]
Typical Peak Day MMBtu	0.82	N/A	N/A	N/A
Extreme Peak Day MMBtu	0.92	N/A	N/A	N/A

[1] The relative precision for MMBtu was based on 25 data points.

[2] The relative precision for winter peak kW was based on 31 datapoints.

The majority of the kWh savings (80%) in the sample were derived from lighting measures, whose gross measured savings tracked extremely closely to gross calculated savings as shown in Table 3-3. Discrepancies in kWh were due primarily to water measures (Table 3-8) and infiltration measures (Table 3-11 and Table 3-14). Summer peak kW discrepancy was also most notable for infiltration projects in gas heated homes (Table 3-11).

The surplus in MMBtu savings for projects sampled can be found in the savings associated with infiltration testing for gas heated homes (Table 3-11). The MMBtu savings associated with infiltration reduction measures accounted for over 50% of the sampled savings, with water measures comprising 28%, duct sealing 20% and pipe insulation 2%.

Applying the realization rates to the total calculated program savings yields the following results shown in Table 3-22. The HES program calculated savings were summed from the 2008 Phase 1 HES installation databases provided by the utilities.

Table 3-22 HES Calculated and Measured Program Savings

Unit	GrossCalculated Savings	Gross Measured Savings
MMBtu	39,649	42,614
kWh	10,936,625	10,679,399
Summer Peak kW	2,859	2,385
Winter Peak kW	2,003	1,841

The results of the engineering adjusted billing analysis study, which sought to measure net electric and natural gas savings, are described below. The Engineering Adjusted Billing Analysis uses the results of two separate means of examining program impacts in order to assess savings caused by the program, i.e. net of consumption changes that would have occurred even if the program had not existed. The two processes used are the statistically-based Billing Analysis and On-Site Measurement (Engineering) Approach. Results of the billing analysis evaluation were combined with the engineering based gross impact evaluation to provide a broad estimate of program and measure level savings combining non program impacts such as customer behavior and economic price changes. The engineering adjusted billing approach consisted of applying the Control Group Ratio (CGR) to the realization rates from the engineering-based impact analysis in order to produce CGR adjusted realization rates.

4.1 PARTICIPANT AND NON-PARTICIPANT RETROFIT ENERGY USE

The energy consumption was examined from Company billing records for a sample of program participants and non-participants, in the baseline year of 2007 and the retrofit year of 2009, across all three home heating fuel types. The average energy use and the percent savings for participants and non-participants are shown in Table 4-1 and Table 4-2. The % Savings columns are calculated by subtracting the retrofit energy use from the baseline energy use and dividing by the baseline energy use.

Table 4-1 HES Participant average per-home use and percent savings

	Baseline Year 2007		Post-Retrofit Year 2009			
Heating Fuel	Energy Use (kWh)	Gas Use (MMBtu)	Energy Use (kWh)	Gas Use (MMBtu)	% Savings (kWh)	% Savings (MMBtu)
Gas	8,140	84.4	7,285	78.7	10.5%	6.8%
Electric	15,929		14,004		12.1%	
Oil & Other	14,088		12,843		8.8%	

Table 4-2 Non-Participant average per-home use and percent savings

	Baseline Year 2007		Post-Retrofit Year 2009			
Heating Fuel	Energy Use (kWh)	Gas Use (MMBtu)	Energy Use (kWh)	Gas Use (MMBtu)	% Savings (kWh)	% Savings (MMBtu)
Gas	8,268	91.4	7,980	88.4	3.5%	3.3%
Electric	16,119		15,292		5.1%	
Oil & Other	8,677		8,158		6.0%	

Gas heated homes in the billing analysis sample contained gas consumption data only for customers of Yankee Gas, however the electric data for gas heated homes was provided by CL&P and UI.

Electric and "Oil & Other" heated homes also contained electric data from both CL&P and UI. It should be noted that there were decreases in energy use for both non-participants and participants across all home heating types.

4.2 CONTROL GROUP RATIO

An important step in the billing analysis study was to take the difference in percent change between participants and non-participants usage to calculate the Impact Rate (IR), as is shown in Figure 2.1. The Impact Rate was multiplied by the 2007 energy consumption to calculate the Control Group Savings (CGS). It should be noted that the Control Group Savings (CGS) is the savings achieved by the participants, with the control group's savings netted out. The Control Group Ratio (CGR) can now be expressed as the ratio of the Control Group Savings to the participant energy bill difference between the baseline and retrofit years. The Impact Rate (IR), Control Group Savings and Control Group Ratio results are shown in Table 4-3.

Table 4-3 Heating fuel specific Billing Analysis Parameters

	Impact Rate (IR)		Control Group Savings (CGS) (per home)		Control Group Ratio (CGR)	
Heating Fuel	kWh (%)	MMBtu(%)	kWh	MMBtu	%	%
Gas	7.0%	3.5%	570	3.0	66.6%	51.1%
Electric	7.0%		1,115		57.9%	
Oil & Other	2.8%		395		31.7%	

The 7.0% Impact Rate (IR) for electrically heated homes in Table 4-3 was calculated by subtracting the non-participant percent savings (5.1%) in Table 4-2 from the participant percent savings (12.1%) in Table 4-1. The Impact Rate (IR) says that participants in electrically heated homes in this sample used 7.0% less energy than similar nonparticipants between baseline and retrofit years.

The Control Group Savings (CGS) for electric heated homes, 1,108 kWh, in Table 4-3 is calculated by multiplying the Impact Rate (IR), 7.0%, by the baseline year consumption per participant household of 15,929 kWh as found in Table 4-1. The Control Group Ratio (CGR) for electric heated homes, 57.9%, is calculated by dividing the Control Group Savings (CGS), 1,108 kWh, by the difference in participant consumption between baseline and retrofit years (15,929 – 14,004 = 1,925 kWh) found in Table 4-1.

4.3 ENGINEERING ADJUSTED BILLING ANALYSIS RESULTS

The results of the billing analysis were combined with the engineering based impact evaluation to provide a broad estimate of program and measure level savings combining non program impacts such as customer behavior and economic price changes. The engineering adjusted billing approach consisted of applying the Control Group Ratio (CGR) to the realization rates from the engineering-based impact analysis in order to produce CGR adjusted realization rates. Table 4-4 illustrates the home heat fuel specific CGRs being applied to measure specific realization rates presented in Section 3 in order to produce the CGR adjusted realization rates.

Table 4-4 Control Group Adjusted Savings by Measure

Measure	Heat Fuel	Gross Measured Realization Rates		CGR		CGR adjusted Net Measured Realization Rates	
		kWh	MMBtu	kWh	MMBtu	kWh	MMBtu
Lighting	Gas	101%		66.6%		67%	
Lighting	Electric	98%		57.9%		57%	
Lighting	Oil/Other	95%		31.7%		30%	
Pipe Insulation	Gas		345%		51.1%		176%
Pipe Insulation	Electric	92%		57.9%		53%	
Water Measures	Gas		80%		51.1%		41%
Water Measures	Electric	82%		57.9%		47%	
Infiltration	Gas	106%	136%	66.6%	51.1%	71%	69%
Infiltration	Electric	80%		57.9%		46%	
Infiltration	Oil/Other	120%		31.7%		38%	
Duct Blasting	Gas	100%	100%	66.6%	51.1%	66.6%	51.1%
Overall RR		97.6%	107.5%			57.2%	54.9%

In a similar manner, the CGR adjusted gross measured savings can be calculated by applying the CGR's to the gross measured savings. Table 4-5 shows the home heat fuel specific CGR's being applied to the gross measured savings to produce the resulting CGR adjusted gross measured savings.

Table 4-5 Net Measured Savings Realization Rates

Measure	Heat Fuel	Gross Measured Savings		CGR		CGR adjusted Net Measured Savings	
		kWh	MMBtu	kWh	MMBtu	kWh	MMBtu
Lighting	Gas	23,609.6		66.6%		15,734.2	
Lighting	Electric	4,566.6		57.9%		2,644.1	
Lighting	Oil/Other	7,786.0		31.7%		2,466.8	
Pipe Insulation	Gas		2.6		51.1%		1.4
Pipe Insulation	Electric	50.5		57.9%		29.2	
Water Measures	Gas		44.5		51.1%		22.8
Water Measures	Electric	2,811.9		57.9%		1,628.0	
Infiltration	Gas	3,050.4	74.0	66.6%	51.1%	2,032.9	37.8
Infiltration	Electric	2,003.6		57.9%		1,160.1	
Infiltration	Oil/Other	328.5		31.7%		104.1	
Duct Blasting	Gas	1,105.9	30.1	66.6%	51.1%	737.0	15.4
Total		45,312.9	151.2			26,536.4	77.3

Applying the overall CGR gross measured realization rates to the gross calculated program savings yields the results shown in Table 4-6. The HES program calculated savings were obtained from the 2008 Phase 1 HES installation databases provided by the utilities.

Table 4-6 Net Measured Program Level Savings

Unit	Gross Calculated Savings	CGR Adjusted Net Measured Realization Rate	CGR Adjusted Net Measured Savings
MMBtu	39,649	54.9%	21,767
kWh	10,936,625	57.2%	6,255,749

The CGR adjusted net measured savings represent the net savings attained by the program through measure installations at participant homes taking in to account the effect of non-participant behavior witnessed in the utility bills. The CGR analysis is a combination of the on-site engineering based impact analysis and the regression based billing analysis conducted to understand the effect of non program impacts on the program and measure level savings. The results of this analysis can be used to study non-program influences such as customer behavior, load changes and energy price increases on program savings. While market attribution factors such as free-ridership, spillover, snapback etc. that have an effect on the program's net savings are included in the total effects, the effect of each cannot be assessed separately. Therefore, free-ridership appears as an increase in savings – a contradictory result. Likewise spillover appears as a reduction of savings, rather than an increase. These two factors offset one another, but the degree to which they offset is unknowable.

4.4 ENGINEERING ADJUSTED BILLING ANALYSIS VERSUS GROSS IMPACT RESULTS

The Engineering Adjusted Billing Analysis realization rates shown in Table 4-6 are vastly different from the Gross Impact realization rates shown in Table 3-21. This is because the Gross Impact analysis is an engineering based calculation that quantifies the savings associated with installed measures while the Engineering Adjusted Billing Analysis is a Net analysis that seeks to isolate the savings due solely to the program by removing the effect of what participants would have done regardless of the program's intervention. Table 4-7 shows a comparison of the Engineering Adjusted Billing Analysis realization rates to the Gross Impact realization rates.

Table 4-7 Gross versus Net Realization Rates

Unit	Gross Impact Realization Rate	Engineering Adjusted Net Realization Rate
MMBtu	107.5%	54.9%
kWh	97.6%	57.2%

The Gross Impact analysis calculated the savings accruing to the individual participants as a result of the installation of measures. However, it does not include measurements of what participating customers would have consumed or conserved regardless of the program's intervention.

The Engineering Adjusted Billing Analysis was conducted with the goal of quantifying the net effect of the program by subtracting out participant behavioral effects and load changes. The magnitude of these effects was quantified by analyzing the billing records of participants and comparable non-participants in pre and post program years. The trends observed in non-participant billing records were subtracted from the trends observed in participant billing records to calculate savings with behavioral and other influences netted out. It is important to note that because some program-related behaviors such as spillover and free ridership remain in the analysis, the savings are not defined unambiguously. The reported net savings may be understated to some extent due to the fact that *all* savings due to non-participant behavior were subtracted from the participant savings, including spillover impacts (behaviors caused by the program but without participating in the program). Alternatively savings may be overstated by the inclusion of free-ridership in the savings estimation, even though savings from free ridership would have been obtained even without a program. In order to completely quantify the magnitude of behavioral savings directly achieved by the intervention of the HES program, a formal attribution study would need to be conducted to quantify free ridership, spillover, snapback and other customer factors.

Important findings from both the Gross Impact analysis and Engineering Adjusted Billing Analysis can be deduced from this evaluation. The Gross Impact realization rates quantify the magnitude of savings from measures installed. The Engineering Adjusted Billing Analysis quantifies the savings caused by the program by eliminating factors that affect both participants and non-participants equally, such as increased awareness and economic conditions. The net Engineering Adjusted Billing Analysis combined with the Gross Impact analysis quantifies the portion of HES participant bill savings that are attributable to program interventions.

A review of the PSD for the measures studied in association with the HES evaluation was completed for the 2010 PSD. The PSD assignment of savings for CFL lighting, water reduction measures and infiltration (blower door) measure changed between 2008 and 2010 versions. The goal of this review was to improve the accuracy of the algorithms, the ease of their implementation, and the quality of the applicable assumptions. The following section includes measure-specific reviews and recommendations for improvements.

5.1 LIGHTING

The savings attributed to residential light bulb replacement in the 2010 PSD are reasonable and conservative. The program incorporates the use of a ratio of incandescent to CFL wattage to determine the baseline fixture wattage, since the specifications of the baseline fixture cannot always be known. This ratio was increased from 3.4 to 1 in 2008 to 4.0 to 1 in 2010.

PSD energy savings for residential direct install CFLs gross are currently calculated by taking the product of the installed CFL wattage, the delta incandescent to CFL wattage ratio, and the annual hours of operation. The PSD source for the incandescent to CFL wattage ratio is a Nexus Market Research[11] study and the source for residential lighting operating hours is an NU analysis[12], itemized by room type.

The gross demand savings are calculated by taking the product of the incandescent to *delta* CFL wattage ratio (3.0 to 1), the CFL fixture wattage and the appropriate seasonal coincident factor. The coincident factors used are from a study by RLW Analytics[13] done directly for the utilities in 2007.

Moving forward the most appropriate calculation methodology for lighting measures can be taken from the Nexus Market Research study which includes hours of operation and coincidence factors by room type. HES project applications are now collecting sufficient room type information for this methodology to be carried out.

5.2 PIPE INSULATION

The PSD assigns savings for pipe insulation through a look-up table based on pipe diameter, pipe length, and fuel type of the equipment that generates hot water. The reference provided for the energy savings entries of the tables does not provide further details of the calculation assumptions and other modeling parameters.

The savings methodology for pipe insulation presented in Section 2.1.2.2 of this report was used to calculate the savings shown in Table 5-1. The savings values are listed by pipe diameter and assume

[11] Residential Lighting Markdown Impact Evaluation, Nexus Market Research, January 20, 2009

[12] Northeast Utilities SPECTRUM Lighting Catalog and Retail Lighting Programs Hours of Use Re-Analysis, December 20, 2001

[13] Coincidence Factor Study Residential and Commercial & Industrial Lighting Measures, RLW Analytics, Spring 2007

10 feet of installed pipe insulation. The savings values from the 2010 PSD are shown for comparison.

Table 5-1 3EPLUS® Annual Savings for 10 feet* of Pipe Insulation

Pipe Diameter (in)	kWh		Therms	
	PSD	Nexant	PSD	Nexant
0.5	55	104	1.2	5.5
0.75	72	159	1.6	8.4

* Savings for less than 10 feet can be linearly scaled.

Nexant recommends that, at a minimum, the program review its current PSD approach for calculating pipe insulation savings as they are much lower than those predicted by 3EPLUS. Nexant has used 3EPLUS for evaluations in other jurisdictions and found it proved to be an accurate predictor of steady state heat loss from an insulated, fluid carrying pipe. The current approach used for 3EPLUS involved using a hot water temperature of 90°F, which is the average between the hot water tank set-point, 120°F, and the ambient unconditioned basement air temperature of 60°F. This average hot water temperature used in conjunction with 8,760 hours was used as an approximation, rather than attempting to model the quantity of instances where hot water is requested and the savings associated with distance from the hot water heater over time. These two parameters will drive the savings achieved by installation of pipe insulation, but quantifying the timing and instances of hot water use is a home-specific parameter. The 3EPLUS approach used to average hot water temperature over annual operating hours is a conservative approximation.

Nexant recommends that CL&P claim no peak demand savings for pipe insulation measures, as they are negligible. UI currently does not claim demand savings for this measure.

5.3 WATER MEASURES

The PSD approach to calculate savings due to low-flow shower heads and faucet aerators are similar, in that both are driven by the difference in flow rate between the baseline fixture and retrofit fixture. The low-flow showerhead savings are determined by selecting 1 of 5 baseline flow rates, from 3.0 gpm to 5.0 gpm, and the fuel source of the hot water heater. The faucet aerator savings are determined by assuming the baseline flow rate is 2.2 gpm (mandated by Federal Energy Policy Act of 1992) and the retrofit flow rate is 1.5 gpm.

The low-flow showerhead savings assumptions are reasonable and conservative. The hot water temperature setpoint is assumed to be 50°F higher than groundwater, and energy factors (efficiencies) for electric, gas, and oil fired hot water heaters are provided. The water usages for showers and faucets are taken from a 1994 study,[14] which is acceptable. However, an alternative that could be considered is a somewhat newer (1999) study from the American Water Work

[14] LBNL-35475, "The Effect of Efficiency Standards on Water Usage and Water Heating Energy Use in the U.S.: A Detailed End-use Treatment", May 1994

Association (AWWA)[15] that lists per capita water usage for faucets, showers and dishwashers among others. Another source for shower usage is the EPA,[16] which specifies an average of 30 gallons per household per day for shower use only. The AWWA source provides per capita water consumption estimates that are based on metered flow-rate data, interviews and water utility record analysis and is considered a more accurate study than the current source of the PSD. Nexant recommends using the FEMP source for shower usage. Nexant recommends using the AWWA source (Figure ES.1, Page xxv) of 10.9 gallons per day, per capita for faucet aerator measures.

5.4 INFILTRATION – BLOWER DOOR

The PSD assigns savings to infiltration reduction measures for retrofit homes according to discrete savings entries listed in tabular format itemized by "measure" (electric heat, heat pump, air handler, cooling, etc). The savings in this table[17] were developed by a simulation model in REM/Rate[18]. Nexant would need to be able to review the assumptions for REM/Rate model to assess their validity. The use of modeling and simulation to calculate savings due to building envelope modifications is appropriate, as long as the model is an accurate representation of the home in question and is calibrated using baseline billing determinants. The program approach for calculating savings is an accurate and cost-effective alternative to developing home-specific models.

[15] "Residential End Uses of Water", AWWA Research Foundation, Peter W. Mayer, William B. DeOreo, 1999

[16] http://www.epa.gov/WaterSense/products/showerheads.html

[17] Table 2 in Section 5.4.4 of 2010 PSD, p.149

[18] REM/Rate™ analysis done by Vinay Ananthachar, Northeast Utilities, August 2008

Program comprehensiveness was investigated to determine the extent to which the HES program has installed all appropriate and agreed-upon measures, captured available savings in each home to limit lost opportunities and to uncover any barriers to comprehensive installations. Included in this section are the Phase 1 measure-specific results gathered through on-site inspections, as well as results from surveys conducted with both participants and vendors.

6.1 PROGRAM COMPREHENSIVENESS

For over 90% of inspected homes, participants reported that contractors were diligent about investigating the implementation of all possible HES Phase 1 measures. Installed measures were always discussed with residents, so that they understood the effectiveness of the measures and approved their installation. Residents appreciated the program's offerings. Many stated that their participation left a lasting positive impression. Kitchen table wrap-up discussions ensured that the residents understood all measures and offered the contractor an opportunity to introduce both Phase 2 and other measures. Participants did indicate that having information on the monetary savings associated with recommended measures would allow them to make a more informed decision and they would like to see more dollar-per-measure saving estimates in program literature. The on-site visit inspections revealed that measures indicated in program documents generally matched what was found in the field and that contractor execution was comprehensive and thorough. The level of comprehensiveness is discussed below using a measure specific approach.

6.1.1 Lighting Measures

All projects inspected on-site included lighting retrofits to some degree. In all cases, contractors installed the replacement CFLs and left the removed incandescent bulbs with the resident. The quantity of bulb replacements listed in project documentation was found to be accurate in over 70% of projects surveyed. Approximately 7of the 40 surveyed homes still had remaining incandescent bulbs that should have been replaced, based on program specifications, but were not – generally due to participant preference. Some residents thought the CFLs were too dim for bathroom lighting or a reading light. Two homes were encountered in which the resident stated that the contractor ran out of CFLs and therefore could not replace all the incandescent bulbs. In the UI program, where the number of CFLs installed was limited to 14, approximately 80% (7 out of 9) of projects surveyed reached the maximum allotted quantity of CFLs, but all still had remaining lighting opportunities unaddressed. Among these (7) homes, an average of 13 additional incandescent light bulbs per home were observed as missed opportunities. This observation agrees with the feedback offered by installation contractors (Section 6.2.2) that the programs caps on lighting were overly restrictive and left potential lighting savings unrealized.

Program-installed CFLs were removed or replaced after contractor installation in five projects (12% of inspected homes). Four residents replaced failed CFLs with their old incandescent bulbs. The quantity of replaced bulbs was three or fewer. One resident replaced three operational program CFLs with incandescent bulbs due to unacceptably low light levels.

6.1.2 Infiltration Measures

Many residents reported less drafty homes and a more comfortable living environment, as a result of the installed infiltration measures. Residents indicated and Nexant inspectors verified that contractors were thorough in providing the following:

- door sweeps
- weather-stripping
- expandable foam
- gaskets for attic hatches
- sealant around pipe entrances under sinks
- sealing around any other large sources of air leakage

In order to quantify the level of comprehensiveness of infiltration reduction measures, the blower door measured infiltration results obtained during on-site inspection were compared to the standards established in a 1998 study by the Lawrence Berkeley Laboratory (LBL)[19]. Table 6-1 presents the characterization of all homes where a blower door test was performed in order to measure infiltration.

