

CONNECTICUT ENERGY EFFICIENCY BOARD

Evaluation Studies and Results, 2013

*A REPORT TO THE ENERGY AND TECHNOLOGY COMMITTEE OF THE
CONNECTICUT GENERAL ASSEMBLY*



Connecticut Energy Efficiency Board Evaluation Committee

March 1, 2014

Final Report

PREFACE FROM THE EEB EVALUATION COMMITTEE

The Energy Efficiency Board (EEB) Evaluation Committee is proud to present the Annual Report of the studies, results and recommendations via the EEB program evaluation, measurement, and verification (EM&V) process. Connecticut has one of the longest EM&V histories, contributing to some of the nation's strongest efficiency programs.

EM&V is very important to the efficiency programs' successes. Evaluations are designed to be comprehensive, independent, actionable and cost-effective. Impact results provide verification that the Fund is being used appropriately and provide beneficial programs and savings. Recommendations also provide essential information on how programs can be improved, additional measures developed and customer needs met. The use of outside evaluators provides for independence and also allows Connecticut to take advantage of the successes and failures of other programs and jurisdictions. The EEB EM&V evaluation process provides funding, leadership, and data, and also reviews studies managed by Northeast Energy Efficiency Partnerships (NEEP).

What follows is a compilation of results and recommendations from studies completed in the last year. Links to the appropriate sections of the Board website will lead you to the full reports, should you want more detail.

Additionally, this report is intended to provide an introduction to the wide range of studies typically completed by the EEB. These current and new studies cover evaluations of program savings, customer and vendor reception to program offerings, assessment of new opportunities and examinations of what pockets of savings remain available in areas already covered.

We believe that you will find the report informative. Please contact us with any questions you may have.

Offered by the EEB Evaluation Committee;
Amy Thompson, Chair
Shirley Bergert
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PREFACE FROM THE EVALUATION OVERSEERS --- OVERVIEW AND VERIFICATION OF THE 2013 EVALUATION OF CONNECTICUT'S ENERGY EFFICIENCY FUND ACTIVITIES

The evaluation efforts conducted in 2013 were designed and managed by third-party independent experienced evaluators.¹ The evaluations themselves were also conducted by independent evaluation teams, operating under the guidelines of Connecticut's Evaluation Roadmap, which instituted policies to assure independence.

The evaluations completed in 2013 add to the evaluation evidence of accomplishments from the use of Connecticut's Energy Efficiency Fund (EEF).

The Evaluation Consultant Team² verify that the 2013 completed evaluations and on-going evaluations meet or exceed the rigor and energy efficiency evaluation practices conducted across the United States. The evaluation results and recommendations are similar to energy efficiency evaluation results elsewhere. The accumulation of the evaluations continues to demonstrate that activities supported by Connecticut's EEF are making reasonable energy efficiency achievements. The research:

C&I:

- Verified that EEF funded programs for commercial and industrial customers are achieving energy savings over what would have been obtained by C&I customers without these EEF activities and near expectations. (C0: C&I Free Ridership and Spillover Study).
- The independent program impact evaluation for the 2008 to 2010 program years for the programs evaluated in this study found electric energy savings realization rates of 74% for the RCx and 73% for O&M. The natural gas savings realization rates were 60% for the RCx and 87% for O&M. (C01: Impact Evaluation of the Retrocommissioning, Operation and Maintenance, and Business Sustainability Challenge Programs).

¹ The Evaluation Consultant and the evaluation contractors conduct energy efficiency program evaluations across the nation and beyond. They are independent from Connecticut utilities and Connecticut boards, state regulatory staff and state agencies. All of the evaluators conducting Connecticut evaluation activities provide objective evaluation and verification, following evaluation ethics and "Guiding Principles for Evaluation" from the American Evaluation Association.

² The current Evaluation Consultant, contracted in February 2013, is a team of experienced independent evaluators led by Skumatz Economic Research Associates (SERA) and includes Apex Analytics, LLC. and Analytical Evaluation Consultants, LLC. Each consultant on the team has between 20 and 35 years of experience in the field, and has conducted work nationwide. The offices of these firms are located in Colorado, Washington and Massachusetts.



- An evaluation reviewing four years of the program tracking databases of the larger C&I programs found that 55% of all Energy Conscious Blueprint (ECB)³ projects with two or more measures and 25% of all such projects for large C&I retrofits (Energy Opportunities (EO) program) contained at least improvements to both lighting and HVAC end-uses (some projects contained a third or fourth end-use).⁴ The report makes preliminary recommendations for consideration prior to the near-term completion of the EO Process and Impact Evaluation and the SBEA Impact Evaluation. (C13: Large C&I Quick Start Market Assessment//Trend Analysis).