Table 6-1 Characterization of Measured Home Infiltration Rates

Leakage Class	Min.NACH	Max.NACH	Typical ACH50	Homes w/ Air Sealing	Homes w/o Air Sealing	Total Homes in Sample	% of Measured Sample	Leakage Class Description
A	0	0.1	1	0	0	0	0.0%	Airtight - ventilation needed
B	0.1	0.14	2	0	0	0	0.0%	Looser, but still considered tight construction - ventilation needed
C	0.14	0.2	3	0	0	0	0.0%	
D	0.2	0.28	5	1	2	3	7.9%	Leaky, but still likely to require added ventilation
E	0.28	0.4	7	1	2	3	7.9%	
F	0.4	0.57	10	12	4	16	42.1%	Sufficiently leaky to not require added ventilation
G	0.57	0.8	14	6	1	7	18.4%	
H	0.8	1.13	20	4	0	4	10.5%	Homes in this range usually represent opportunities for cost-effective tightening
I	1.13	1.6	27	3	2	5	13.2%	
J	1.6			0	0	0	0.0%	
Total				27	11	38	100%	

The LBL study presents the leakage classes shown in Table 6-1 which correspond to levels of Natural Air Changes Per Hour (NACH) or the Typical Air Changes per Hour at 50 Pascals (ACH50). The ACH50 was calculated for each home as the blower door test CFM divided by the home's volume in ft^3 multiplied by 60 minutes/hour. The LBL leakage classes A, B and C represent blower door results

[19] http://epb.lbl.gov/publications/lbl-35173.pdf: Lawrence Berkeley Laboratory, "The Use of Blower Door Data", March, 1998.

that suggest a home is too tight and requires ventilation while leakage classes H, I and J represent homes where opportunity for implementation of cost-effective air sealing measures exist.

Table 6-1 indicates that 76% of homes tested were categorized between classes D and G which are considered to have appropriate levels of natural infiltration. The remaining 24% were categorized between classes H and I which suggest that additional opportunities for implementation of cost-effective air sealing measures still exist. Examining homes that did not receive air sealing showed that only two homes fell in to the range suggesting air sealing opportunities still exist. This seems to indicate that implementation vendors did a sufficient job of not leaving cost effective opportunities unaddressed. Alternatively, of homes that received air sealing, seven were categorized as having additional cost-effective air sealing opportunities that still existed. Of these seven homes, five showed CFM improvements over the program cap of 10%, but still had remaining opportunity for cost effective infiltration reduction. The data suggests that there is considerable, but not excessive opportunity for additional infiltration measures at homes which received air sealing up to program caps.

In addition to the measurement data suggesting lost opportunity for air sealing, contractors also offered qualitative feedback indicating that some homes left some portion cost-effective air sealing on the table due to program caps. In order to capture this missed savings opportunity, Nexant recommends removing the 10% CFM improvement cap and instituting a cap that considers both CFM improvement and ACH50. Contractors should be incentivized for CFM improvement on a $/CFM basis, without limit, up to an ACH50 value of 10 (corresponds to LBL[20] leakage Class F).

6.1.3 Pipe Insulation

Pipe insulation was installed in 10 of the 40 homes that were inspected. In 9 of the 10 homes that received pipe insulation, contractors were able to insulate the entire length of bare pipe within the program limit of 10 feet. The remaining home contained approximately 14 feet of un-insulated pipe, but was only provided 10 feet of insulation through the program. This indicates that the program cap of 10 feet is appropriate, especially considering that associated savings further than 10 feet away from the hot water tank become increasingly negligible. Only one home was encountered in which the installed length was shorter than the stated length in the project record (3 feet installed, 9 feet stated).

Of the 30 sites that did not receive pipe insulation, bare hot water pipes in the form of lost opportunity were found in two homes, or about 7%. In both of these cases, the exposed length of pipe was less than 5 feet. This indicates that contractors were thorough in assessing this measure and implementing it appropriately.

Contractors installed insulation primarily on domestic hot water piping exiting a hot water heater. In some cases, hot water baseboard heating pipes were insulated near their point of origin at the

[20] http://epb.lbl.gov/publications/lbl-35173.pdf: Lawrence Berkeley Laboratory, "The Use of Blower Door Data", March, 1998.

boiler or hot water heater. The tubular foam insulation was uniform across all homes and fairly easy to spot during inspection.

6.1.4 Water Measures

Low-flow water measures were installed in 22 of the 40 homes that were inspected. Of the 18 homes visited where low-flow measures were not installed, the following observations were made:

- Two residents stated they rejected installation of low-flow showerheads or faucet aerators, due to preference in maintaining their current flow levels.
- One resident declined this measure for aesthetic reasons, stating that the program equipment would disrupt the decorative theme of the bathroom or kitchen.
- One resident who was willing to install a low-flow showerhead said that contractors indicated that they could not complete the installation, due to fear of breaking the supply pipe on the difficult-to-remove existing showerhead. During the inspection visit for this particular home, rust was visible on the exposed threads of the supply pipe, just above the existing showerhead. It is very plausible that the contractor attempted to remove it, but decided not to after encountering excessive difficulty.
- 6 residents stated that, to their recollection, the contractor did not investigate this measure. In each of these homes Nexant observed all flow-rates to be standard; ie. faucet aerators (2.2 GPM or higher) and showerheads (3.0 GPM or higher).
- 8 residents already had low-flow equipment installed on their most frequently used faucets and showerheads.

Of the 22 residents who agreed to install these low-flow measures, 2 reported having to take longer showers and 1 stated that more effort was required to hand-wash dishes, but that this change was acceptable to them. Two homes were found where residents initially agreed to these two measures, but quickly switched back to their original showerhead and/or faucet heads because of dissatisfaction with the low-flow program equipment.

6.2 SATISFACTION AND GENERAL FEEDBACK

Interviews with participant homeowners and installation vendors were completed that allowed each party to provide feedback about their HES experience. Separate survey instruments were developed for homeowners and vendors to capture satisfaction levels and to allow for any feedback.

6.2.1 Participants

The HES program left a positive impression with participating homeowners. Question 17 of the resident interview form asked homeowners to rate their satisfaction level of the program on a scale of 1 to 5 (1: Not satisfied; 5: Completely satisfied). The average response was 3.9. The median response was 4 and there were a total of 6 responses for either 1 or 2. As a result of their HES experience, more than half of homeowners indicated their level of education and energy awareness had increased, and they will likely install more energy efficiency measures in the future.

Most residents felt that their home was thoroughly evaluated and that contractors did a good job explaining the program and the effectiveness of the measures. Residents also provided positive feedback regarding the kitchen table wrap-up discussion and welcomed the opportunity to discuss home energy issues with the contractor. Many residents stated that contractors offered advice about Phase 2 measures and non-program sponsored measures that would offer not only reduction in energy costs, but also improve the comfort of the home. A total of 5 residents indicated intent to use program distributed rebates, but the time period for which the rebates were valid did not allow them significant time to make such a large purchase. These residents indicated that a 1 to 1.5 year lead time would allow them to secure finances to take advantage of a Phase 2 rebate.

Most residents reported that contractors usually arrived in teams of two. The average reported visit time was approximately three hours. Residents expressed satisfaction that two-person teams allowed one technician to execute tests and install measures, while the other team member explained the process and spent more time interviewing the resident. Due to the high volume of information presented in a relatively short assessment, some participants suggested that contractors perform follow-up consultation on installed measures or follow-up phone calls for further education regarding Phase 2 measures.

Fewer than 10% of residents had critical feedback regarding the contractor and/or the program. One resident reported looking forward to the blower door test and associated infiltration measures, but the contractor stated that the home was not eligible, due to the fuel oil boiler and not having central AC. Two residents indicated dissatisfaction that program caps prevented them from replacing all incandescent bulbs. Negative feedback was not prevalent for any particular contractor. Residents were generally pleased with program offerings and the method of implementation.

Approximately 50% of participants indicated that they were energy conscious to some degree and operated their home in a manner to conserve energy. Operational behavior commonly included being diligent about turning off lights in unoccupied rooms and setting the thermostat at comfortable but not excessive levels. Their motivation was mostly rooted in financial concerns but some expressed environmental reasons as well. These residents were also more likely to have some existing CFL's and programmable thermostats. All indicated that they welcomed the opportunity to participate in HES in hopes of learning something new and reducing their energy consumption.

As a way to recruit a greater quantity of less energy conscious potential participants Nexant recommends including more non-energy benefits in the marketing material. For instance, better air quality, greater occupant comfort and a more even temperature distribution could be listed as possible advantages for participating in the HES program.

6.2.2 Vendors

A list of 20 HES implementation vendors was received from the utilities and telephone surveys were administered to gather vendor feedback. A total of seven vendors agreed to have a discussion regarding their HES participation.

The general opinion of the vendors was that the HES program does a good job of achieving savings through cost-effective measures, but they all agreed that more opportunities to save energy exist at all homes and that the vendor compensation structure and administrative aspects of the vendor-Company relationship could be improved. Most vendors had constructive comments on how program improvements could be achieved, including feedback regarding program measures, non-program measures, program-imposed limits, and compensation structure.

One theme that was common among all vendors comments was that there were generally two types of HES program participants:

- Energy efficiency enthusiasts - identified by already having basic energy efficiency measures (CFLs, programmable thermostats, door sweeps, etc.) installed in their homes and a greater knowledge of the advantages of an energy-efficient home.
- Casual program participants - generally unaware of basic energy-efficiency measures and owned homes that included only incandescent light bulbs and manual HVAC operation.

Vendors stated that there was more incentive and opportunity for them to perform assessments complete installations for homeowners they categorized as casual participants.

Program Caps

Vendors considered all current HES Phase 1 measures to be effective, but most thought these measures could be implemented to a greater extent. For instance, vendors felt the UI limits for CFLs (10 specialty bulbs, 4 regular bulbs) were overly restrictive and left potential lighting savings unrealized.

Vendors also expressed concerns regarding program caps for air sealing and duct sealing measures. Vendors were unanimously of the opinion that it is more cost-effective to seal all air and duct leaks while they are performing the blower door test and duct sealing test, irrespective of the program CFM reduction caps. The time intensive set-up involved for these tests warrants a thorough sealing job. For example, achieving a 10% CFM reduction by only installing a door sweep on the interior basement door is leaving a lot of potential savings on the table. One vendor proposed a tiered compensation structure for air and duct sealing measures suggesting $1/CFM up to 20% reduction and $0.50/CFM for further reductions. This structure would motivate vendors to install more difficult, time consuming infiltration measures, such as stud sealing in attic corners or other difficult-to-access areas.

Measures and Services

Vendors also suggested that the HES program was missing an element of homeowner involvement and accountability. Installed measures are sometimes uninstalled after vendor installation, and there is little homeowner follow-through. Vendors said that homeowners sometimes agree to the installation of free measures without seriously considering changes the measures could introduce. This was most common for low-flow showerheads and faucet aerators where homeowners initially agreed to have them, but shortly switched back to their original fixtures. Vendors suggested that if homeowners had a “stake” in their energy reduction, they would be more likely to maintain the installed measures or give serious consideration to measures before agreeing to have them installed. Suggestions for ensuring savings persistence included requiring payment of a fee on the front end of HES site visit or applying a monetary incentive if their bills showed a year-over-year reduction.

Finally, while vendors liked the idea of the kitchen table wrap-up, they felt that many homeowners do not have the endurance to absorb more information after an intensive 3-4 hour visit. It was suggested that perhaps written documentation for Phase 2 measures could be provided, for the homeowner to review at a later time. The vendor could then make a follow-up phone call after the homeowner has reviewed the provided information.

Other measures that vendors would like to see offered by the program could be categorized as safety-related and efficiency-related. Safety measures included carbon monoxide sensors, checking for asbestos, checking for lead paint, and inspecting smoke alarm functionality. Proposed energy efficiency measures included refrigerator coil service (cleaning and brushing), occupancy sensors, bathroom fan timers, kWh meter on Company meter, attic hatch covers, power strips with “kill” switch for TVs and electronics, audible whistle for furnace filter change, window air conditioning covers, and LED lighting.

<u>Lead Generation</u>

For some issues, vendor responses diverged based on size and experience. Larger and more established vendors with greater experience preferred finding their own leads and suggested that utilities should provide a bonus for these enrollees. These vendors were also not interested in Company-sponsored marketing of their businesses. Smaller vendors with less experience and confidence who routinely receive leads from the utilities were more likely to express contentment with the compensation structure. All of the smaller vendors were interested in Company sponsored marketing for their businesses.

<u>Compensation Lag</u>

All vendors indicated that it took the utilities too long to provide payment for completed HES visits. Most quoted a 45-60 day timeframe to receive payment, which they felt was unacceptable. One vendor was willing to pay a slight premium for expedited payments.

The different reporting rules and forms between the two utilities was also something suggested by all vendors as a cause of delay on their end. A more uniform reporting structure would be appreciated by all vendors.

The evaluation of the HES program sought to measure energy impacts, provide gross realization rates, identify the level of comprehensiveness, and gauge participant satisfaction.

7.1 GROSS IMPACTS

The gross realization rates were calculated and can be applied at the program level with a confidence interval of 80% at the precision levels shown. These rates are summarized in Table 7-1.

Table 7-1 Realization Rate Summary

Unit	Realization Rate	Relative Precision
MMBtu	107.5%	±45.4%
kWh	97.6%	±5.1%
Summer Peak kW	83.4%	±16.7%
Winter Peak kW	91.9%	±5.6%

Differences in gross measured summer peak kW savings and program claimed savings were primarily due to Nexant's simulation model calculating lower peak kW savings for cooling equipment in association with air sealing measures. The realization rate for gas savings was dominated by eQUEST model results, where Nexant savings were greater than program savings.

7.2 NET IMPACTS

The CGR adjusted net realization rate and associated net savings are summarized in Table 7-2.

Table 7-2 Net Measured Program Level Savings

Unit	HES Claimed Savings	CGR Adjusted Net Realization Rate	CGR Adjusted Net Savings
MMBtu	39,649	54.9%	21,767
kWh	10,936,625	57.2%	6,255,749

The purpose of the billing analysis study was to separate out non-program effects from those attributable to the program. The billing analysis study showed that both participants and non-participants across all fuel categories reduced their energy usage from 2007 to 2009. The results speak loudly of the economic climate during this timeframe, in that many homeowners have become more energy conscious. They have become aware that a large percentage of their monthly costs are rooted in home energy consumption and the way they operate the HVAC equipment and lighting fixtures.

7.3 PROGRAM COMPREHENSIVENESS

Site inspection visits and interviews with participants suggested that the program is being delivered in a thorough and comprehensive manner. Implementation vendors, however, believe that program caps, need for additional measures and the long assessment visit cause opportunities to be left on the table. Nexant's comparison of the measured infiltration rates against the standards established by the Lawrence Berkeley Laboratory suggested approximately 25% of homes studied showed remaining opportunity for cost-effective infiltration reduction above the current program cap.

Nexant found few instances where measures were not installed according to program protocol and or in numbers different from those reported in project documentation. Homeowners reported that they felt well-informed throughout the assessment process and had gotten substantial information on the benefits of accepting program measures. Permission was always sought by implementation vendors prior to installation.

Program implementation vendors praised the program for what they thought it was doing correctly, but they also offered constructive criticism for perceived shortcomings. Vendors would like to see caps removed from the program for air sealing and duct sealing measures. Increased marketing was something that all smaller vendors would be interested in, while larger vendors preferred to be receive increased compensation for self-generated leads. All vendors expressed concern with the timeframe in which they receive payment. Some volunteered to pay an additional accounting fee if payments could be provided faster.

7.4 PSD REVIEW

The calculation methodology in the PSD for CFLs and infiltration measures are appropriate as presented. Savings calculations associated with CFLs are using region-specific studies for parameters such as delta wattage factors and hours of operation. Infiltration results are calculated using a simulation model calibrated to the HES service territories.

Nexant has made recommendations suggesting an alternative method to calculate pipe insulation savings. It is based on the approach used in this evaluation that uses the pipe insulation software, 3EPLUS®. Sources for residential water consumption, in association with water reduction measures, have also been recommended, faucet use from a study done by AWWA and shower use from FEMP.

7.5 FINDINGS AND RECOMMENDATIONS

The following summarizes the major findings of the evaluation and presents their corresponding recommendations. Nexant recommends the following changes to the HES program:

- **Finding**: Difficulty assembling monthly energy consumption records for billing analysis.
  - **Recommendation**: Develop a well-organized enterprise relational database system at CL&P and Yankee Gas that more cleanly links gas and electric account data.
- **Finding**: HES database systems are not uniform across Companies.

  - **Recommendation**: Create a consistent database system for all HES program administrators that allows the HES participant records from multiple companies to be compiled easily.
- **Finding**: Vendor and participant interviews indicated that a large percentage of HES participants identified themselves as being energy conscious and operating their home to conserve energy. These customers generally have limited additional opportunities for savings and are more likely to be free-riders.
  - **Recommendation**: Marketing of the HES program should be redirected to attract a greater quantity of casual, less energy-conscious participants. HES marketing material should include more non-energy benefits such as better air quality, greater occupant comfort and more even temperature distribution. This would result in greater savings per home and more cost effective site-visits.
- **Finding**: Participants indicated that having more information on the monetary savings associated with recommended Phase 2 measures would allow them to make a more informed decision about potential installation and they would like to see more dollar per savings information in program literature.
  - **Recommendation**: Estimates of recommended Phase 2 energy savings (in dollars) per measure should be included in marketing literature.
- **Finding**: Under the UI HES program, where a 14 CFL per-home cap exists for lighting measures, approximately 80% of inspected homes reached the cap, but still had unaddressed lighting opportunities that remained.
  - **Recommendation**: The program caps placed on CFLs in the UI HES program should be removed in order to capture the missed savings opportunities observed during home inspections.
- **Finding**: Table 6-1 showed that approximately 24% of homes inspected were categorized as having additional opportunities for implementation of cost-effective air sealing measures, derived from their blower door test results.
  - **Recommendation**: The program caps placed on air sealing should be removed and replaced with a cap that considers both CFM improvement and ACH50. Contractors should be incentivized for CFM improvement on a $/CFM basis, without limit, up to an ACH50 value of 10 which corresponds to LBL[21] leakage Class F. See details in Section 6.1.2.
- **Finding**: Vendors indicated a need to be compensated for self-generated leads. As the HES program matures and gains greater market penetration, new participants will be more difficult to acquire.
  - **Recommendation**: An incentive premium should be offered to contractors for self-generated leads.

[21] http://epb.lbl.gov/publications/lbl-35173.pdf: Lawrence Berkeley Laboratory, "The Use of Blower Door Data", March, 1998.

- **Finding**: Due to the high volume of information presented in a relatively short home assessment, some participants indicated the need to have contractors perform follow-up consultation on installed measures or follow-up phone calls for further education regarding Phase 2 measures.
  - **Recommendation**: To promote greater participation in Phase 2 offerings, contractors should be encouraged to follow up with homeowners approximately one month following the on-site assessment.
- **Finding**: A total of 5 residents indicated intent to use program distributed rebates, but the time period for which the rebates were valid did not allow them significant time to make such a large purchase.
  - **Recommendation**: The application deadlines on Phase 2 offerings should be extended, to allow homeowners additional time to plan for large expenditures in their budgets.
- **Finding**: Nexant found significant differences between the savings verified for pipe insulation measures and water reduction measures and what is currently stipulated by the HES PSD.
  - **Recommendation**: The PSD savings calculations for pipe insulation and water measures should be revised according to the suggestions in Section 5.2 and 5.3.

7.6 RECOMMENDATIONS FOR FUTURE EVALUATIONS

Future evaluations of the HES program should incorporate enhancement to improve precision, and eliminate roadblocks identified in this study. Nexant recommends:

- Measures that achieve natural gas savings should be evaluated separately using an on-site inspection sample based on gas savings so that their impacts can be reported with better statistical precision. Moreover, it is essential that full data be available to document gas savings
- The billing analysis showed that comparable non-participants exhibited a large decrease in their energy bills from 2007 to 2009. The change in energy usage of non-participants was similar to the participants and was deducted from the installed measure savings to calculate net savings. The effects of market attributes like spillover and free ridership were included in this analysis and could not be isolated due to the lack of attribution results. Future evaluation studies should include a Net-to-Gross study to quantify market effects including free-ridership, spillover and snapback to better isolate the effects of non program impacts like economic price fluctuations and load changes.
- The instant study could not include the impacts of Phase 2 measures due to limited numbers and difficulty recruiting participants who elected to install Phase 2 measures. Phase 2 measures should be studied using an independent, statistically valid, home inspection sample.

The following guide was used for HES home site inspection visits to supplement the Residential Inspection Form, by providing the Nexant inspector with additional guidance for each of the measures below.

CT HES Evaluation
Home Inspection Guide - CL&P

Measures
1. Lighting Retrofits
2. Water Retrofits (low-flow shower heads, faucet aerators)
3. Pipe insulation
4. DHW temperature turn-down and tank wrap
5. Blower Door

1. Lighting Retrofits
In the project database (for CL&P projects), there is a field labeled “Number of Bulbs”, which is the total number of CFLs installed by the contractor. There are also fields such as “60-Watt Light Bulb” which indicate how many 60W bulbs were replaced with CFL equivalents. If possible, look at fixtures in the immediate area to see that they were replaced. Ask if they are replacing dead CFLs with the old incandescent or not.

2. Water Retrofits
In the project database (for CL&P projects) there is a field labeled “Number of Water Widgets”. The most common application of this measure was low-flow shower heads and faucet nozzles in kitchens and bathrooms. Ask the resident how many were installed, where they are and if they are still in operation. Ask about the average quantity showers/day and minutes/shower or average faucet use per day; quantity/day and minutes/quantity. Ask to see baseline fixtures if still on-site.

3. Pipe Insulation
In the project database (for CL&P projects) there is a field labeled “Number of Feet of Insulation”, which is the pipe insulation that was placed on the domestic hot water pipes. The most common location of this insulation is on the first 6-10ft of pipe exiting the domestic hot water boiler. Program sponsored insulation is dark gray and about ½ inch in thickness. It is usually attached with black electrical tape or some other heat resistant tape. Determine setpoint temperature on DHW heater. Estimate ambient temperature in basement. Note if piping in is conditioned or unconditioned space. Use IR gun to get temperature of any exposed pipe. Use thermometer to get estimate of ambient basement temperature.

4. DHW Tank turn-down or tank insulation
In the project database (for CL&P projects) there is a field labeled “Number of Tanks Turned Down” and “Number of Tanks Wrapped”. For “Number of Tanks Turned Down” the contractor should have indicated the number of degrees Fahrenheit that the tank was turned down. Ask the resident if this was done, and if they know the number of degrees that the set-point was reduced. Ask if the tank has

remained at this reduced set-point or if they have subsequently increased it. Check against what is specified in the project database. Note any discrepancies.

For "Number of Tanks Wrapped", the contractor should have listed the quantity of domestic hot water tanks wrapped. If this measure was implemented, check to see if the tank is wrapped and ask the resident if he or she recalls the measure being installed as part of HES.

5. Blower Door

In the project database (for CL&P projects) the fields relevant to the blower door test are:

- CFM(Initial)
- CFM(Post)
- Natural ACH(Initial)
- Natural ACH(Post)
- CFM Reduction

The following procedure should be executed when administering the blower door test. The following steps are meant to supplement the procedures listed in the blower door equipment manual.

1. Prepare the home
    a. Make sure all exterior doors and windows are closed
    b. Interior doors and windows should be open. Bedroom, bathroom, etc.
    c. Closet doors are not a big deal, if open or closed
    d. Make sure the fireplace flue, wood stove flue or gas stove flue are in the closed position. Put newspaper on any ashes resting in the fireplace so they don't blow around during the test
    e. For natural gas domestic hot water heaters, engage the PILOT setting
    f. Ask the resident to turn off any HVAC systems
    g. Ask the resident if they recall any infiltration measures that the contractor installed, such as:
        i. Door sweeps
        ii. Weather stripping
        iii. Caulking around windows/doors
        iv. Expandable foam in bigger leaky areas in attics or basements
        v. Sealing of pipes underneath kitchen sinks/bathroom sinks
        vi. Take note of what was done
2. Prepare the door where the blower-door equipment will be deployed
    a. Open the door and make sure the any storm door is in its most open, propped position
    b. Plan to put the blower door frame where the door lies, in its closed position
    c. Open the gun case and situate the (4) aluminum beams. Attach them with the spring-pegs and make sure the rubber knobs are loose
    d. Place the aluminum BD frame in the door frame and extend to a snug position, using the rubber knobs to lock the lengths in place
    e. Find a nice spot to lay the red canvas on the ground. Ensure that the logo is facing up so the velcro can be attached
    f. Remove the BD frame and place it on top of the canvas with the knobs facing up
    g. Start velcroing the canvas to the BD frame. Start at the bottom and work your way up, pulling the canvas horizontally and vertically to ensure a snug fit

h. Raise the BD frame/canvas to vertical position and place NEAR the door frame
i. Before you "lock" yourself inside ensure that the following is done
    i. The fan and other BD equipment is all inside
    ii. You have pen and paper with you, all inside
    iii. Run the red tube from the fluke through the hole in the lower portion of the canvas and ensure it's in a nice spot outside the door. Make sure it won't get wet and that it's not too close to the fan
j. Now "lock" yourself inside by placing the BD frame/canvas in the door frame.
k. Engage the (4) locking cams. Poke your head through the elastic hole to ensure snugness of BD frame to door frame. Look at all four corners
l. Find the cross-bar (BD frame piece #5) and install it horizontally in the top set of slots. Make sure its snug and engage its locking cam
m. Wrestle the fan out of the box. Make sure the direction of the fan is blowing air out of the house. Employ the "A" and "B" plates for average size (~2,000ft2) homes. Grab the fan at 3 and 9 o'clock. There's a little hook at the bottom of the fan which you should attempt to "catch" on the 6 o'clock portion of the elastic ring. With this accomplished, allow the fan to rest on the bottom BD frame bar and your knees. Now position both your hands at 6 o'clock and between the fan and the elastic ring. Run your hands from 6 o'clock to 12 o'clock, ensuring that the elastic ring remains snug on the fan's outer case. If all went okay, the elastic ring should be sealed against the fan case.
n. Undo the piece of velcro on the cross bar and loop it through the carrying handle on top of the fan. The fan should be resting in the correct position without any assistance now
o. Holder

3. Connect all the fluke tubes and power cords for the fluke and fan
4. Make sure the fluke, your briefcase, shoes, fan box or anything else is not in front of the fan
5. Turn on the fluke and do the following
    a. Hit Exit to go to home screen
    b. Make sure the device is correct "Retrotech 2000"
    c. Make sure time averaging is ON
    d. Do a baseline
    e. Set mode to AirChg/hr
        i. Hit Enter
        ii. Enter home volume (from project database or use ft^2 * 8)
        iii. Hit Enter
    f. Hit "Set Pressure"
    g. Set pressure to 10Pa, hit enter
    h. Fan should start up
    i. When PrA hits 10Pa take the readings for the following parameters. Use the "Mode" button to toggle through
        i. Flow
        ii. EqLa (in^2)
        iii. AirChg/hr
        iv. Fan speed %(lower right hand corner)
    j. Now hit "Toggle". Hit the up arrow to change the set pressure to 20Pa. The toggle arrows will increase the pressure in increments of 5Pa.
    k. Once PrA hits 20Pa, record the same four parameters listed above

l. Do this for set pressures of 30Pa, 40Pa and 50Pa
    i. IF the fan speed gets to 100% and the pressure is not reached, remove the "B" plate and run the test again. Remove the "A" plate if fan still cannot reach the target pressure
    ii. IF the fluke says "FLOW TOO LOW", insert the "C" plate and run the test again
m. Once the fan reaches the 50Pa set pressure, give the resident the opportunity to walk around the house to investigate any suspected leaky windows and/or doors
n. After this, hit "Exit" to stop the fan. Hit "ON/OFF" to turn off the fluke
o. Remove the fan and BD frame in reverse order
p. Pack all away, nicely.

B.1 On-site Data Collection Form& Resident Interview Form

Inspector		Date		Time	

Site Information:

Name	
Address	
City	
Zip	
Phone #	

GENERAL BUILDING INFORMATION:

Home Age [yrs]		Heated ft^2		# Stories		# Occupants	

Home Type		SFD		2-4 units		> 4 units		Mobile

Notes: *Make special note to record any missed energy conservation opportunities found during the inspection.*

Heating Systems:

#	Fuel	Htg System Type	% of home heated	Age	Eff*	Mgft	Model #	Capacity [Btu/hr output]	Cond'g or Sealed Comb.?	Distr Sys.
Retrofit/Existing Equipment …										
Baseline Equipment (if applicable) …										

*indicate AFUE or combustion efficiency

Cooling Systems:

#	Clg System Type	% of Home Cooled	Age [yrs]	Eff*	Capacity [Btu/hr output]	Mgft	Model #
Retrofit/Existing Equipment …							
Baseline Equipment (if applicable) …							

* indicate EER or SEER

Ducts (if applicable):

#	Ducts sealed?	Insulated?	Location*	Sealed by HES?
*i.e. unconditioned crawlspace, conditioned crawlspace, attic, etc.				

Distribution Systems	
Code	**Description**
FA	Forced Air
BB	HW Baseboard
HWR	HW Radiator
SR	Steam Radiator
R	Radiant
FC	Fan Coil

Heating Systems		Cooling Systems		Fuels	
Code	**Code**	**Code**	**Description**	**Code**	**Description**
F	Furnace	CAC	Central AC	FO	Fuel Oil
HWB	HW Boiler	WAC	Window AC	NG	Natural Gas
SB	Steam Boiler	HP	Heat Pump	E	Electricity
HP	Heat Pump	DE	Direct Evaporative	P	Propane
EBB	Elec. Baseboard	IE	In-direct Evaporative	W	Wood
SH, NV	Non-venting space heater	CAC,W	Central AC, water cooled condenser	C	Coal
SH,V	Venting space heater			S	Solar
ST	Stove			OT	Other
S	Solar				
OT	Other				

Thermostat Schedule

Current T-stat setting	

Approximately what temperature is it outside when the AC first comes on in the summer?	
Approximately what temperature is it outside when the heating comes on in the fall?	

Enter all data for the hour ending indicated in the table. For instance, under the column labeled 8am, enter the T-stat setting in place from 7 am till 8 am.

Start Month												End Month												
	AM											PM												
Day	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Mon																								
Tues																								
Wed																								
Thur																								
Fri																								
Sat																								
Sun																								

Start Month												End Month												
	AM											PM												
Day	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Mon																								
Tues																								
Wed																								
Thur																								
Fri																								
Sat																								
Sun																								

Start Month												End Month												
	AM											PM												
Day	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Mon																								
Tues																								
Wed																								
Thur																								
Fri																								
Sat																								
Sun																								

DHW Heaters:

#	Fuel	System Type	Age	Energy Factor	% of DHW load met	Hot Water Temp	Tank Size [gal]	Tank height [in]	Tank diam. [in]

DHW Heaters (cont)

#	Tank Insul Type	Tank Insul thickness [in]	Mfg.	Model #

DHW Tank and Pipe Insulation

	Tank Wrap			Pipe Insulation				
#	Tank Wrap Insul. Type	Tank Wrap Thickness [in]	Supplied by HES?	HW Pipe Insul. Type	Pipe diameter [in]	HW Pipe Insul. Thickness [in]	Pipe Insulation Length [ft]	Supplied by HES?

DHW Fixtures:

Measure the flow rates for the following fixtures and note ay low flow devices.

End Use	**Flow Rate [gpm]**	**Low flow device?**	**Supplied by HES?**
Kitchen Faucet			
Bath Faucet #1			
Bath Faucet #2			
Bath Faucet #3			
Shower #1			
Shower #2			
Shower #3			

Insulation Type	**Code**
Fiberglass	FG
Foam	F

DHW Heater Types	**Code**
Tank	T
Instantaneous – tankless	I

Low Flow Device	**Code**
Faucet Head On/Off	On/Off
Dual Thread	DT
Flip Swivel	FS

Lighting:

Collect as much baseline information as you can.

	Post Retrofit				Baseline**			
Room	Lamp Type	Length [in]*	Watts	Qty	Lamp Type	Length [in]*	Watts	Qty

*For fluorescent tubes

** Discuss with site contact to make your best estimate.

Lamp Codes	
Type	**Code**
Incandescent	Incan
Compact Fluorescent	CFL
T5 Fluorescent	T5
T8 Fluorescent	T8
T12 Fluorescent	T12
Light Emitting Diode	LED

Appliances:

Appliance	Age [yrs]	E-Star?	Bought with HES Rebate?	Age of Baseline Unit [yrs]

Exterior Walls:

#	Constr. Type	Orientation*	Area [ft2]	Insul. Layer #1		Insul. Layer #2	
				Insul. Type	**Insul. Thickness [in]**	**Insul. Type**	**Insul. Thickness [in]**
Retrofit/Existing Insulation …							
Baseline Insulation (if applicable) …							

*N = 0 deg, E = 90 deg, etc. CT's approx. magnetic declination is 13 deg W of true N.

Windows:

#	Wall #	# glazing	Frame Material	Low-e? (1)	Storm Windows?	Storms Used?

(1) Low-e coatings and the number of panes of glass can be determined using a lighter or a flashlight. The number of reflections equals the number of panes and reflections with a greenish cast indicate a surface coated with a low-e coating.

Attic/Ceiling:

#	Constr. Type	Area [ft^2]	Insulation Type	Insulation Thickness [in]	Vented?
Retrofit/Existing Insulation …					
Baseline Insulation (if applicable) …					

Foundation:

#	Type	% of Footprint	Heated?	Floor insulation		Foundation Insulation		
				Type*	Thickness [in]	Placement	Type*	Thickness [in]
Retrofit/Existing Insulation …								
Baseline Insulation (if applicable) …								

* use insulation codes

Construction Type Codes	
Attic/Ceiling Construction Type	**Code**
Attic	A
Cathedral	C

Wall Construction Types	Code
2x4, 16" O.C.	2x4,16
2x4, 16" O.C, foam	2x4,16,F
2x6, 16" O.C	2x6,16
2x6, 16: O.C., foam	2x6,16,F
Structurally insulated panels	SIP
Solid masonry, ext insulation	SM,E
Solid masonry, interior insulation	SM,I
Insulated Concrete Forms	ICF

Insulation Type Codes		
Insulation Form	**Insulation Type**	**Code**
Batts	Fiberglass	FB
Batts	Mineral Wool	MWB
Batts	Cotton	CTB
Loose	Cellulose	CL
Loose	Fiberglass	FL
Loose	Mineral Wool	MWL
Loose	Perlite	PL
Loose	Vermiculite	VL
Board	Molded Expanded Polystyrene	MEPS
Board	Extruded Polystyrene	XPS
Board	Polyisocyanurate	PIR
Board	Polyurethane	PUR,Bd
Blown	Polyurethane foam, blown	PUR,B
Blown	Icyene foam, blown	ICE,B
Foil	Radiant/reflective barrier	R

See http://www.inspect-ny.com/sickhouse/asbestoslookE.htm for descriptions and photos of the various insulation types.

Blower Door Test

Follow the project's blower door testing procedure. Ducts are not to be isolated from the test.

Time of Test	
Inside Air Temperature [F]	
Outside Air Temperature [F]	
Wind Conditions	Calm Breezy Gusty Strong
Conditioned Volume of Home [ft3]	
Shielding *	Well Normal Exposed
# Stories	

* Shielding Definitions

- Well Shielded is defined as urban areas with high buildings or sheltered areas, and building surrounded by trees, bermed earth, or higher terrain.
- Normal is defined as buildings in a residential neighborhood or subdivision setting, with yard space between buildings. 80-90% of houses fall in this category.
- Exposed is defined as buildings in an open setting with few buildings or trees around and buildings on top of a hill or ocean front, exposed to winds.

Record the flow rate at each of the pressures in the table. If you are unable to achieve these pressures, record the flow rates for the pressures you do achieve. Be sure to record the pressure at 50 [Pa] if at all possible.

#	Test Pressure [Pa]	CFM	EqLa (in^2)	AirChg/hr	% Fan
	10				
	20				
	30				
	40				
	50				
	60				

Program Comprehensiveness:

Questions for the resident …

1) Did you/do you make the decision of whether to install energy conservation measures in your home?

2) As part of the HES program the installer might have recommended the following energy measures if they were needed in your home. Were the following measures covered during your initial consultation?

Measure	Recommended?	Implemented? and Explanation
Lighting		
(Blower door)		
Caulking/weather-stripping/ door sweeps		
Water saving devices such as shower heads or faucet aerators		
Pipe insulation		
Hot water tank insulation		

3) The following measures might have been suggested to you as items you might want to install with a rebate from your utility. Were the following measures and their associated rebates introduced to you at the time of you consultation?

Measure	Recommended?	Implemented? and Explanation
Windows		
Appliances		
Insulation		

4) Did you install any of the recommended **during this year (2009)**? Why did you decide to install them? Please list:

5) Are you still planning to install some of the recommended measures that haven't been installed? Please list:

6) Are there energy conservation opportunities that you would like to be available through the program in the future? What are they?

7) Are there energy conservation opportunities in your home that you feel the program overlooked?

Program Attitudes and Impressions:
Please respond to the following questions on a scale of 1 to 5 with 1 being "I do not agree at all" and 5 being "I agree completely."

ATTITUDES					
8) I received my rebate payment promptly (if applicable).	1	2	3	4	5
9) My opinion of my electric utility has improved since participating in the Home Energy Solutions program.	1	2	3	4	5
10) My opinion of my natural gas supplier has improved since participating in the Home Energy Solutions program.	1	2	3	4	5
11) The program should offer support for more types of conservations measures.	1	2	3	4	5
12) My cost for participating in this program was reasonable.	1	2	3	4	5
13) I believe my electrical energy consumption is lower since participating in the program.	1	2	3	4	5
14) I believe my gas/oil energy consumption is lower since participating in the program.	1	2	3	4	5
15) I pay closer attention to my electrical consumption since participating.	1	2	3	4	5
16) I pay closer attention to my gas/oil consumption since participating.	1	2	3	4	5
17) I am satisfied with the program.	1	2	3	4	5
18) I am satisfied with the quality of the work performed by the contractor.	1	2	3	4	5
19) My contractor kept their appointment on time.	1	2	3	4	5
20) My contractor's appearance was professional	1	2	3	4	5
21) My contractor's behavior was professional.	1	2	3	4	5
22) I am satisfied with my contractor overall.	1	2	3	4	5
EFFECTS					
23) I pay more attention to my electrical expenses since participating.	1	2	3	4	5
24) I pay more attention to my natural gas expenses since participating.	1	2	3	4	5
25) Participation in the program has increased how likely I am to install more energy efficiency measures in the future.	1	2	3	4	5
26) I recommend this program to my neighbors, friends, family, and/or co-workers.	1	2	3	4	5
27) I am more likely to encourage my neighbors, friends, family, and/or co-workers to install energy conservation measures now than I was before the program.	1	2	3	4	5
28) My home is more comfortable since participating in the program.	1	2	3	4	5

29) Have you changed the temperature you usually heat or cool your house since participating in the program? If so, how much and in what seasons?

Season	ΔT*
Summer	
Winter	

*Denote decreases with a negative sign (-)

30) Have you changed how you use your new lights? If so, what changes did you make?

31) Have you installed energy conservation measures since participating in the program that the program didn't help pay for or recommend? Please list:

32) Do you have suggestions for how the Home Energy Solutions program be improved?

- **Inspection Kit**

€ Step ladder (accessing attics)
€ Dust masks (N95)
€ Safety glasses
€ Gloves
€ Multi-end screwdriver including nut drivers
€ Pliers
€ 6" adjustable wrench
€ Compass, preferably with magnetic declination
€ Flashlight
€ Inspection mirror on adjustable arm
€ 100' tape measure (ext home dimensions)
€ Ultrasonic distance measurement tool (interior dimensions)
€ Thermometer (measuring water temperature)
€ Quart container (sink flow rates)
€ Gallon container (shower flow rates)
€ Stop watch/timer (flow rates)
€ Clip board
€ Forms
€ Digital camera

B.2 Vendor Interview Form

Interviewer ____________________________ Date __________ Time _________________

Installer ____

Introduction:
Hi, I'm _______ from Nexant. Our company has been hired by Northeast Utilities and United Illuminating to help improve and evaluate the Home Energy Solutions Program your firm has provided services for. May I speak with (*installer contact name*) please?

- *If "yes" continue to questions section*
- *If "no" or "he/she isn't in right now", ask when would be a good time to call back and ask to leave a message.*

Questions:

Hi (*installer contact name*), my name is ______ and I'm calling from Nexant. We're an energy consultant company hired by Northeast Utilities and United Illuminating to talk with contractors who know the Home Energy Solutions program on how to improve the program's effectiveness. . We' d like to take about 10 minutes of your time to discuss your experience with the program. The results of our discussions will be included in our report, but the identities of the people we talk with and their companies will be kept strictly confidential. Of course, answers will have no effect on your participation in the program or your payment. Would you be willing to spend a few minutes with me on the phone to help improve the program?

- *If, yes, continue with the questions below.*
- *If no, ask if there might be a better time to call. If still no, thanks them for their time and end call.*

Thanks. Ok, let's get started.

1) Are there are significant cost effective opportunities for energy conservation left at homes after program services are complete?

2) What are the most significant opportunities being missed by the program in your opinion?

3) What percentage of homes would you estimate have significant, cost effective, energy conservation opportunities remaining after the program services are complete?

4) What are the most important reasons that some energy conservation opportunities aren't implemented?

5) Are there cases when your crews don't or haven't recommended all the eligible measures? Why?

6) What are the most common reasons your crew may not have been able to fully implement all eligible measures at a home?

7) Have there been cases when the program rules have prevented you from implementing all the possible energy conservation measures at a home? For instance, do program limits on the number of CFLs or the final infiltration rate cause you to leave some opportunities?

8) Approximately what fraction of homes have work limited by the program rules rather than the opportunities for energy conservation at the site?

9) Are there cases where your crews didn't have enough materials with them to treat the house up to the program limits? How is this handled? How often does this happen?

10) Are there some free measures that residents seem to reject? What are they?

11) What are some of the most common reasons you hear from customers for NOT agreeing to implement recommended conservation measures?

12) Do you talk to customers about rebates available for Tier 2 measures? What information do you provide on cost/rebates/savings/where to buy/what to look for?

13) Does the program's payment structure encourage your crews to capture all the eligible energy conservation opportunities?

14) Would you recommend changes to the program's installer payment structure that would encourage more comprehensive implementation of the eligible measures?

    14b) (IF APPROPRIATE) Other than increasing the installer monetary incentive what other forms of compensation or recognition would encourage greater implementation?

    - Would increased marketing of your business through utility avenues be something that would motivate you to further implement measures?
    - If more discretion was given to you on which measures to place emphasis on a home-by-home basis, do you believe you could achieve more savings?

15) Do you have any recommendations for changes to the program that you think would cost effectively improve the fraction of the potential conservation measures that get implemented?

16) Do you have any other suggestions for improving the program?

Thanks for your time. Nexant and the Energy Conservation Management Board appreciate you spending your time with us and appreciate your efforts to help us improve the Home Energy Solutions program.

Appendix C PROJECT SPECIFIC SUMMARY

C.1 Project Summary Sheets

CT Home Energy Solutions Evaluation Acct 7

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.207
Summer Peak kW savings	0.119	0.109
Winter Peak kW savings	0.356	0.314
Annual kWh savings	1282.3	1145.6
Pipe Insulation		
Annual MMBtu Savings		
Typical peak day gas savings (MMBtu)		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 9

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.5544
Summer Peak kW savings	0.0489	0.0499
Winter Peak kW savings	0.1462	0.1441
Annual kWh savings	526.1200	526.1256
Pipe Insulation		
Annual MMBtu Savings	0.096	0.382
Typical peak day gas savings (MMBtu)		0.00124
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 12

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.4296
Summer Peak kW savings	0.03516	0.03866
Winter Peak kW savings	0.10511	0.11170
Annual kWh savings	378.0816	407.6904
Pipe Insulation		
Annual MMBtu Savings	n/a	n/a
Water Widgets		
Annual kWh savings	749.3	917.0
Summer Peak kW savings	0.0707	0.0866
Winter Peak kW savings	0.1041	0.1274

CT Home Energy Solutions Evaluation Acct 15

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	2.9472
Summer Peak kW savings	0.2463	0.265248
Winter Peak kW savings	0.7363	0.766272
Annual kWh savings	2648.849	2796.8928
Duct Sealing		
Annual MMBtu Savings	3.752	
Annual kWh Savings	141.12	
Summer kW	0.188	
Winter kW	0.017	

CT Home Energy Solutions Evaluation Acct 14

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.0080
Summer Peak kW savings	0.0890	0.0907
Winter Peak kW savings	0.2659	0.2621
Annual kWh savings	956.5900	956.5920
Pipe Insulation		
Annual MMBtu Savings	0.048	0.258
Typical peak day gas savings (MMBtu)		0.000838
Duct Sealing		
Annual MMBtu Savings	3.886	
Annual kWh Savings	146.16	
Summer kW	0.194	
Winter kW	0.018	
Water Widgets		
Annual MMBtu Savings	1.9	2.4
Peak Gas Savings		0.0076

CT Home Energy Solutions Evaluation Acct 6

Measures	HES	Nexant
Lighting		
Annual kW savings	N/A	0.288
Summer Peak kW savings	0.0244	0.0259
Winter Peak kW savings	0.0728	0.0749
Annual kWh savings	261.9	273.3
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 32

Measures	HES	Nexant
Lighting		
Annual kWh Savings	1721.000	1771.973
Annual kW Savings	1.8134	1.8672
Summer Peak kW savings	0.1632	0.1680
Winter Peak kW savings	n/a in UI db	0.4855
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	1.8340	1.3
Peak Gas Savings		0.0044

CT Home Energy Solutions Evaluation Acct 29

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	2.378
Summer Peak kW savings	0.20991	0.21406
Winter Peak kW savings	0.62747	0.61838
Annual kWh savings	2257.102	2257.102
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 9

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.689
Summer Peak kW savings	0.051	0.062
Winter Peak kW savings	0.151	0.179
Annual kWh savings	544.346	653.671
Pipe Insulation		
Annual MMBtu Savings	0.048	0.000
Water Widgets		
Annual kWh savings	368.0	411.9
Summer Peak kW savings	0.0347	0.0389
Winter Peak kW savings	0.0511	0.0572

CT Home Energy Solutions Evaluation Acct 26

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.437
Summer Peak kW savings	0.036	0.039
Winter Peak kW savings	0.109	0.114
Annual kWh savings	391.747	414.523
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 35

Measures	HES	Nexant
Lighting		
Annual kWh Savings	313.000	306.337
Annual kW Savings	0.3290	0.3228
Summer Peak kW savings	0.0296	0.0291
Winter Peak kW savings	N/A	0.084
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 17

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.1080
Summer Peak kW savings	0.0095	0.0097
Winter Peak kW savings	0.0285	0.0281
Annual kWh savings	102.4920	102.4920
Pipe Insulation		
Annual MMBtu Savings	21.6	50.5
Summer Peak kW savings	0.00204	0.0048
Winter Peak kW savings	0.00300	0.0070
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 20

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.3288
Summer Peak kW savings	0.0322	0.0296
Winter Peak kW savings	0.0962	0.0855
Annual kWh savings	346.1952	312.0312
Pipe Insulation		
Annual MMBtu Savings	33.00	0.00
Summer Peak kW savings	0.0031	0.0000
Winter Peak kW savings	0.0046	0.0000
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 36

Measures	HES	Nexant
Lighting		
Annual kWh Savings	744.000	744.775
Annual kW Savings	0.7853	0.7848
Summer Peak kW savings	0.0707	0.0706
Winter Peak kW savings	n/a in UI db	0.204
Duct Sealing		
Annual MMBtu Savings	2.31	
Annual kWh Savings	65	
Summer kW	0.0765	
Water Widgets		
Annual MMBtu Savings	3.474	3.089
Peak Gas Savings		0.010

CT Home Energy Solutions Evaluation Acct 38

Measures	HES	Nexant
Lighting		
Annual kWh Savings	148.000	148.044
Annual kW Savings	0.156	0.156
Summer Peak kW savings	0.014	0.014
Winter Peak kW savings	n/a	0.041
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	0.917	0.657
Peak Gas Savings		0.0021

CT Home Energy Solutions Evaluation Acct 34

Measures	HES	Nexant
Lighting		
Annual kWh Savings	1120.000	1122.857
Annual kW Savings	1.184	1.183
Summer Peak kW savings	0.107	0.106
Winter Peak kW savings	n/a	0.308
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	4.1970	4.535
Peak Gas Savings		0.0147

CT Home Energy Solutions Evaluation Acct 19

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.518
Summer Peak kW savings	0.04575	0.04666
Winter Peak kW savings	0.13677	0.13478
Annual kWh savings	491.962	491.962
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 28

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.848
Summer Peak kW savings	0.1618	0.16632
Winter Peak kW savings	0.4837	0.48048
Annual kWh savings	1740.086	1753.752
Pipe Insulation		
Annual MMBtu Savings	0.144	0.258
Typical peak day gas savings (MMBtu)	0.000858	
Water Widgets		
Annual MMBtu Savings	5.8	4.8
Peak Gas Savings		0.015

CT Home Energy Solutions Evaluation Acct 33

Measures	HES	Nexant
Lighting		
Annual kWh Savings	831.000	831.324
Annual kW Savings	0.877	0.876
Summer Peak kW savings	0.079	0.079
Winter Peak kW savings	n/a	0.228
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 4

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	2.501
Summer Peak kW savings	0.2067	0.2251
Winter Peak kW savings	0.6180	0.6502
Annual kWh savings	2222.938	2373.259
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 24

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.3480
Summer Peak kW savings	0.0307	0.0313
Winter Peak kW savings	0.0918	0.0905
Annual kWh savings	330.2520	330.2520
Pipe Insulation		
Annual MMBtu Savings		
Duct Sealing		
Annual MMBtu Savings	16.415	
Annual kWh	617.4	
Summer kW	.821	
Winter kW	.075	

CT Home Energy Solutions Evaluation Acct 11

Measures	HES	Nexant
Lighting		
Annual kW savings	N/A	2.0328
Summer Peak kW savings	0.18873	0.1736
Winter Peak kW savings	0.56416	0.5016
Annual kWh savings	2029.342	1929.1272
Pipe Insulation		
Annual MMBtu Savings	0.144	0.574
Peak Gas Savings		0.00186
Water Widgets		
Annual MMBtu Savings	4.9	2.070
Peak Gas Savings		0.0064

CT Home Energy Solutions Evaluation Acct 40

Measures	HES	Nexant
Lighting		
Annual kWh Savings	502.000	455.520
Annual kW Savings	0.528	0.480
Summer Peak kW savings	0.048	0.043
Winter Peak kW savings	n/a	0.125
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual kWh Savings	996.0	812.2
Summer Peak kW savings	0.0946	0.0767
Winter Peak kW savings	n/a	-

CT Home Energy Solutions Evaluation Acct 27

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.329
Summer Peak kW savings	0.03071	0.02959
Winter Peak kW savings	0.09181	0.08549
Annual kWh savings	330.252	312.031
Duct Sealing		
Annual MMBtu Savings	3.149	
Annual kWh Savings	118.4	
Summer kW	0.157	
Winter kW	0.014	
Water Widgets		
Annual kW savings	749.3	0.0
Summer Peak kW savings	0.0707	0.0
Winter Peak kW savings	0.1041	0.0

CT Home Energy Solutions Evaluation Acct 8

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.260
Summer Peak kW savings	0.105	0.113
Winter Peak kW savings	0.313	0.328
Annual kWh savings	1127.412	1195.740
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	1.9	0.69
Peak Gas Savings		0.002

CT Home Energy Solutions Evaluation Acct 10

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.768
Summer Peak kW savings	0.068	0.069
Winter Peak kW savings	0.203	0.200
Annual kWh savings	728.832	728.832
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 1

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.9192
Summer Peak kW savings	0.0815	0.0827
Winter Peak kW savings	0.2438	0.2390
Annual kWh savings	876.8760	872.3208
Pipe Insulation		
Annual MMBtu Savings	0.144	0.581
Typical peak day gas savings (MMBtu)		0.00189
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 23

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.653
Summer Peak kW savings	0.045	0.059
Winter Peak kW savings	0.134	0.170
Annual kWh savings	482.851	619.507
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	3.8	3.2
Peak Gas Savings		0.010

CT Home Energy Solutions Evaluation Acct 25

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.243
Summer Peak kW savings	0.107	0.112
Winter Peak kW savings	0.319	0.323
Annual kWh savings	1147.910	1179.797
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual kWh savings	368.0	468.7
Summer Peak kW savings	0.035	0.044
Winter Peak kW savings	0.051	0.065

CT Home Energy Solutions Evaluation Acct 5

Measures	HES	Nexant
Lighting		
Annual kW savings	N/A	0.5064
Summer Peak kW savings	0.0559	0.0433
Winter Peak kW savings	0.1672	0.1249
Annual kWh savings	601.3	480.6
Duct Sealing		
Annual MMBtu Savings	0.603	
Annual kWh Savings	17.73	
Summer kW	0.030	
Water Widgets		
Annual MMBtu Savings	2.0	2.4
Peak Gas Savings		0.0074

CT Home Energy Solutions Evaluation Acct 31

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.514
Summer Peak kW savings	0.13366	0.13630
Winter Peak kW savings	0.39953	0.39374
Annual kWh savings	1437.166	1437.166
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 21

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.6672
Summer Peak kW savings	0.0640	0.0600
Winter Peak kW savings	0.1912	0.1735
Annual kWh savings	687.8352	633.1728
Pipe Insulation		
Annual MMBtu Savings	N/A	N/A
Water Widgets		
Annual MMBtu Savings	0.9	0.69
Peak Gas Savings		0.0022

CT Home Energy Solutions Evaluation Acct 22

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.643
Summer Peak kW savings	0.0599	0.0579
Winter Peak kW savings	0.1792	0.1672
Annual kWh savings	644.6	610.4
Pipe Insulation		
Annual MMBtu Savings	0.06	0.0
Water Widgets		
Annual MMBtu Savings	4.9	4.8
Peak Gas Savings		0.054

CT Home Energy Solutions Evaluation Acct 16

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.5336
Summer Peak kW savings	0.1525	0.1380
Winter Peak kW savings	0.4559	0.3987
Annual kWh savings	1639.872	1455.386
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual kWh savings	184.0	202.2
Summer Peak kW savings	0.0174	0.0191
Winter Peak kW savings	0.0256	0.0281

CT Home Energy Solutions Evaluation Acct 18

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.5856
Summer Peak kW savings	0.0510	0.0527
Winter Peak kW savings	0.1525	0.1523
Annual kWh savings	548.9000	555.7344
Pipe Insulation		
Annual MMBtu Savings	0.024	0.107
Typical peak day gas savings (MMBtu)		0.000349
Water Widgets		
Annual MMBtu Savings	2.9	1.4
Peak Gas Savings		0.0044

CT Home Energy Solutions Evaluation Acct 3

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	0.2304
Summer Peak kW savings	0.0220	0.0207
Winter Peak kW savings	0.0659	0.0599
Annual kWh savings	236.8700	218.6496
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

CT Home Energy Solutions Evaluation Acct 37

Measures	HES	Nexant
Lighting		
Annual kWh Savings	510	512
Annual kW Savings	0.54057	0.54000
Summer Peak kW savings	0.048650	0.048600
Winter Peak kW savings	n/a in UI db	0.1404
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	3.2800	3.4
Peak Gas Savings		0.011

CT Home Energy Solutions Evaluation Acct 39

Measures	HES	Nexant
Lighting		
Annual kWh Savings	1612	1203
Annual kW Savings	1.6999	1.2672
Summer Peak kW savings	0.1530	0.1140
Winter Peak kW savings	n/a in UI db	0.3
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings	8.8	5.23
		0.0170

CT Home Energy Solutions Evaluation Acct 30

Measures	HES	Nexant
Lighting		
Annual kW savings	n/a	1.3968
Summer Peak kW savings	0.1142	0.1257
Winter Peak kW savings	0.3413	0.3632
Annual kWh savings	1227.6260	1,325.5632
Pipe Insulation		
Annual MMBtu Savings	0.108	0.484
Typical peak day gas savings (MMBtu)		0.0016
Water Widgets		
Annual MMBtu Savings	3.8	3.8
Peak Gas Savings		0.013

CT Home Energy Solutions Evaluation Acct 2

Measures	HES	Nexant
Lighting		
Annual kW savings	N/A	0.545
Summer Peak kW savings	0.042	0.049
Winter Peak kW savings	0.125	0.142
Annual kWh savings	448.7	517.0
Pipe Insulation		
Annual MMBtu Savings		
Water Widgets		
Annual MMBtu Savings		

C.2 Project Savings Summary Table

Summary savings table for all projects.

Acct #	Total kWh Nexant	Total kWh HES	Total Summer kW Nexant	Total Summer kW HES	Total Winter kW Nexant	Total Winter kW HES	Total MMBtu Nexant	Total MMBtu HES	Total Typical Peak MMBtu Nexant	Total Extreme Peak MMBtu Nexant
1	941	946	0.20	0.20	0.24	0.24	1.81	1.37	0.00	0.00
2	787	664	0.28	0.41	0.15	0.12	0.00	0.00	0.00	0.00
3	-171	502	-0.35	0.47	0.04	0.07	-16.72	4.71	-0.16	-0.19
4	2,413	2,323	0.23	0.38	0.66	0.62	6.06	1.78	0.06	0.07
5	498	619	0.07	0.09	0.12	0.17	3.00	2.56	0.01	0.01
6	273	262	0.03	0.02	0.07	0.07	0.00	0.00	0.00	0.00
7	1,146	1,282	0.11	0.12	0.31	0.36	0.00	0.00	0.00	0.00
8	1,266	1,248	0.11	0.31	0.34	0.31	10.76	4.04	0.10	0.12
9	1,484	623	0.61	0.21	0.26	0.15	15.36	1.82	0.15	0.17
10	1,229	1,022	0.54	0.57	0.22	0.20	16.14	5.22	0.16	0.18
11	1,929	2,029	0.17	0.19	0.50	0.56	2.64	5.06	0.01	0.01
12	1,475	1,489	0.24	0.24	0.24	0.37	0.00	0.00	0.00	0.00
13	1,826	1,724	0.78	0.39	0.24	0.55	0.00	0.00	0.00	0.00
14	1,913	1,423	1.00	0.83	0.31	0.28	28.44	11.51	0.22	0.26
15	2,728	2,868	0.27	0.57	0.76	0.75	-12.01	5.14	-0.15	-0.18
16	2,263	2,429	0.16	0.17	0.76	0.82	0.00	0.00	0.00	0.00
17	411	382	0.18	0.17	0.13	0.12	0.00	0.00	0.00	0.00
18	1,096	683	0.53	0.28	0.18	0.15	17.81	5.31	0.16	0.19
19	492	492	0.05	0.05	0.13	0.14	0.00	0.00	0.00	0.00
20	392	713	0.03	0.04	0.09	0.29	0.00	0.00	0.00	0.00
21	351	788	0.02	0.23	0.15	0.19	-14.65	2.73	-0.15	-0.17
22	610	645	0.06	0.06	0.17	0.18	4.80	4.91	0.05	0.05
23	732	595	0.25	0.24	0.17	0.13	5.24	5.84	0.01	0.01
24	1,248	1,090	1.12	1.09	0.17	0.17	26.00	18.94	0.09	0.11
25	1,798	1,652	0.16	0.14	0.39	0.45	0.00	0.00	0.00	0.00
26	415	392	0.04	0.04	0.11	0.11	0.00	0.00	0.00	0.00
27	489	1,256	0.29	0.36	0.10	0.21	0.00	0.00	0.00	0.00
28	1,874	1,946	0.28	0.51	0.49	0.48	10.55	9.60	0.07	0.08
29	2,257	2,257	0.21	0.21	0.62	0.63	0.00	0.00	0.00	0.00
30	796	1,462	-0.34	0.51	0.34	0.34	-10.26	8.11	-0.13	-0.15
31	1,437	1,437	0.14	0.13	0.39	0.40	0.00	0.00	0.00	0.00
32	1,772	1,721	0.17	0.16	0.00	0.00	1.34	1.83	0.00	0.00
33	1,125	1,125	0.46	0.46	0.00	0.00	6.12	6.12	0.00	0.00
34	1,343	1,227	0.11	0.25	0.00	0.00	13.22	6.42	0.10	0.11
35	306	313	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00
36	1,094	935	0.42	0.31	0.00	0.00	17.80	8.40	0.13	0.15
37	632	521	0.16	0.05	0.00	0.00	7.12	5.17	0.05	0.05
38	173	207	0.04	0.09	0.00	0.00	2.31	2.15	0.02	0.02
39	1,203	1,612	0.11	0.15	0.00	0.00	5.23	8.83	0.02	0.02
40	1,268	1,498	0.12	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Sum	45,313	46,404	9.08	10.88	8.86	9.63	151.20	140.7	0.82	0.92

Appendix D EQUEST MODEL RESULTS

D.1 Model Details

Presented in this section are details of the eQUEST model simulations created as part of the HES program evaluation.

Physical home-specific properties that were entered in to each model were number of floors, home square footage and basement type. Some of the generic characteristics entered for each home were: The floor heights were specified as 8ft floor to ceiling and 9 ft floor to floor for all homes. Wood frame construction was specified for all homes with exterior wall construction that consisted of fiberboard and polystyrene. Interior walls and ceilings were specified as standard drywall. The windows were modeled as double-pane, clear glass and the window to wall ratio was 6.4% for the entire home.

The HVAC system associated with all homes that were gas furnace heat and central air conditioning. were set up to auto-size the unit between 4-6 tons based on the size of the home. The AFUE for heating mode and the SEER for cooling mode were set according to the nameplate of the equipment gathered onsite. The fans were modeled containing VSDs and were allowed to run during shoulder seasons based on temperature set-points. Return ducts were modeled and 1" WG static pressure was used to specify minimum design supply airflow.

Electric heated homes had electric baseboard heat modeled which was encountered in all (4) electric heated homes which had simulation models created. None of the homes had vents so return air was not modeled. (2) of the homes contained window air conditioners whose efficiencies were modeled according to nameplate information gathered onsite.

One home was modeled with oil heat and central air conditioning. The nameplate information (efficiencies) gathered onsite for both units were input to the model.

Occupancy schedules were gathered onsite during interview with residents and were input in to each simulation. This included when the home's occupants were home and the temperature set points used throughout the year. Minor adjustments (+/- 3^{o}F) in temperature set point schedule were used as a variable to calibrate the models energy consumption to match billing records.

Domestic hot water fuel type was natural gas for all homes. Hot water use was specified as 12 gallons/person per day as a starting point. Hot water use was conservatively adjusted based on the occupant types (single family, quantity of children, retirees, etc) in order to provide another variable to match gas bills.

The loads for lighting and miscellaneous electric loads were relied on to match electric bills. The occupant type of each home was taken in to consideration while adjusting W/ft^2 in a conservative manner. Due to time constraints, the inspector could not collect explicit information for all miscellaneous electric loads at each home. A consistent W/ft^2 value for lighting and miscellaneous electric loads could not be used across all homes due to the variability of billing records.

Homeowner behavioral and operational patterns as well as differences in miscellaneous electronic loads necessitated the need to have home-specific

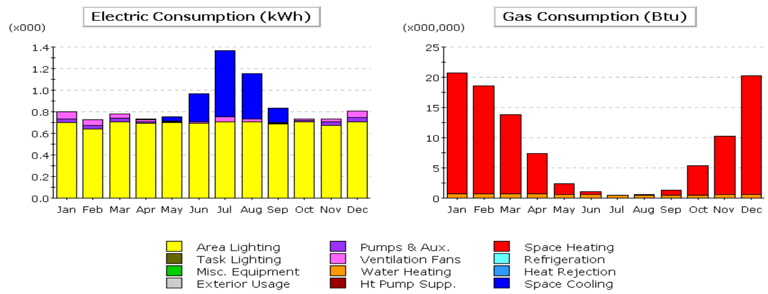
The approach used to calibrate each model to actual billing records included many considerations. When adjusting any of the variables listed above, the occupant type and occupant schedule was considered to ensure any adjustments made were reasonable.

In order to calculate savings predicted by the model, two simulations were performed: 1. Baseline and 2. Retrofit. The baseline model was calibrated to the baseline year's billing records and the baseline CFM (prior to installation of air sealing measures) from HES project records was used as the infiltration rate in to the home. The retrofit simulation was identical to the baseline year simulation except the CFM infiltration result obtained through blower door testing onsite. The energy difference between the baseline and retrofit simulations is the energy savings associated with the project.

D.2 eQUEST Model Results

CL&PGas Heat / Central AC : Account 15

Baseline Case:



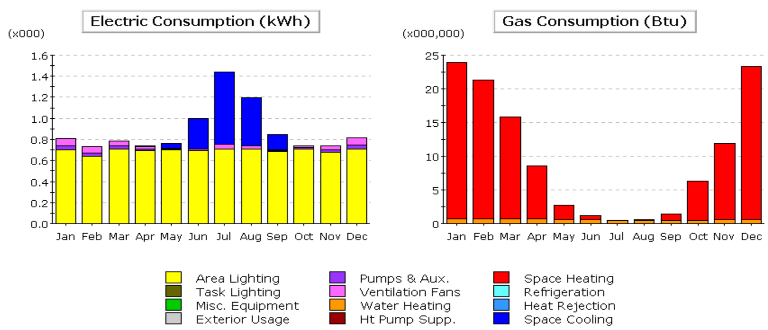
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0.04	0.26	0.62	0.42	0.13	0	0	0	1.47
Vent. Fans	0.06	0.05	0.04	0.02	0.01	0.02	0.04	0.03	0.01	0.01	0.03	0.06	0.38
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.7	0.64	0.71	0.69	0.7	0.69	0.71	0.7	0.69	0.7	0.68	0.71	8.32
Total	0.8	0.72	0.78	0.73	0.75	0.97	1.37	1.15	0.84	0.73	0.73	0.81	10.38

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	20.06	17.91	13.03	6.73	1.68	0.45	0	0.07	0.79	4.79	9.73	19.59	94.82
Hot Water	0.7	0.66	0.73	0.69	0.65	0.56	0.52	0.48	0.47	0.51	0.55	0.64	7.17
Total	20.76	18.57	13.76	7.42	2.32	1.01	0.52	0.56	1.25	5.3	10.28	20.23	102

Retrofit Case:



Electric Consumption (kWh x000)

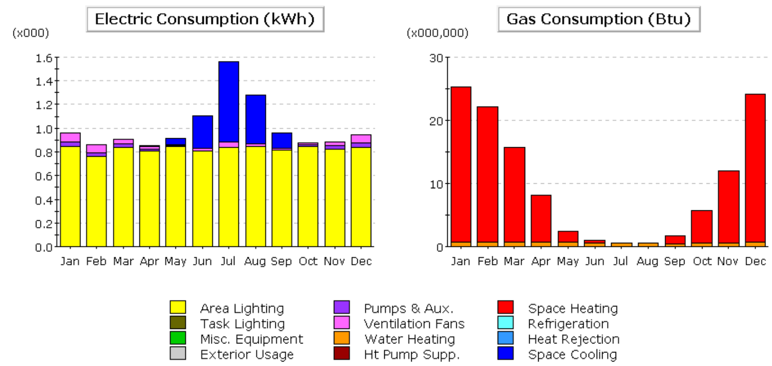
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0.04	0.29	0.68	0.46	0.15	0	0	0	1.62
Vent. Fans	0.07	0.06	0.04	0.02	0.01	0.02	0.05	0.03	0.01	0.02	0.03	0.07	0.43
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.7	0.64	0.71	0.69	0.7	0.69	0.71	0.7	0.69	0.7	0.68	0.71	8.32
Total	0.81	0.73	0.78	0.74	0.76	1	1.44	1.19	0.85	0.74	0.74	0.82	10.59

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	23.17	20.7	15.14	7.91	2.08	0.59	0	0.11	0.99	5.81	11.41	22.68	110.58
Hot Water	0.7	0.66	0.73	0.69	0.65	0.56	0.52	0.48	0.47	0.51	0.55	0.64	7.18
Total	23.87	21.36	15.87	8.61	2.72	1.16	0.53	0.59	1.45	6.32	11.96	23.31	117.76

CL&PGas Heat / Central AC : Account 8

Baseline Case:



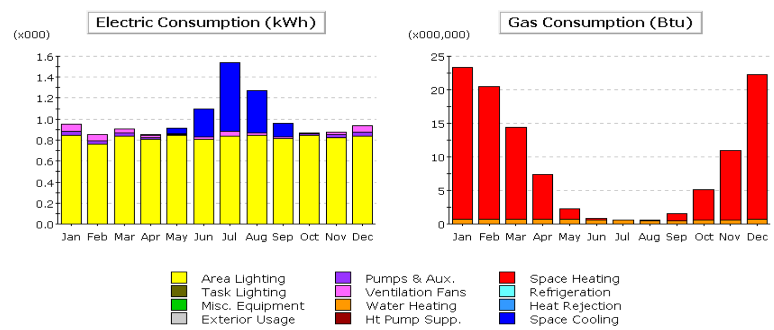
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.05	0.28	0.68	0.41	0.13	0	0	0	1.55
Vent. Fans	0.07	0.06	0.04	0.02	0.01	0.02	0.05	0.03	0.01	0.01	0.03	0.07	0.43
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.85	0.76	0.84	0.81	0.85	0.81	0.84	0.84	0.81	0.84	0.82	0.84	9.91
Total	0.96	0.86	0.91	0.85	0.91	1.1	1.56	1.28	0.96	0.87	0.88	0.95	12.1

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	24.6	21.49	14.9	7.43	1.82	0.35	0	0.08	1.2	5.2	11.45	23.51	112.03
Hot Water	0.73	0.69	0.76	0.72	0.66	0.58	0.54	0.51	0.49	0.55	0.58	0.68	7.49
Total	25.33	22.18	15.66	8.15	2.48	0.93	0.54	0.59	1.7	5.75	12.02	24.19	119.52

Retrofit Case:



Electric Consumption (kWh x000)

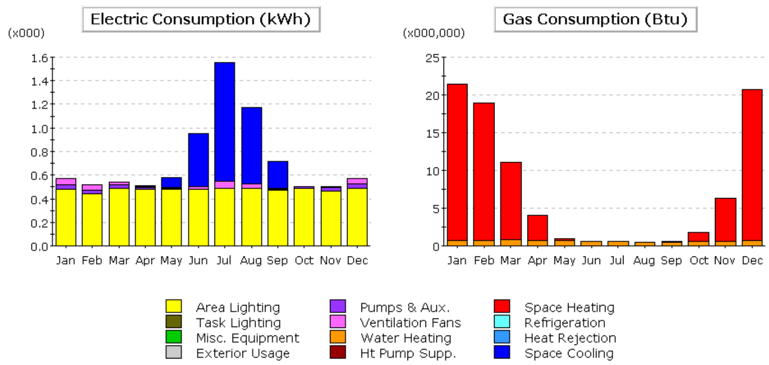
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.05	0.27	0.65	0.4	0.13	0	0	0	1.51
Vent. Fans	0.07	0.06	0.04	0.02	0.01	0.02	0.05	0.03	0.01	0.01	0.03	0.07	0.4
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.85	0.76	0.84	0.81	0.85	0.81	0.84	0.84	0.81	0.84	0.82	0.84	9.91
Total	0.95	0.85	0.91	0.85	0.91	1.09	1.54	1.27	0.96	0.87	0.88	0.94	12.03

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	22.58	19.73	13.58	6.68	1.55	0.27	0	0.06	1.01	4.57	10.34	21.57	101.96
Hot Water	0.73	0.69	0.76	0.72	0.66	0.58	0.54	0.5	0.49	0.55	0.58	0.68	7.49
Total	23.31	20.42	14.35	7.4	2.22	0.85	0.54	0.56	1.5	5.12	10.92	22.25	109.45

CL&PGas Heat / Central AC : Account 10

Baseline Case:



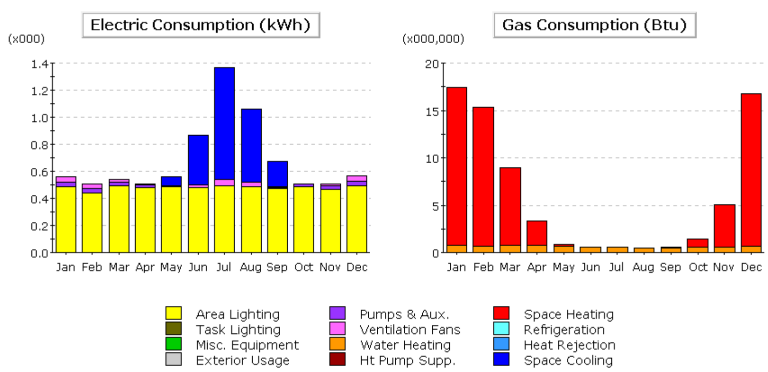
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.08	0.45	1.01	0.65	0.22	0	0	0	2.43
Vent. Fans	0.05	0.04	0.02	0.01	0.01	0.03	0.06	0.04	0.01	0	0.01	0.05	0.32
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.48	0.44	0.49	0.48	0.48	0.48	0.49	0.49	0.47	0.49	0.47	0.49	5.75
Total	0.57	0.52	0.54	0.51	0.58	0.96	1.55	1.18	0.71	0.51	0.51	0.57	8.71

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	20.7	18.21	10.3	3.3	0.27	0	0	0	0.1	1.24	5.66	19.98	79.76
Hot Water	0.76	0.71	0.79	0.74	0.69	0.6	0.55	0.52	0.5	0.56	0.6	0.7	7.71
Total	21.46	18.92	11.09	4.04	0.95	0.6	0.55	0.52	0.61	1.8	6.27	20.68	87.47

Retrofit Case:



Electric Consumption (kWh x000)

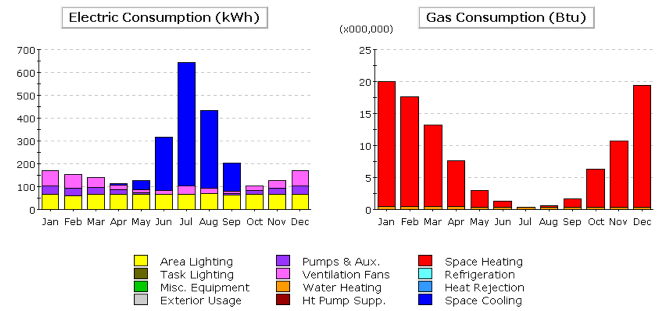
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.06	0.37	0.83	0.54	0.18	0	0	0	1.99
Vent. Fans	0.04	0.03	0.02	0.01	0	0.02	0.05	0.03	0.01	0	0.01	0.04	0.26
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.48	0.44	0.49	0.48	0.48	0.48	0.49	0.49	0.47	0.49	0.47	0.49	5.75
Total	0.56	0.51	0.54	0.51	0.56	0.87	1.37	1.06	0.67	0.51	0.5	0.56	8.21

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	16.64	14.61	8.2	2.55	0.19	0	0	0	0.07	0.9	4.42	16.03	63.62
Hot Water	0.75	0.71	0.79	0.74	0.68	0.59	0.55	0.52	0.5	0.56	0.6	0.7	7.71
Total	17.4	15.33	8.98	3.29	0.88	0.59	0.55	0.52	0.58	1.46	5.03	16.73	71.33

CL&P Gas Heat / Central AC : Account 21

Baseline Case:



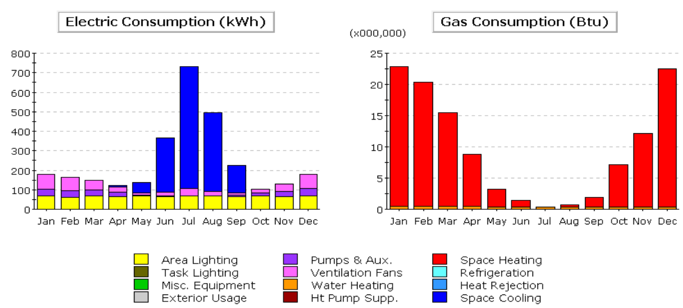
Electric Consumption (kWh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	5.4	42	231.8	540.3	340.6	121.5	0	0	0	1,281.50
Vent. Fans	67.3	58.9	42.3	23	10.4	17.9	36.5	23.2	11.5	17.9	33	65.1	406.9
Pumps & Aux.	36.6	33.5	29.8	19.5	6.8	1.1	0	0.7	4.9	16.3	27.8	37.2	214.2
Lights &Misc	67.6	61.1	68.1	65.8	68.1	65.8	67.6	68.6	64.8	68.1	65.3	67.1	797.9
Total	171.5	153.5	140.2	113.6	127.2	316.5	644.5	433	202.6	102.2	126.1	169.4	2,700.50

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	19.55	17.19	12.77	7.17	2.51	0.93	0.07	0.29	1.31	5.93	10.31	18.95	96.98
Hot Water	0.45	0.42	0.47	0.44	0.41	0.35	0.33	0.31	0.3	0.34	0.36	0.41	4.59
Total	20	17.61	13.24	7.6	2.92	1.29	0.39	0.6	1.61	6.27	10.67	19.36	101.57

Retrofit Case:



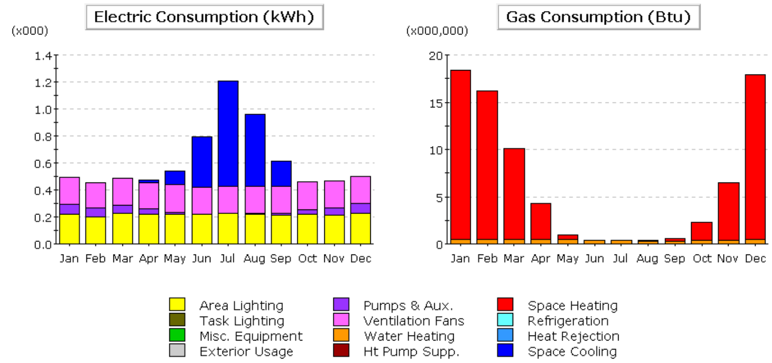
Electric Consumption (kWh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	7.7	53.2	278.9	628.3	403.7	140.1	0	0	0	1,511.80
Vent. Fans	76.9	68.1	49.2	26.7	11.7	19.5	37	23.9	12.1	20.3	37.7	75.4	458.5
Pumps & Aux.	36.6	33.5	29.8	19.5	6.8	1.1	0	0.7	4.9	16.3	27.8	37.2	214.2
Lights &Misc	67.1	61.1	68.1	66.2	67.1	66.2	68.1	67.6	65.8	67.6	64.8	68.1	797.9
Total	180.6	162.8	147.1	120.2	138.8	365.7	733.3	495.9	222.9	104.1	130.3	180.7	2,982.40

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	22.4	19.97	14.95	8.38	2.79	1.11	0.08	0.39	1.56	6.81	11.83	22.05	112.31
Hot Water	0.45	0.42	0.47	0.44	0.41	0.36	0.33	0.31	0.3	0.34	0.36	0.42	4.59
Total	22.84	20.39	15.42	8.81	3.2	1.47	0.41	0.7	1.87	7.14	12.19	22.46	116.91

CL&P Gas Heat / Central AC: Account 9
Baseline Case:



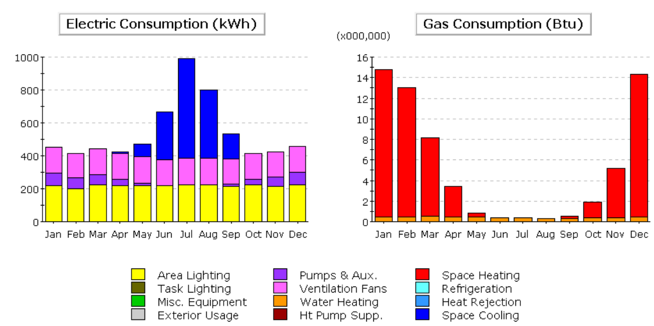
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.02	0.1	0.38	0.78	0.53	0.19	0	0	0	2
Vent. Fans	0.2	0.18	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.4
Pumps & Aux.	0.07	0.07	0.06	0.04	0.01	0	0	0	0.01	0.03	0.06	0.07	0.43
Lights &Misc	0.22	0.2	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21	0.22	2.63
Total	0.5	0.45	0.49	0.47	0.54	0.8	1.21	0.96	0.61	0.46	0.46	0.5	7.45

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	17.88	15.72	9.59	3.77	0.49	0.04	0	0.02	0.26	1.97	6.13	17.42	73.29
Hot Water	0.48	0.45	0.5	0.47	0.44	0.38	0.35	0.33	0.32	0.36	0.38	0.44	4.92
Total	18.36	16.17	10.09	4.24	0.93	0.42	0.36	0.35	0.59	2.33	6.51	17.86	78.21

Retrofit Case:



Electric Consumption (kWh x000)

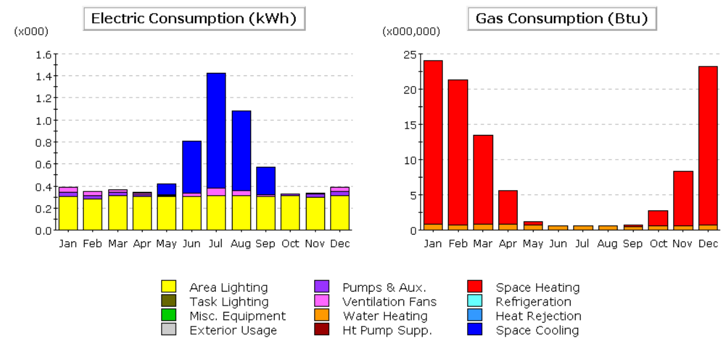
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0.1	13	76.4	289.7	607.4	414.4	149.5	1	0	0	1,551.30
Vent. Fans	158.8	144.2	160.5	155.9	158.8	155.9	160.5	159.7	155.1	159.7	153.4	160.5	1,883.00
Pumps & Aux.	73.2	67.1	59.5	39.1	13.5	2.2	0	1.4	9.8	32.5	55.6	74.4	428.3
Lights &Misc	221.2	201.3	224.3	218.2	221.2	218.2	224.3	222.8	216.6	222.8	213.5	224.3	2,628.90
Total	453.3	412.6	444.5	426.2	469.9	666	992.2	798.2	531	415.9	422.6	459.2	6,491.60

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	14.3	12.54	7.62	2.96	0.37	0.03	0	0.01	0.22	1.52	4.83	13.92	58.31
Hot Water	0.48	0.45	0.5	0.47	0.44	0.38	0.35	0.33	0.32	0.36	0.38	0.44	4.92
Total	14.78	13	8.13	3.43	0.81	0.41	0.36	0.34	0.54	1.87	5.22	14.36	63.23

CL&P Gas Heat / Central AC: Account 24

Baseline Case:



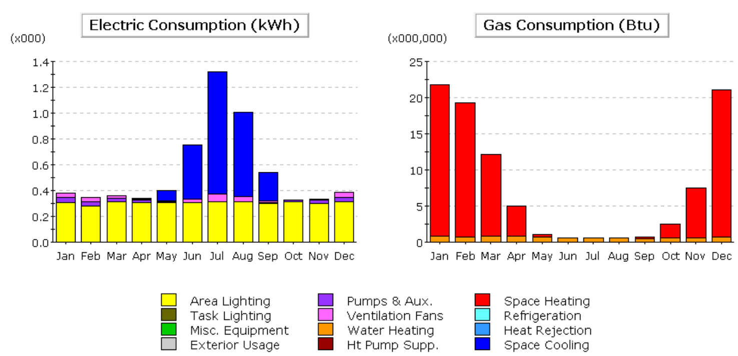
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.09	0.47	1.04	0.72	0.25	0	0	0	2.59
Vent. Fans	0.04	0.04	0.02	0.01	0.01	0.03	0.07	0.05	0.02	0	0.01	0.04	0.33
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.31	0.28	0.31	0.3	0.31	0.3	0.31	0.31	0.3	0.31	0.3	0.31	3.66
Total	0.39	0.35	0.36	0.34	0.42	0.81	1.42	1.08	0.57	0.33	0.34	0.39	6.8

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	23.26	20.59	12.56	4.77	0.46	0.01	0	0	0.21	2.13	7.75	22.54	94.28
Hot Water	0.8	0.76	0.84	0.79	0.73	0.64	0.59	0.55	0.54	0.59	0.64	0.74	8.2
Total	24.06	21.35	13.4	5.56	1.19	0.65	0.59	0.55	0.75	2.72	8.39	23.27	102.48

Retrofit Case:



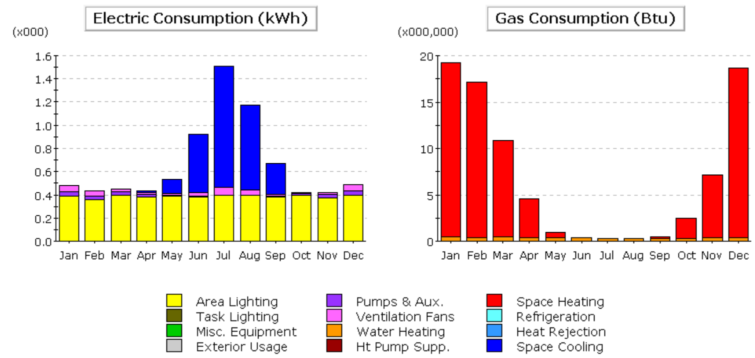
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.08	0.42	0.94	0.65	0.22	0	0	0	2.33
Vent. Fans	0.04	0.03	0.02	0.01	0.01	0.03	0.06	0.04	0.01	0	0.01	0.04	0.3
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.31	0.28	0.31	0.3	0.31	0.3	0.31	0.31	0.3	0.31	0.3	0.31	3.66
Total	0.38	0.35	0.36	0.34	0.4	0.75	1.32	1.01	0.54	0.33	0.34	0.39	6.5

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	20.98	18.56	11.28	4.24	0.39	0.01	0	0	0.19	1.85	6.9	20.3	84.7
Hot Water	0.8	0.76	0.84	0.79	0.73	0.64	0.59	0.55	0.54	0.59	0.64	0.74	8.2
Total	21.77	19.32	12.12	5.03	1.12	0.64	0.59	0.55	0.72	2.45	7.54	21.04	92.9

CL&P Gas Heat / Central AC: Account 14
Baseline Case:



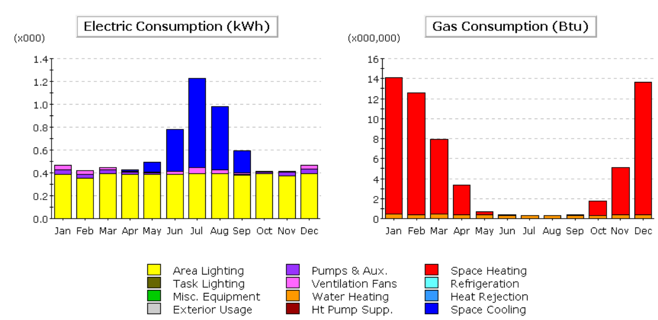
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.02	0.13	0.5	1.04	0.73	0.26	0	0	0	2.69
Vent. Fans	0.05	0.05	0.03	0.01	0.01	0.04	0.07	0.05	0.02	0	0.02	0.05	0.39
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.39	0.35	0.4	0.38	0.39	0.38	0.4	0.39	0.38	0.39	0.38	0.4	4.63
Total	0.48	0.44	0.45	0.44	0.54	0.92	1.51	1.17	0.67	0.42	0.42	0.48	7.93

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	18.79	16.74	10.38	4.18	0.54	0.04	0	0	0.19	2.15	6.77	18.27	78.05
Hot Water	0.43	0.41	0.45	0.42	0.39	0.34	0.31	0.29	0.29	0.32	0.35	0.4	4.38
Total	19.22	17.14	10.83	4.59	0.92	0.37	0.31	0.3	0.48	2.47	7.12	18.67	82.44

Retrofit Case:



Electric Consumption (kWh x000)

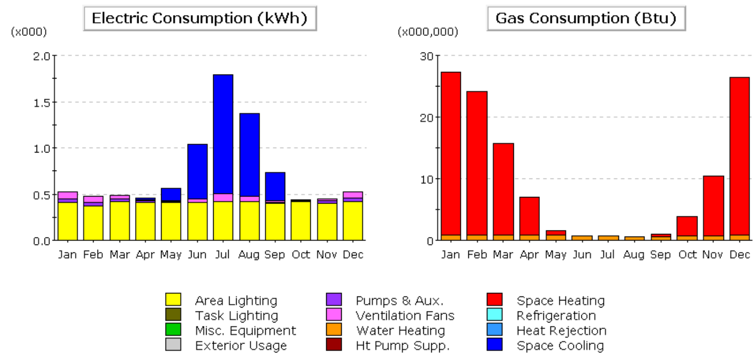
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.09	0.37	0.78	0.55	0.2	0	0	0	1.99
Vent. Fans	0.04	0.03	0.02	0.01	0.01	0.03	0.05	0.04	0.01	0	0.01	0.04	0.29
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.39	0.35	0.4	0.38	0.39	0.38	0.4	0.39	0.38	0.39	0.38	0.4	4.63
Total	0.46	0.42	0.45	0.42	0.49	0.78	1.22	0.98	0.59	0.41	0.42	0.47	7.12

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	13.66	12.17	7.5	2.94	0.33	0.02	0	0	0.11	1.41	4.77	13.25	56.16
Hot Water	0.43	0.4	0.45	0.42	0.39	0.34	0.31	0.29	0.29	0.32	0.34	0.4	4.38
Total	14.09	12.57	7.94	3.35	0.72	0.35	0.31	0.29	0.4	1.73	5.12	13.65	60.54

CL&P Gas Heat / Central AC: Account 18

Baseline Case:



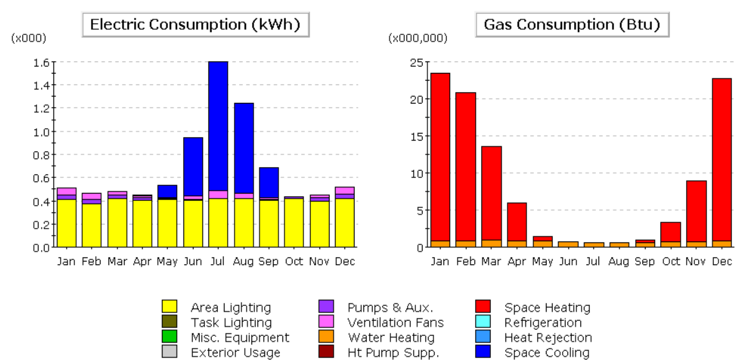
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.13	0.59	1.29	0.89	0.31	0	0	0	3.22
Vent. Fans	0.07	0.06	0.04	0.02	0.01	0.04	0.08	0.06	0.02	0.01	0.02	0.07	0.51
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.41	0.38	0.42	0.41	0.41	0.41	0.42	0.42	0.4	0.42	0.4	0.42	4.9
Total	0.52	0.47	0.49	0.46	0.56	1.04	1.79	1.37	0.74	0.44	0.45	0.53	8.85

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	26.34	23.36	14.8	6.08	0.79	0.06	0	0.02	0.38	3.22	9.77	25.59	110.42
Hot Water	0.88	0.84	0.93	0.87	0.81	0.71	0.65	0.61	0.59	0.66	0.7	0.81	9.07
Total	27.22	24.2	15.72	6.95	1.61	0.77	0.65	0.63	0.98	3.87	10.48	26.41	119.49

Retrofit Case:



Electric Consumption (kWh x000)

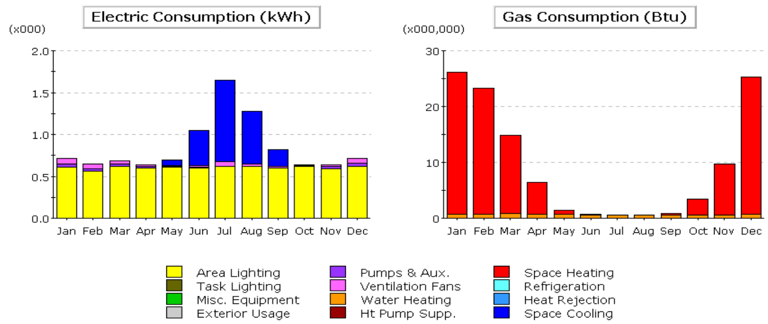
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.1	0.5	1.11	0.77	0.26	0	0	0	2.76
Vent. Fans	0.06	0.06	0.03	0.01	0.01	0.03	0.07	0.05	0.02	0.01	0.02	0.06	0.44
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.41	0.38	0.42	0.41	0.41	0.41	0.42	0.42	0.4	0.42	0.4	0.42	4.9
Total	0.51	0.46	0.48	0.45	0.53	0.94	1.6	1.24	0.69	0.44	0.45	0.52	8.31

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	22.55	19.99	12.64	5.13	0.63	0.05	0	0	0.31	2.66	8.26	21.88	94.11
Hot Water	0.88	0.84	0.93	0.87	0.81	0.71	0.65	0.61	0.59	0.66	0.7	0.81	9.07
Total	23.43	20.83	13.57	6	1.44	0.75	0.65	0.62	0.91	3.32	8.96	22.7	103.17

CL&P Gas Heat / Central AC: Account 3

Baseline Case:



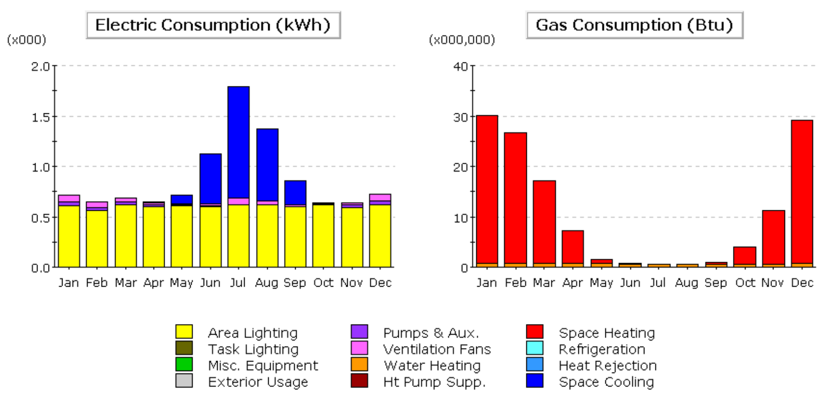
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.07	0.42	0.97	0.63	0.21	0	0	0	2.3
Vent. Fans	0.06	0.05	0.03	0.01	0.01	0.02	0.05	0.03	0.01	0.01	0.02	0.06	0.37
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.61	0.56	0.62	0.6	0.61	0.6	0.62	0.62	0.6	0.62	0.59	0.62	7.28
Total	0.71	0.64	0.68	0.64	0.7	1.05	1.64	1.28	0.82	0.64	0.64	0.72	10.17

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	25.37	22.49	14.02	5.6	0.68	0.05	0	0.01	0.33	2.87	9.07	24.62	105.1
Hot Water	0.77	0.73	0.81	0.77	0.71	0.62	0.57	0.53	0.52	0.57	0.61	0.71	7.91
Total	26.14	23.22	14.83	6.37	1.39	0.67	0.57	0.54	0.85	3.43	9.68	25.33	113.01

Retrofit Case:



Electric Consumption (kWh x000)

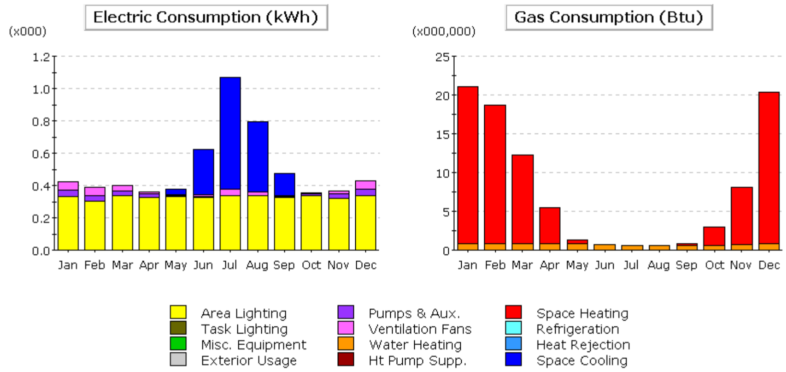
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.09	0.49	1.11	0.71	0.24	0	0	0	2.64
Vent. Fans	0.07	0.06	0.04	0.01	0.01	0.03	0.06	0.04	0.01	0.01	0.02	0.07	0.43
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.61	0.56	0.62	0.6	0.61	0.6	0.62	0.62	0.6	0.62	0.59	0.62	7.28
Total	0.72	0.65	0.69	0.65	0.71	1.12	1.79	1.37	0.85	0.64	0.64	0.73	10.56

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	29.28	25.97	16.24	6.55	0.83	0.07	0	0.02	0.39	3.42	10.6	28.45	121.82
Hot Water	0.77	0.73	0.81	0.77	0.71	0.62	0.57	0.53	0.52	0.57	0.61	0.71	7.91
Total	30.05	26.7	17.05	7.32	1.55	0.68	0.57	0.55	0.91	3.99	11.21	29.15	129.73

CL&P Gas Heat / Central AC: Account 28

Baseline Case:



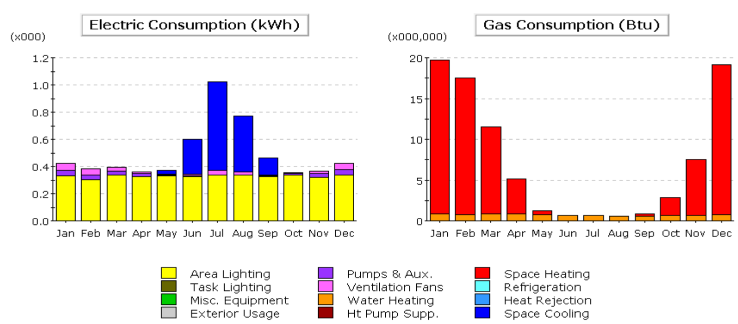
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0.03	0.28	0.69	0.44	0.14	0	0	0	1.58
Vent. Fans	0.06	0.05	0.03	0.01	0	0.02	0.04	0.02	0.01	0.01	0.02	0.05	0.32
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.33	0.3	0.34	0.33	0.33	0.33	0.34	0.33	0.33	0.33	0.32	0.34	3.95
Total	0.43	0.39	0.4	0.36	0.38	0.62	1.07	0.8	0.47	0.36	0.37	0.43	6.06

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	20.18	17.9	11.32	4.6	0.55	0.04	0	0	0.28	2.38	7.4	19.58	84.24
Hot Water	0.85	0.8	0.89	0.84	0.78	0.67	0.62	0.58	0.57	0.63	0.67	0.78	8.68
Total	21.03	18.7	12.21	5.43	1.33	0.72	0.62	0.58	0.85	3	8.08	20.36	92.92

Retrofit Case:



Electric Consumption (kWh x000)

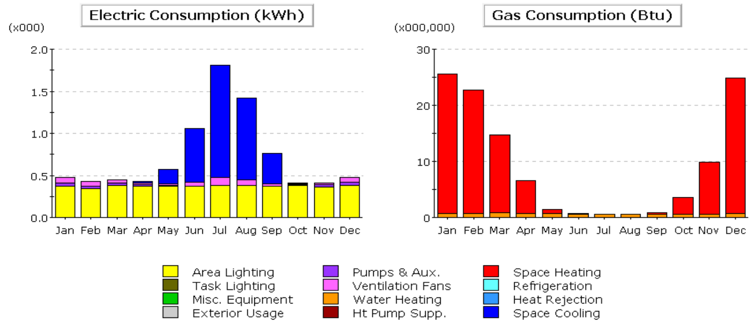
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0.03	0.26	0.65	0.41	0.13	0	0	0	1.48
Vent. Fans	0.05	0.05	0.03	0.01	0	0.01	0.04	0.02	0.01	0.01	0.02	0.05	0.3
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.33	0.3	0.34	0.33	0.33	0.33	0.34	0.33	0.33	0.33	0.32	0.34	3.95
Total	0.42	0.38	0.4	0.36	0.37	0.6	1.02	0.77	0.46	0.36	0.37	0.43	5.94

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	18.91	16.77	10.6	4.28	0.5	0.04	0	0	0.26	2.19	6.89	18.33	78.75
Hot Water	0.85	0.8	0.89	0.84	0.78	0.67	0.62	0.58	0.57	0.63	0.67	0.78	8.68
Total	19.75	17.57	11.48	5.12	1.28	0.71	0.62	0.58	0.83	2.82	7.56	19.11	87.43

CL&P Gas Heat / Central AC:Account 30

Baseline Case:



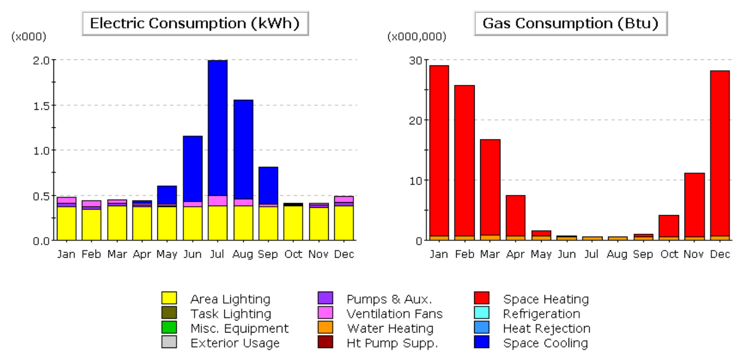
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.02	0.17	0.64	1.33	0.97	0.36	0	0	0	3.49
Vent. Fans	0.06	0.05	0.03	0.01	0.02	0.05	0.1	0.07	0.03	0.01	0.02	0.06	0.51
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.38	0.34	0.38	0.37	0.38	0.37	0.38	0.38	0.37	0.38	0.36	0.38	4.47
Total	0.47	0.43	0.44	0.43	0.57	1.06	1.81	1.42	0.76	0.4	0.41	0.48	8.69

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	24.82	22.01	13.98	5.78	0.76	0.06	0	0.02	0.38	3.06	9.25	24.13	104.24
Hot Water	0.76	0.72	0.79	0.75	0.69	0.6	0.56	0.52	0.51	0.56	0.6	0.7	7.77
Total	25.58	22.73	14.77	6.53	1.45	0.66	0.56	0.54	0.88	3.63	9.85	24.82	112.01

Retrofit Case:



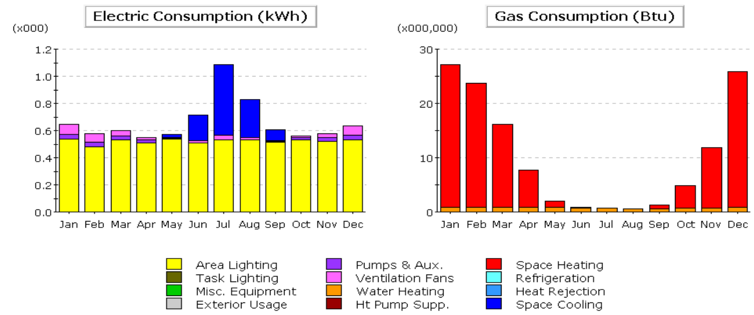
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.03	0.2	0.73	1.5	1.1	0.41	0	0	0	3.96
Vent. Fans	0.07	0.06	0.04	0.02	0.02	0.06	0.11	0.08	0.03	0.01	0.02	0.07	0.58
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.38	0.34	0.38	0.37	0.38	0.37	0.38	0.38	0.37	0.38	0.36	0.38	4.47
Total	0.48	0.44	0.45	0.44	0.6	1.16	1.99	1.56	0.81	0.41	0.41	0.48	9.22

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	28.18	25	15.9	6.65	0.9	0.08	0	0.02	0.43	3.56	10.61	27.42	118.76
Hot Water	0.76	0.72	0.79	0.75	0.69	0.6	0.56	0.52	0.51	0.56	0.6	0.7	7.77
Total	28.94	25.72	16.7	7.39	1.6	0.68	0.56	0.55	0.94	4.13	11.21	28.12	126.53

CL&P Gas Heat / Central AC: Account 4
Baseline Case:



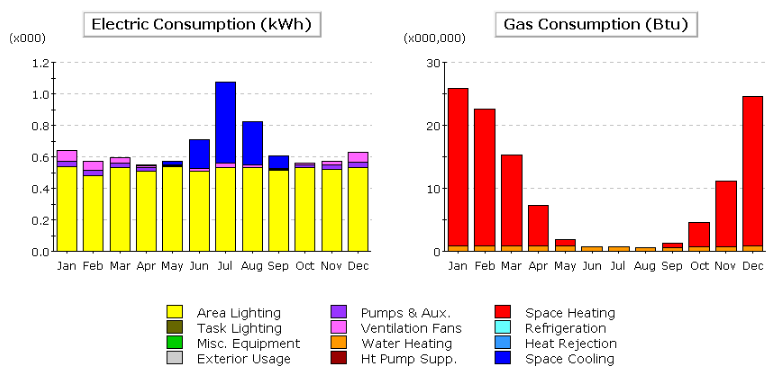
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0.02	0.19	0.52	0.28	0.08	0	0	0	1.1
Vent. Fans	0.07	0.06	0.04	0.02	0	0.01	0.03	0.02	0.01	0.01	0.03	0.07	0.37
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.54	0.48	0.53	0.51	0.54	0.51	0.53	0.53	0.51	0.53	0.52	0.53	6.26
Total	0.64	0.58	0.6	0.55	0.57	0.71	1.09	0.83	0.6	0.56	0.57	0.63	7.94

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	26.25	22.93	15.2	6.82	1.2	0.1	0	0.01	0.76	4.21	11.13	25.06	113.65
Hot Water	0.87	0.82	0.92	0.87	0.8	0.7	0.65	0.6	0.58	0.65	0.68	0.8	8.95
Total	27.11	23.75	16.11	7.69	1.99	0.8	0.65	0.62	1.35	4.86	11.81	25.86	122.6

Retrofit Case:



Electric Consumption (kWh x000)

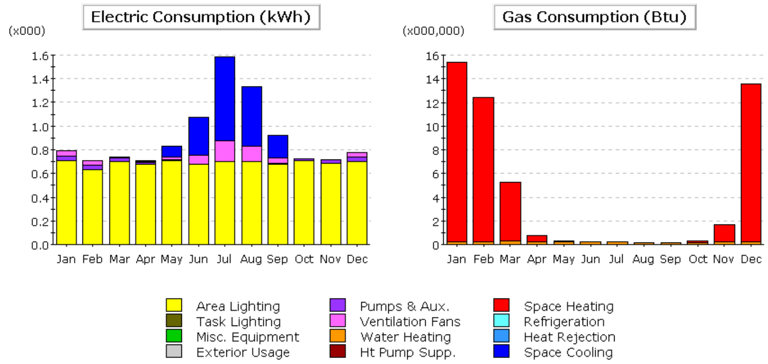
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	0.02	0.19	0.51	0.28	0.08	0	0	0	1.08
Vent. Fans	0.07	0.06	0.04	0.02	0	0.01	0.03	0.02	0.01	0.01	0.03	0.06	0.35
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.54	0.48	0.53	0.51	0.54	0.51	0.53	0.53	0.51	0.53	0.52	0.53	6.26
Total	0.64	0.57	0.6	0.55	0.57	0.71	1.07	0.83	0.6	0.56	0.57	0.63	7.9

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	24.96	21.8	14.4	6.4	1.07	0.08	0	0	0.68	3.9	10.49	23.82	107.59
Hot Water	0.87	0.82	0.92	0.87	0.8	0.7	0.65	0.6	0.58	0.65	0.68	0.8	8.95
Total	25.82	22.63	15.31	7.27	1.86	0.79	0.65	0.61	1.27	4.55	11.17	24.62	116.54

UI Gas Heat / Central AC : Account 34

Baseline Case:



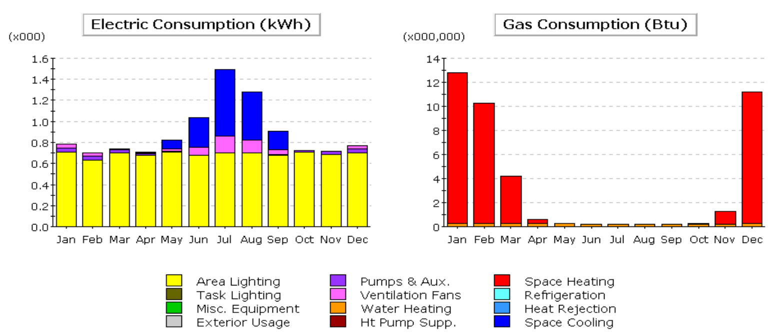
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.09	0.32	0.7	0.5	0.19	0	0	0	1.82
Vent. Fans	0.05	0.04	0.01	0	0.02	0.08	0.18	0.13	0.05	0	0	0.04	0.61
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.71	0.64	0.7	0.67	0.71	0.67	0.7	0.7	0.68	0.7	0.69	0.7	8.28
Total	0.79	0.71	0.74	0.71	0.83	1.07	1.58	1.33	0.92	0.73	0.72	0.78	10.91

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	15.15	12.17	4.99	0.51	0.03	0	0	0	0	0.11	1.45	13.3	47.71
Hot Water	0.26	0.24	0.27	0.26	0.24	0.21	0.19	0.18	0.17	0.19	0.2	0.24	2.64
Total	15.41	12.41	5.26	0.77	0.27	0.21	0.19	0.18	0.17	0.3	1.65	13.54	50.35

Retrofit Case:



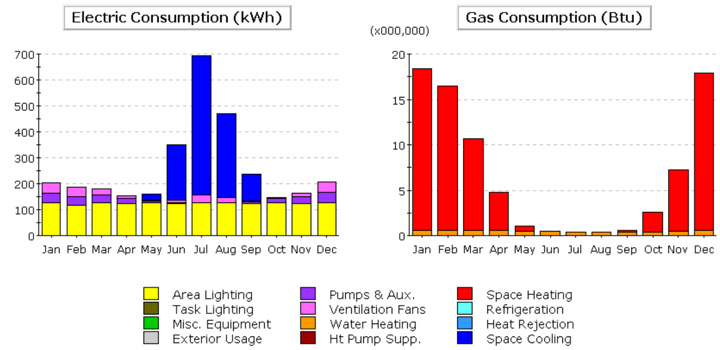
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.08	0.29	0.63	0.46	0.18	0	0	0	1.65
Vent. Fans	0.04	0.03	0.01	0	0.02	0.08	0.16	0.12	0.05	0	0	0.03	0.54
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.71	0.64	0.7	0.67	0.71	0.67	0.7	0.7	0.68	0.7	0.69	0.7	8.28
Total	0.78	0.7	0.74	0.71	0.82	1.04	1.5	1.28	0.91	0.73	0.72	0.77	10.69

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	12.57	10.05	3.93	0.37	0.01	0	0	0	0	0.05	1.05	11	39.01
Hot Water	0.26	0.24	0.27	0.26	0.24	0.21	0.19	0.18	0.17	0.19	0.2	0.24	2.64
Total	12.83	10.29	4.2	0.63	0.24	0.21	0.19	0.18	0.17	0.24	1.25	11.23	41.66

UI Gas Heat / Central AC : Account 36
Baseline Case:



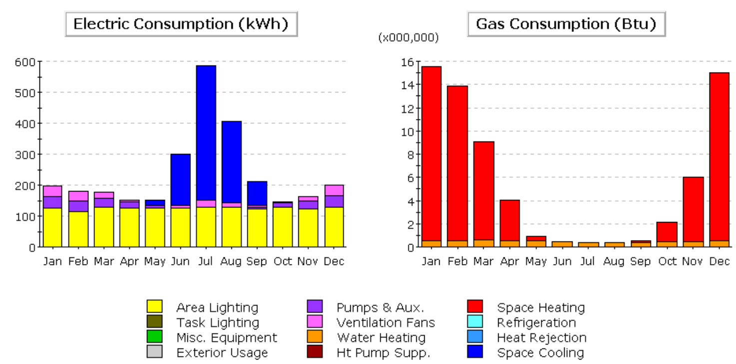
Electric Consumption (kWh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	1.1	24.6	213	535.5	325.7	101.7	0	0	0	1,201.70
Vent. Fans	41.7	37.1	22.7	8.8	2.7	12.1	29	17.2	5.4	4.2	14.3	40.5	235.6
Pumps & Aux.	36.6	33.5	29.8	19.5	6.8	1.1	0	0.7	4.9	16.3	27.8	37.2	214.2
Lights &Misc	126.5	115.1	128.3	124.8	126.5	124.8	128.3	127.4	123.9	127.4	122.1	128.3	1,503.70
Total	204.8	185.7	180.8	154.3	160.6	351.1	692.8	471.1	236	147.9	164.2	206	3,155.20

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	17.84	15.93	10.11	4.17	0.53	0.04	0	0	0.18	2.16	6.74	17.34	75.03
Hot Water	0.57	0.54	0.59	0.56	0.52	0.45	0.42	0.39	0.38	0.42	0.46	0.53	5.82
Total	18.41	16.47	10.7	4.72	1.05	0.49	0.42	0.39	0.56	2.58	7.2	17.86	80.85

Retrofit Case:



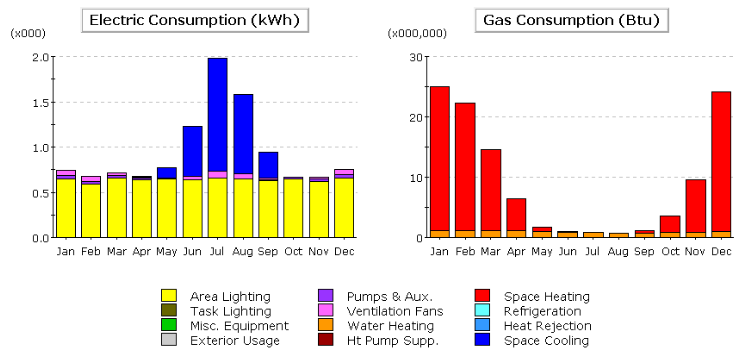
Electric Consumption (kWh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.1	16.1	165	434.8	263	79.8	0	0	0	958.8
Vent. Fans	35	31.1	19.1	7.3	1.9	9.4	23.5	13.9	4.2	3.4	11.9	33.9	194.7
Pumps & Aux.	36.6	33.5	29.8	19.5	6.8	1.1	0	0.7	4.9	16.3	27.8	37.2	214.2
Lights &Misc	126.5	115.1	128.3	124.8	126.5	124.8	128.3	127.4	123.9	127.4	122.1	128.3	1,503.70
Total	198.1	179.8	177.2	151.8	151.3	300.3	586.6	405	212.8	147.1	161.9	199.4	2,871.50

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	14.94	13.34	8.48	3.47	0.41	0.03	0	0	0.14	1.73	5.6	14.49	62.64
Hot Water	0.57	0.54	0.59	0.56	0.52	0.45	0.42	0.39	0.38	0.42	0.46	0.52	5.81
Total	15.51	13.88	9.08	4.03	0.93	0.48	0.42	0.39	0.52	2.16	6.05	15.02	68.45

UI Gas Heat / Central AC : Account 37
Baseline Case:



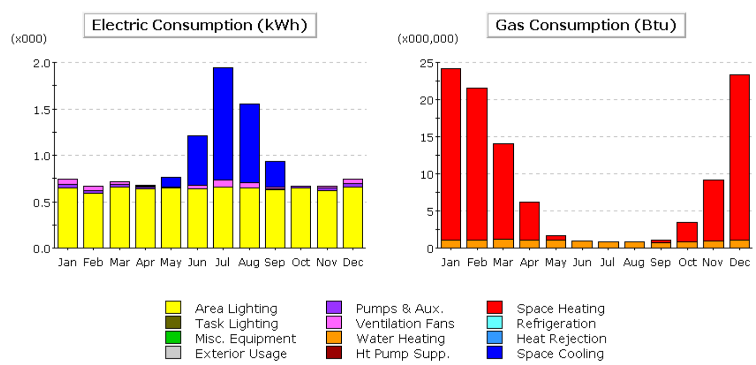
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.11	0.55	1.25	0.87	0.29	0	0	0	3.08
Vent. Fans	0.06	0.05	0.03	0.01	0.01	0.04	0.08	0.06	0.02	0.01	0.02	0.06	0.45
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.64	0.59	0.65	0.64	0.64	0.64	0.65	0.65	0.63	0.65	0.62	0.65	7.66
Total	0.74	0.67	0.72	0.68	0.77	1.23	1.98	1.58	0.95	0.67	0.67	0.75	11.4

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	23.89	21.19	13.37	5.35	0.6	0.03	0	0	0.31	2.69	8.64	23.16	99.23
Hot Water	1.13	1.07	1.19	1.12	1.04	0.91	0.84	0.78	0.76	0.84	0.9	1.04	11.62
Total	25.02	22.26	14.55	6.47	1.65	0.94	0.84	0.78	1.07	3.53	9.54	24.2	110.85

Retrofit Case:



Electric Consumption (kWh x000)

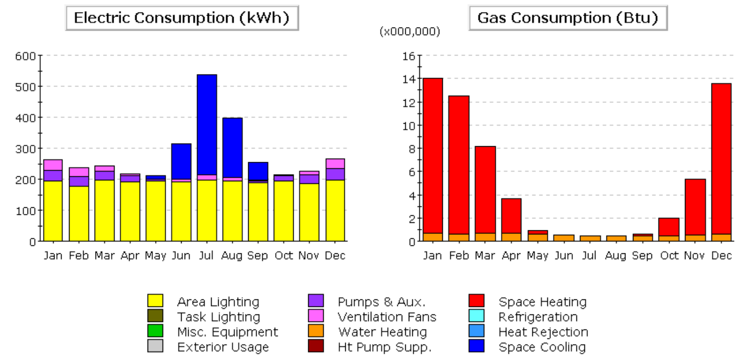
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.01	0.1	0.53	1.21	0.84	0.28	0	0	0	2.97
Vent. Fans	0.06	0.05	0.03	0.01	0.01	0.04	0.08	0.06	0.02	0.01	0.02	0.06	0.43
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Lights &Misc	0.64	0.59	0.65	0.64	0.64	0.64	0.65	0.65	0.63	0.65	0.62	0.65	7.66
Total	0.74	0.67	0.71	0.68	0.76	1.21	1.94	1.55	0.94	0.67	0.67	0.75	11.28

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	23.03	20.43	12.87	5.13	0.57	0.03	0	0	0.3	2.57	8.29	22.32	95.53
Hot Water	1.13	1.07	1.19	1.12	1.04	0.91	0.84	0.78	0.76	0.84	0.9	1.04	11.61
Total	24.16	21.5	14.06	6.25	1.61	0.94	0.84	0.78	1.06	3.41	9.19	23.35	107.15

UI Gas Heat / Central AC : Account 38

Baseline Case:



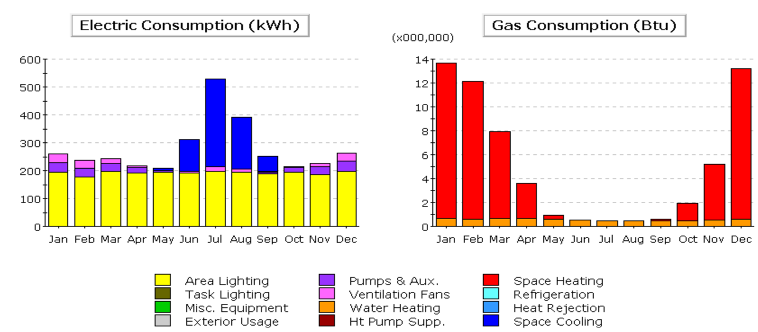
Electric Consumption (kWh)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	9.1	117	323.3	191.1	55.4	0	0	0	695.8
Vent. Fans	32.3	28.5	17.4	6.6	1.3	6.9	19.2	11	3.5	3.1	10.7	31.2	171.8
Pumps & Aux.	36.6	33.5	29.8	19.5	6.8	1.1	0	0.7	4.9	16.3	27.8	37.2	214.2
Lights &Misc	193.3	175.9	196	190.7	193.3	190.7	196	194.7	189.3	194.7	186.6	196	2,297.10
Total	262.2	237.9	243.3	216.9	210.4	315.7	538.5	397.5	253.1	214	225.1	264.4	3,379.00

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	13.38	11.84	7.48	3.02	0.34	0.02	0	0	0.18	1.51	4.83	12.96	55.57
Hot Water	0.66	0.62	0.69	0.65	0.6	0.52	0.48	0.45	0.44	0.49	0.53	0.61	6.76
Total	14.04	12.47	8.17	3.67	0.95	0.55	0.48	0.45	0.62	2	5.36	13.57	62.33

Retrofit Case:



Electric Consumption (kWh)

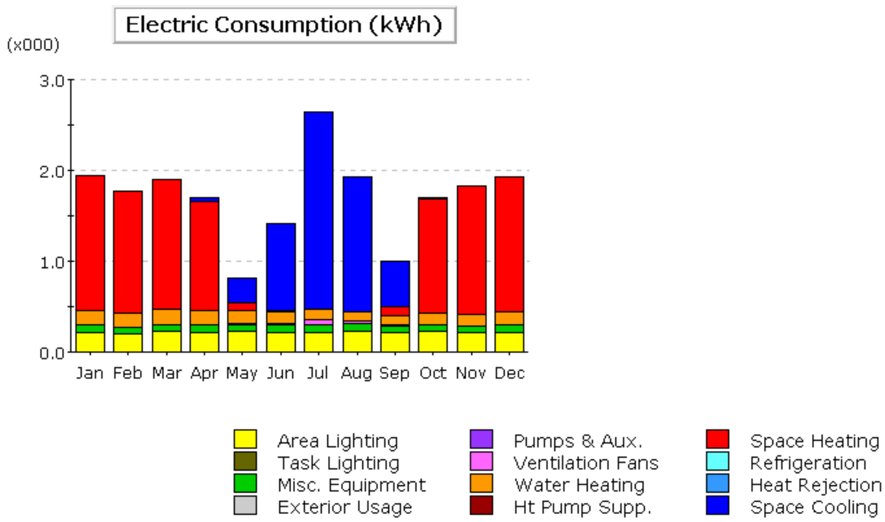
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0	8.5	113.2	314.2	186	53.7	0	0	0	675.6
Vent. Fans	31.4	27.7	16.9	6.4	1.2	6.7	18.7	10.7	3.4	3	10.4	30.3	166.9
Pumps & Aux.	36.6	33.5	29.8	19.5	6.8	1.1	0	0.7	4.9	16.3	27.8	37.2	214.2
Lights &Misc	193.3	175.9	196	190.7	193.3	190.7	196	194.7	189.3	194.7	186.6	196	2,297.10
Total	261.3	237.1	242.8	216.7	209.7	311.6	529	392.1	251.3	213.9	224.8	263.5	3,353.80

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	13	11.5	7.26	2.92	0.33	0.02	0	0	0.17	1.45	4.68	12.59	53.92
Hot Water	0.66	0.62	0.69	0.65	0.6	0.52	0.48	0.45	0.44	0.49	0.53	0.61	6.76
Total	13.66	12.13	7.95	3.57	0.93	0.55	0.48	0.45	0.61	1.94	5.21	13.2	60.68

Electric Heat : Account 12

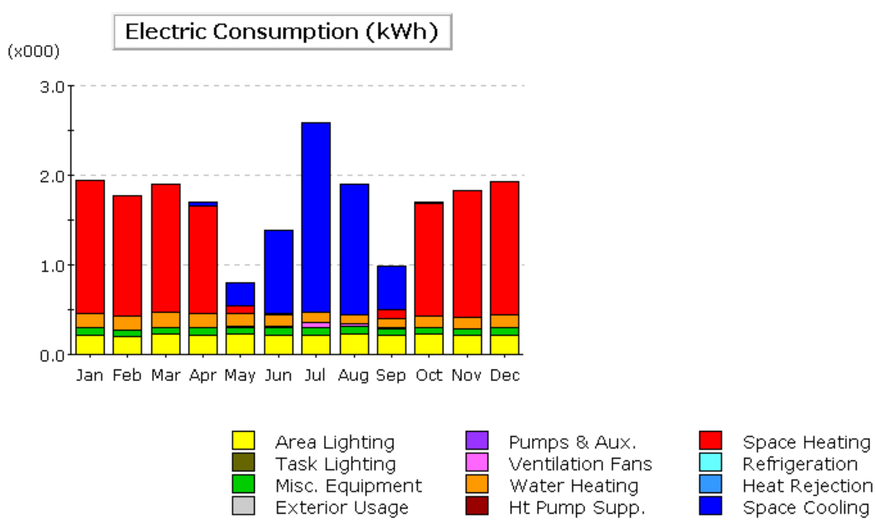
Baseline Case:



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.05	0.27	0.96	2.17	1.48	0.5	0	0	0	5.44
Space Heat	1.49	1.34	1.43	1.2	0.09	0.01	0	0	0.09	1.27	1.4	1.49	9.82
Hot Water	0.16	0.15	0.17	0.16	0.15	0.13	0.12	0.11	0.11	0.12	0.13	0.15	1.62
Vent. Fans	0	0	0	0	0	0.02	0.05	0.03	0.01	0	0	0	0.12
Misc. Equip.	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.97
Area Lights	0.22	0.2	0.22	0.21	0.22	0.21	0.22	0.22	0.21	0.22	0.21	0.22	2.61
Total	1.95	1.77	1.9	1.71	0.82	1.41	2.64	1.93	1	1.7	1.82	1.93	20.57

Retrofit Case:

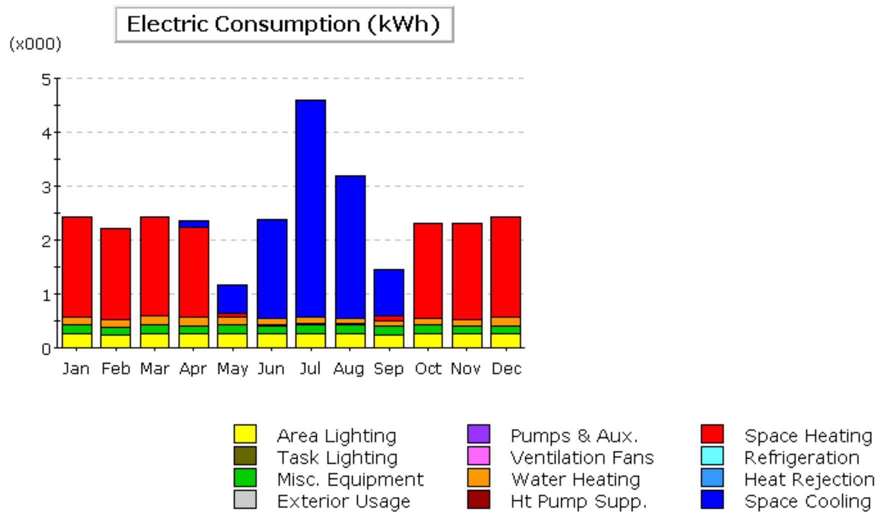


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.05	0.26	0.94	2.11	1.45	0.49	0	0	0	5.3
Space Heat	1.49	1.34	1.43	1.2	0.09	0.01	0	0	0.09	1.27	1.4	1.49	9.8
Hot Water	0.16	0.15	0.17	0.16	0.15	0.13	0.12	0.11	0.11	0.12	0.13	0.15	1.62
Vent. Fans	0	0	0	0	0	0.02	0.05	0.03	0.01	0	0	0	0.11
Misc. Equip.	0.08	0.07	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.97
Area Lights	0.22	0.2	0.22	0.21	0.22	0.21	0.22	0.22	0.21	0.22	0.21	0.22	2.61
Total	1.95	1.77	1.9	1.7	0.81	1.39	2.58	1.9	0.98	1.69	1.82	1.93	20.42

Electric Heat : Account 13

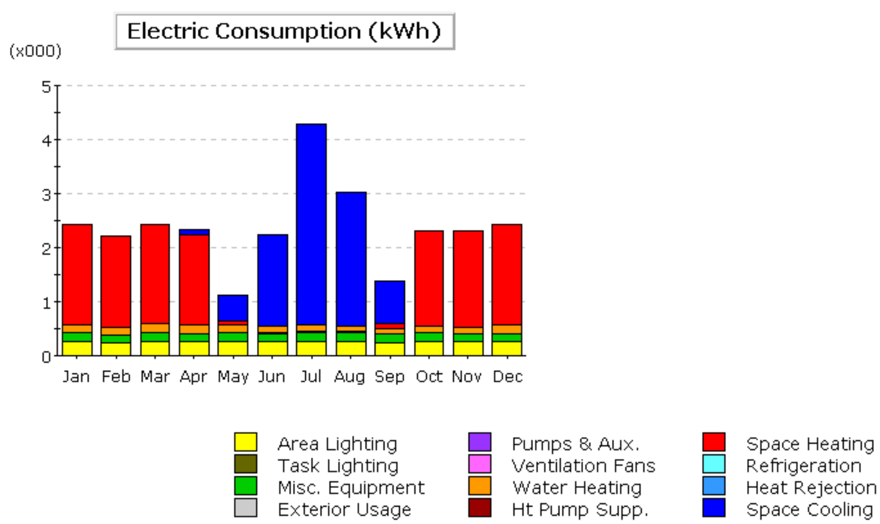
Baseline Case:



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.12	0.51	1.83	4.03	2.64	0.85	0	0	0	9.98
Space Heat	1.86	1.68	1.84	1.67	0.07	0.01	0	0	0.09	1.77	1.79	1.86	12.64
Hot Water	0.16	0.15	0.17	0.16	0.15	0.13	0.12	0.11	0.11	0.12	0.13	0.15	1.67
Vent. Fans	0	0	0	0	0	0.01	0.03	0.02	0.01	0	0	0	0.07
Misc. Equip.	0.16	0.14	0.16	0.15	0.16	0.15	0.16	0.16	0.15	0.16	0.15	0.15	1.86
Area Lights	0.26	0.24	0.26	0.25	0.26	0.25	0.26	0.26	0.25	0.26	0.25	0.26	3.07
Total	2.44	2.21	2.44	2.35	1.16	2.38	4.6	3.19	1.45	2.31	2.32	2.42	29.29

Retrofit Case:

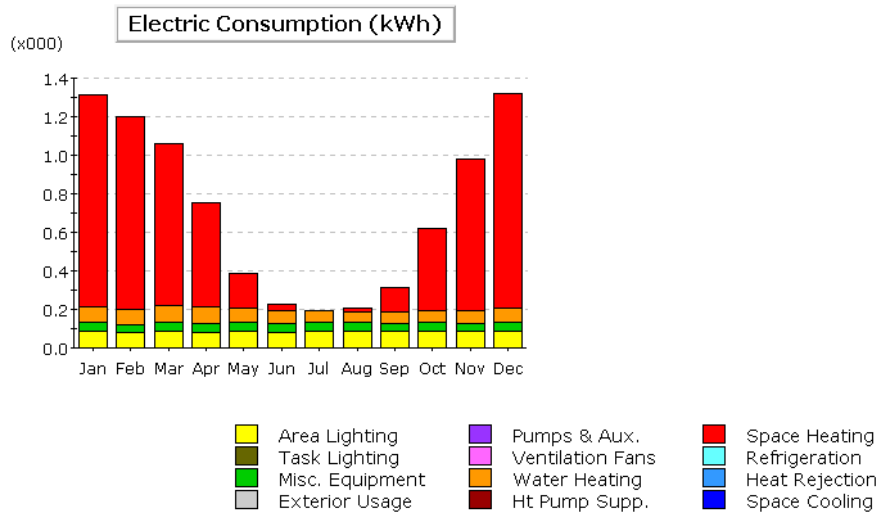


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.11	0.47	1.69	3.73	2.46	0.79	0	0	0	9.25
Space Heat	1.86	1.68	1.84	1.66	0.07	0.01	0	0	0.08	1.76	1.79	1.86	12.62
Hot Water	0.16	0.15	0.17	0.16	0.15	0.13	0.12	0.11	0.11	0.12	0.13	0.15	1.67
Vent. Fans	0	0	0	0	0	0.01	0.03	0.02	0.01	0	0	0	0.07
Misc. Equip.	0.16	0.14	0.16	0.15	0.16	0.15	0.16	0.16	0.15	0.16	0.15	0.15	1.86
Area Lights	0.26	0.24	0.26	0.25	0.26	0.25	0.26	0.26	0.25	0.26	0.25	0.26	3.07
Total	2.44	2.21	2.44	2.34	1.12	2.25	4.29	3.02	1.38	2.31	2.32	2.42	28.53

Electric Heat : Account 20

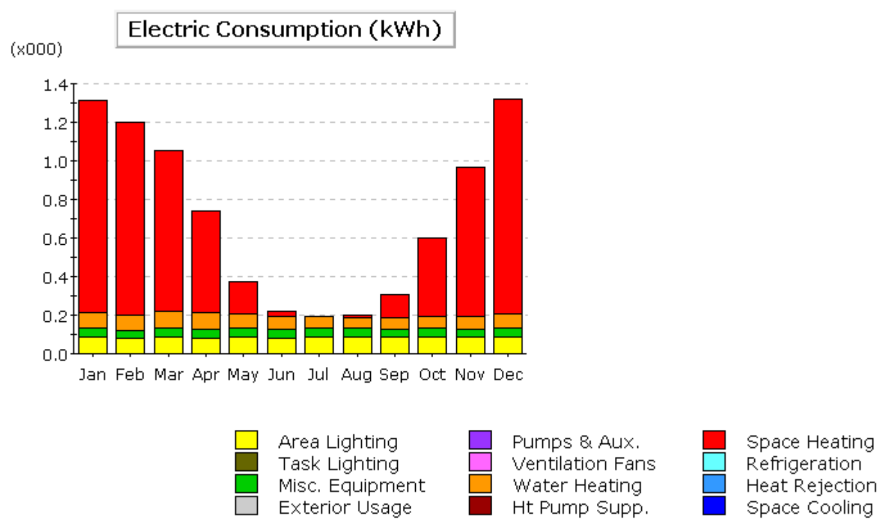
Baseline Case:



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	1.1	1	0.84	0.54	0.18	0.03	0	0.02	0.13	0.42	0.79	1.11	6.15
Hot Water	0.08	0.08	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.06	0.07	0.08	0.85
Misc. Equip.	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.55
Area Lights	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.09	0.08	0.09	0.08	0.09	1.01
Total	1.31	1.2	1.06	0.75	0.39	0.23	0.19	0.21	0.31	0.62	0.98	1.32	8.57

Retrofit Case:

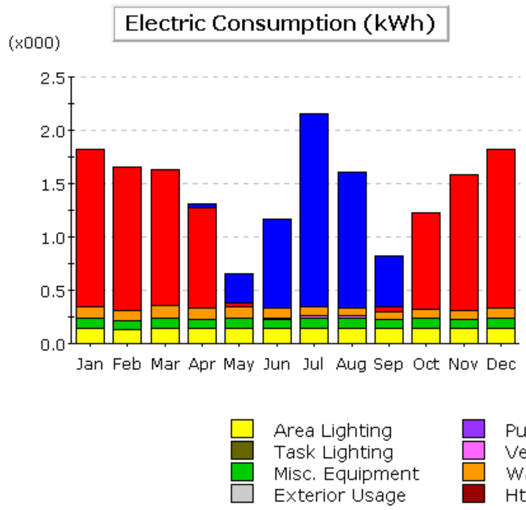


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	1.1	1	0.83	0.53	0.17	0.03	0	0.01	0.12	0.41	0.77	1.11	6.08
Hot Water	0.08	0.08	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.06	0.07	0.08	0.85
Misc. Equip.	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.55
Area Lights	0.09	0.08	0.09	0.08	0.09	0.08	0.09	0.09	0.08	0.09	0.08	0.09	1.01
Total	1.31	1.2	1.05	0.74	0.38	0.22	0.19	0.2	0.3	0.6	0.97	1.32	8.49

Electric Heat : Account 25

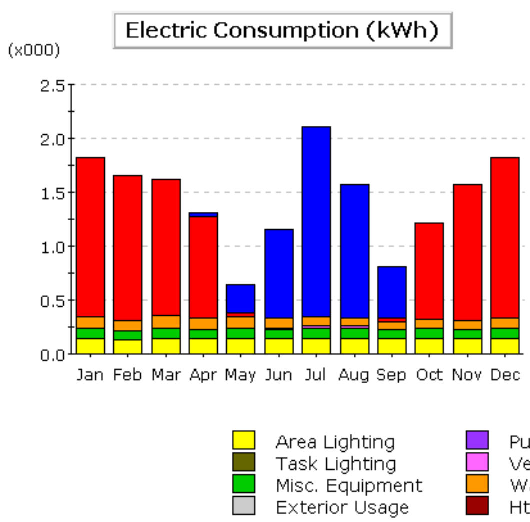
Baseline Case:



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.04	0.27	0.84	1.8	1.27	0.49	0	0	0	4.71
Space Heat	1.48	1.34	1.28	0.94	0.04	0	0	0	0.04	0.91	1.27	1.49	8.79
Hot Water	0.11	0.1	0.11	0.11	0.1	0.09	0.08	0.07	0.07	0.08	0.09	0.1	1.11
Vent. Fans	0	0	0	0	0	0.01	0.03	0.02	0.01	0	0	0	0.08
Misc. Equip.	0.09	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	1.08
Area Lights	0.14	0.13	0.15	0.14	0.15	0.14	0.14	0.15	0.14	0.15	0.14	0.14	1.7
Total	1.83	1.66	1.63	1.31	0.65	1.17	2.15	1.61	0.83	1.23	1.58	1.82	17.46

Retrofit Case:

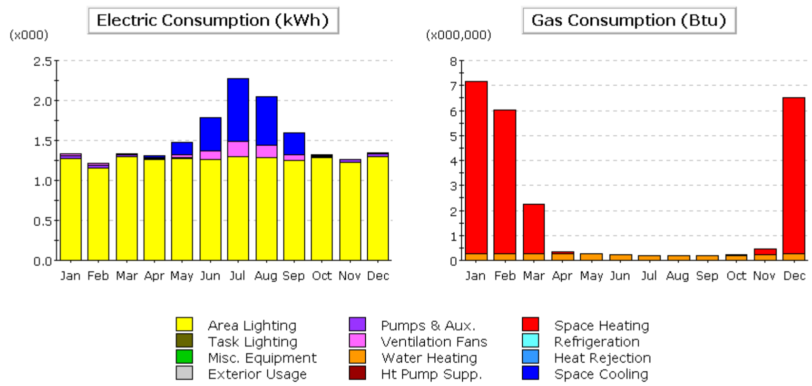


Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.04	0.26	0.82	1.76	1.24	0.48	0	0	0	4.59
Space Heat	1.48	1.34	1.27	0.93	0.04	0	0	0	0.04	0.9	1.26	1.49	8.75
Hot Water	0.11	0.1	0.11	0.11	0.1	0.09	0.08	0.07	0.07	0.08	0.09	0.1	1.11
Vent. Fans	0	0	0	0	0	0.01	0.03	0.02	0.01	0	0	0	0.07
Misc. Equip.	0.09	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	1.08
Area Lights	0.14	0.13	0.15	0.14	0.15	0.14	0.14	0.15	0.14	0.15	0.14	0.14	1.7
Total	1.83	1.66	1.62	1.3	0.64	1.15	2.1	1.57	0.81	1.22	1.57	1.82	17.31

Oil Heat : Account 2

Baseline Case:



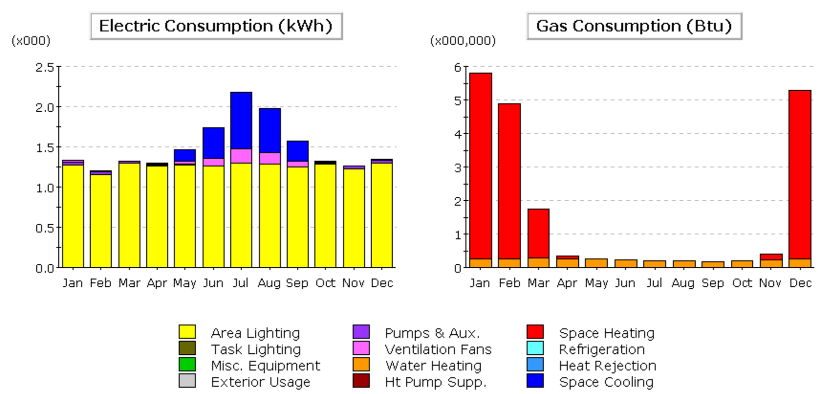
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.02	0.15	0.42	0.78	0.61	0.28	0.02	0	0	2.29
Vent. Fans	0.02	0.02	0.01	0.01	0.04	0.11	0.2	0.15	0.07	0.01	0	0.02	0.65
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Area Lights	1.27	1.16	1.29	1.26	1.27	1.26	1.29	1.28	1.25	1.28	1.23	1.29	15.15
Total	1.33	1.21	1.33	1.31	1.48	1.79	2.28	2.05	1.6	1.33	1.26	1.35	18.3

Oil Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	6.89	5.76	1.97	0.09	0	0	0	0	0	0.01	0.23	6.26	21.21
Hot Water	0.27	0.26	0.29	0.27	0.25	0.22	0.2	0.19	0.18	0.2	0.21	0.25	2.79
Total	7.16	6.02	2.25	0.36	0.25	0.22	0.2	0.19	0.18	0.21	0.44	6.51	24

Retrofit Case:



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0	0	0	0.02	0.14	0.38	0.71	0.55	0.26	0.02	0	0	2.08
Vent. Fans	0.02	0.01	0	0.01	0.04	0.1	0.18	0.14	0.07	0.01	0	0.02	0.59
Pumps & Aux.	0.04	0.03	0.03	0.02	0.01	0	0	0	0	0.02	0.03	0.04	0.21
Area Lights	1.27	1.16	1.29	1.26	1.27	1.26	1.29	1.28	1.25	1.28	1.23	1.29	15.15
Total	1.33	1.21	1.33	1.3	1.46	1.74	2.18	1.98	1.58	1.33	1.26	1.35	18.03

Oil Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Heat	5.53	4.62	1.46	0.06	0	0	0	0	0	0.01	0.18	5.04	16.9
Hot Water	0.27	0.26	0.29	0.27	0.25	0.22	0.2	0.19	0.18	0.2	0.21	0.25	2.79
Total	5.81	4.88	1.74	0.33	0.25	0.22	0.2	0.19	0.18	0.21	0.4	5.29	19.69

Control groups composed of randomly selected homes with similar pre-program energy consumption patterns were created for each electric utility. The percent change in electrical and natural gas consumption from 2007 billing data to weather adjusted 2009 billing data was computed for the participants and non-participants. The percentage change in the non-participants was subtracted from the percentage change in the participants. The resulting percentage difference was multiplied by the 2007 consumption of the participant group to obtain the energy savings of the participant group. Savings were calculated for electricity and natural gas for each of the electric utilities by home heat fuel type. A month-by-month comparison of the savings was made to investigate the temperature dependence of the savings.

Sampling Details

Cooperation with CL&P and UI allowed the samples for participants and non-participants to be drawn uniformly. Both utilities were able to identify the home heating fuel type of non-participants with acceptable accuracy, using billing rate identifiers and seasonal consumption thresholds. The goal was to have 100 homes in each home heating fuel category from which to calculate savings. Out of the 100 homes, 78 were from CL&P and 22 from UI. This was based on the weighted proportion of the program estimated electrical demand savings in each utility's territory.

There were some compromises in matching electric consumption that had to be made in order to match zip codes. There were also challenges associated with identifying the home heat fuel type of the non-participants. This primarily affected CL&P oil/other heated homes and UI electric heat and oil/other heated homes.

The procedure for identifying non-participant CL&P oil/other heated homes was to create a list of accounts with the CL&P rate identifier "Rate 001", which means that the home is heated with gas, oil or other fuel. From this list, the gas-heated homes had to be removed. The list was manually culled by CL&P staff to remove all accounts with gas service. The remaining homes were heated with oil or other fuel. From this truncated list, emphasis was placed on matching zip codes (while matching consumption as closely as possible) with a corresponding participant sample since geographic proximity will be a more significant matching parameter than magnitude of consumption. Homes in the same geographic area have a greater chance of being in the same economic standing and the operational patterns of the homes should be similar.

The procedure for identifying non-participant UI electric heated homes was to use the utility billing record database "Rate A" designation, which identifies a home as having electric heat. The data delivered contained annual consumption ranging from 16,000 kWh to 30,000 kWh. There was difficulty matching participants in this consumption range for any range of closely located zip codes. Again, emphasis was placed on matching zip codes (while matching consumption as closely as possible) with the participant sample since geographic proximity will be a more significant matching parameter than magnitude of consumption.

While not having the magnitude of energy consumption match between participants and non-participants will introduce bias due to homes with larger energy consumption potentially having different behavioral patterns than homes with lower energy consumption, homes in the same geographic region will have a stronger probability of responding similarly to changing economic conditions. It is more detrimental comparing homes in different geographic area (zip codes) attempting to make a close match in consumption magnitude than comparing homes in the same geographic area even though their energy consumption magnitudes (participants vs. non-participants) may be different.

Southern Connecticut Gas and Connecticut Natural Gas were unable to provide billing data, so all billing analysis study gas results are based on Yankee Gas billing records provided by CL&P.

Regression Details

For gas heated homes, account-specific correlations (linear trendlines) were made between the monthly 2007 gas consumption figures and the monthly 2007 HDDs (Heating Degree Days) for the heating months (defined as HDD>CDD). The R^2 for these correlations were always above 0.75; therefore the monthly 2009 HDDs for heating months were inserted in to the 2007 trendline, in place of 2007 HDDs, to calculate the adjusted monthly 2007 gas consumption figures. Gas savings were calculated for the heating months, as the difference between the adjusted 2007 consumption and the actual 2009 gas consumption, for each account. Monthly savings were summed to calculate annual savings.

For gas heated homes, account-specific correlations (linear trendlines) were made between the monthly 2007 electric consumption figures and the monthly 2007 CDDs (Cooling Degree Days) for the cooling months (defined as CDD>HDD). If the resulting trendline had an R^2 value greater than 0.5 for that particular account, the monthly 2009 CDDs for cooling months were inserted in to the 2007 trendline to calculate the adjusted monthly 2007 electric consumption figures. If the resulting trendline had an R^2 value less than 0.5, no weather correlation was deemed to exist, and the monthly 2007 electric consumption figures were not adjusted. An R^2 of 0.5 was chosen as the cutoff because the trendline can be said to more likely represent a trend, than not. Using trendlines with low R^2 can cause energy consumptions scaled with that trendline to be very inaccurate. Electric savings were calculated for the cooling months, as the difference between the adjusted 2007 electric consumption and the actual 2009 electric consumption, for each account. Monthly savings were summed to calculate annual savings.

For electric heated homes, account-specific correlations (linear trendlines) were made between the monthly 2007 electric consumption figures and the monthly 2007 HDDs (Heating Degree Days) for the heating months (defined as HDD>CDD). The R^2 for these correlations were greater than 0.5 for all accounts, so the monthly 2009 HDDs for heating months were inserted in to the 2007 trendline to calculate the adjusted monthly 2007 electric consumption figures. Electric savings were calculated for the heating months, as the difference between the adjusted 2007 electric consumption and the actual 2009 electric consumption, for each account. Monthly savings were summed to calculate annual savings.

For electric heated homes, account-specific correlations (linear trendlines) were made between the monthly 2007 electric consumption figures and the monthly 2007 CDDs (Cooling Degree Days) for the cooling months (defined as CDD>HDD). If the resulting trendline had an R^2 value greater than 0.5 for that particular account, the monthly 2009 CDDs for cooling months were inserted in to the 2007 trendline to calculate the adjusted monthly 2007 electric consumption figures. If the resulting trendline had an R^2 value less than 0.5, no weather correlation was deemed to exist, and the monthly 2007 electric consumption figures were not adjusted. Electric savings were calculated for the cooling months, as the difference between the adjusted 2007 electric consumption and the actual 2009 electric consumption, for each account. Monthly savings were summed to calculate annual savings.

For oil and other heated homes, there were no adjustment for 2007 electric consumption figures for the heating months (defined as HDD>CDD).

For oil and other heated homes, account-specific correlations (linear trendlines) were made between the monthly 2007 electric consumption figures and the monthly 2007 CDDs (Cooling Degree Days) for the cooling months (defined as CDD>HDD). If the resulting trendline had an R^2 value greater than 0.5 for that particular account, the monthly 2009 CDDs for cooling months were inserted in to the 2007 trendline to calculate the adjusted monthly 2007 electric consumption figures. If the resulting trendline had an R^2 value less than 0.5, no weather correlation was deemed to exist, and the monthly 2007 electric consumption figures were not adjusted. Electric savings were calculated for the cooling months, as the difference between the adjusted 2007 electric consumption and the actual 2009 electric consumption, for each account. Monthly savings were summed to calculate annual savings.

The same process for regression/normalization was used for participants and non-participants. Average annual consumptions were calculated by taking the simple arithmetic average for each fuel type for participants and non-participants across all accounts used.

CL&P Billing Analysis Savings Results

	Gas Heated		Electric Heated		Oil Heated	
	Participants	Non-Participants	Participants	Non-Participants	Participants	Non-Participants
Average Annual Baseline Gas Consumption	844	914				
Average Annual Retrofit Gas Consumption	787	884				
Sum of Annual Baseline Gas Consumption	64,168	74,036				
Sum of Annual Retrofit Gas Consumption	59,774	71,591				
Average Annual Baseline Electric Consumption	7,896	8,240	17,028	15,016	14,447	8,603
Average Annual Retrofit Electric Consumption	7,099	8,080	15,210	14,138	13,197	7,938
Sum of Annual Baseline Electric Consumption	600,066	667,462	1,328,182	1,246,292	996,857	602,189
Sum of Annual Retrofit Electric Consumption	539,512	654,468	1,186,389	1,173,484	910,560	555,658
Average Annual Gas Savings	58	30				
Sum of Annual Gas Savings	4,394	2,445				
Average Annual Electric Savings	797	160	1,818	877	1,251	665
Sum of Annual Electric Savings	60,554	12,994	141,793	72,808	86,297	46,531
R^2 Heating (Gas: CCF vs HDD, Other: kWh vs HDD)	0.898	0.908	0.679	0.628	0.230	0.200
R^2 Cooling (kWh vs CDD)	0.513	0.440	0.321	0.355	0.393	0.377
Sample Size	76	81	78	83	69	70

Average Monthly Gas Savings						
January	13	15.34				
February	-15	-15.08				
March	11	16.30				
April	-1	-0.49				
May	3	4.16				
June	-5	-4.69				
July	-6	-4.84				
August	-3	-2.64				
September	2	1.07				
October	20	17.48				
November	13	6.59				
December	25	-3.02				
Average Monthly Electrical Savings						
January	6	-13.54	228	22.85	35	39
February	81	32.12	-32	-86.91	87	54
March	81	77.38	322	216.37	102	66
April	11	-31.58	204	111.20	34	65
May	45	5.43	194	171.48	28	27
June	152	74.31	88	25.37	175	58
July	176	85.48	48	59.42	246	117
August	25	-27.17	-11	-24.69	151	89
September	33	-2.90	-3	-16.89	-8	-14
October	35	-18.62	384	295.13	125	45
November	86	33.27	240	180.99	146	78
December	65	-53.77	156	-77.11	128	40

UI Billing Analysis Savings Results

	Gas Heated		Electric Heated		Oil Heated	
	Participants	Non-Participants	Participants	Non-Participants	Participants	Non-Participants
Average Annual Baseline Gas Consumption						
Average Annual Retrofit Gas Consumption						
Sum of Annual Baseline Gas Consumption						
Sum of Annual Retrofit Gas Consumption						
Average Annual Baseline Electric Consumption	8,853	8,364	12,634	19,642	13,204	8,904
Average Annual Retrofit Electric Consumption	7,830	7,642	10,384	18,974	11,973	8,830
Sum of Annual Baseline Electric Consumption	230,167	200,724	328,474	510,688	369,718	204,782
Sum of Annual Retrofit Electric Consumption	203,581	183,404	269,986	493,332	335,240	203,079
Average Annual Gas Savings						
Sum of Annual Gas Savings						
Average Annual Electric Savings	1023	722	2,250	668	1,231	74
Sum of Annual Electric Savings	26586	17,320	58,488	17,356	34,478	1,703
R^2 Heating (kWh vs HDD)			0.286	0.242	0.227	0.274
R^2 Cooling (kWh vs CDD)	0.3995	0.472	0.407	0.450	0.537	0.367
Sample Size	26	24	26	26	28	23
Monthly Gas Savings						
January						
February						
March						
April						
May						
June						
July						
August						
September						

October						
November						
December						
Monthly Electrical Savings						
January	27.5	-53.5	-32.76	-493.56	26.11	-47.35
February	36.7	72.9	-4.23	-146.63	74.00	15.48
March	47.6	62.8	160.54	-77.79	100.29	119.26
April	34.2	24.1	225.89	62.44	30.54	-47.13
May	46.4	73.7	295.33	362.16	-7.61	-61.78
June	167.8	158.8	233.24	216.61	226.51	40.79
July	205.6	94.8	192.08	338.97	286.64	21.51
August	196.5	140.2	275.50	102.81	217.67	37.01
September	-19.8	-18.5	70.29	-75.58	-46.31	-93.45
October	54.9	28.0	307.63	257.69	72.21	-28.61
November	87.4	28.8	309.91	193.50	133.61	32.70
December	137.8	109.5	216.10	-73.07	117.71	85.61

The results from both utilities were combined based on their percentage weights and shown in the following tables.

Participant Average per home annual consumption (NU & UI)

	Baseline		Retrofit		Average HES Program Savings		% change	
Home Heating Fuel	kWh	CCF	kWh	CCF	kWh	CCF	kWh	CCF
Gas	8,140	844	7,285	787	1,278	52.7	10.5%	6.8%
Electric	15,929		14,004		1,381		12.1%	
Oil / Other	14,088		12,843		1,673		8.8%	

Non-Participant Average per home annual consumption (NU & UI)

	Baseline		Retrofit			% change	
Home Heating Fuel	kWh	CCF	kWh	CCF		kWh	CCF
Gas	8,268	914	7,980	884		3.5%	3.3%
Electric	16,119		15,292			5.1%	
Oil / Other	8,677		8,158			6.0%	

Finally the control group ratio was calculated and can be seen in the following table.

Control Group Ratio

	% Change Difference		Nexant Program Savings		Control group Ratio	
Home Heating Fuel	kWh	CCF	kWh	CCF	kWh	CCF
Gas	7.0%	3.5%	571.5	29.9	66.8%	51.8%
Electric	7.0%		1,108.3		57.6%	
Oil / Other	2.9%		403.0		32.4%	

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