Residential:

- An evaluation of an information//feedback-based residential pilot program finds first-year savings from large users average 1.7% of energy usage (388 kWh less than control households), that monthly information delivery increased savings over less frequent outreach (although cost-effectiveness should be considered), and that customers were satisfied, but were somewhat confused about the source of the “neighbor comparison” figures included in the feedback, and desired more personalized energy-saving “tips” as part of the outreach. (R1, the CL&P Behavioral Pilot (HER)).
- A study of the energy-related features of single family homes used secondary data to explore household and building characteristics that affect program and weatherization planning and targeting efforts in the State. The report found 63% of homes were built prior to 1970 (and only about 8% have been remodeled since standards requiring R-11 insulation have been in effect); about 70% of households are heated with oil, about one-fifth are heated with natural gas, and 5-9% use electricity; and that ownership patterns imply that residential retrofit program will continue to serve more owner-occupied than renter-occupied households.

Evaluation Consultant Team

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³ The ECB program is the C&I program for new construction and lost opportunities (for instances where equipment is already planned to be replaced).

⁴ The remainder of the projects are for one measure.

Contents

PREFACE FROM THE EEB EVALUATION COMMITTEE	ii
PREFACE FROM THE EVALUATION OVERSEERS --- OVERVIEW AND VERIFICATION OF THE 2013 EVALUATION OF CONNECTICUT'S ENERGY EFFICIENCY FUND ACTIVITIES	iii
1. INTRODUCTION	1
1.1 Definition of Evaluation Types	2
1.2 Organization of the Report.....	3
1.3 Completed, In-Progress, and In-Development Studies	3
2. COMPLETED STUDIES.....	6
2.1 Commercial Process and Impact Evaluation Research Area	6
C0: C&I Free Ridership and Spillover Report.....	6
C01: Impact Evaluation of the Retrocommissioning, Operation & Maintenance, and Business Sustainability Challenge Programs	10
2.2 Commercial Market Research and Evaluation Research Area	16
C13: Large Commercial & Industrial Research: Quick Start Market Assessment/Participant Trend Analysis ...	16
2.3 Residential Process and Impact Evaluation Research Area	20
R1: Evaluation of the Year 1 CL&P Pilot Customer Behavior Program (HER).....	20
2.4 Residential Market Research and Evaluation Research Area	24
R6: Housing Characterization Study.....	24
3. STUDIES IN PROGRESS	26
3.1 Commercial Process and Impact Evaluation Research Area	26
C9: Small Business Impact Study.....	26
C14: EO Process and Impact Evaluation.....	26
C18: SBEA Process Evaluation	28
C20: Energy Conscious Blueprint (ECB) Evaluation.....	29
3.2 Commercial Market Research and Evaluation Research Area	30
C10: SBEA Data Mining Evaluation Objectives and Approach	30
C11: Barriers to Commercial and Industrial Program Participation with a Focus on Financing and Cancellations.....	31
C12: Small Business Research Area Limited English and Low Income Barriers Project (Phase 2)	32
C17: Connecticut Commercial and Industrial (C&I) Market Research	33
3.3 Residential Process and Impact Evaluation Research Area	34
R2: CL&P Behavior (HER) Pilot Studies 2012 Year 2 (and Persistence add-on).....	34
R4: HES/HES-IE Process Evaluation and Effective Useful Life Study (incorporating 97/24).....	35
R7: Residential Ground Source Heat Pump Evaluation Study.....	36
R8: Residential Central Air Conditioning Study.....	38
R16: HES/HES-IE Impact Evaluation and Effective Useful Life Study	39

R86: Residential Lighting Net-to-Gross Study	40
3.4 Residential Market Research and Evaluation Research Area	41
R3: Regional Lighting Hours of Use Study	41
R5: Weatherization Baseline Study	42
R15: Residential SF Potential Study – Oil, NG, and Electric Baseline	43
4. STUDIES IN DEVELOPMENT FOR 2014	45
4.1 Commercial Process and Impact Evaluation Research Area	45
C101: ECB Process/NEI & Impact Evaluation	45
4.2 Commercial Market Research and Evaluation Research Area	45
C19: New Construction Baseline and Code Compliance (incorporates Study 10)	45
C52: Assess Lighting Structure for Capability Regarding High Performance Lighting	46
C104: Detailed review of C&I PSD Existing Buildings – FR, SO, load shapes, and their use	47
C105: Evaluability Assessment of New/Major Program Changes for Strategic Energy Management (SEM)	47
4.3 Residential Process and Impact Evaluation Research Area	47
R67: Lighting Interactive Effects Study	47
4.4 Residential Market Research and Evaluation Research Area	48
R31: Real Time Data Collection	48
R38: Field Test of Wireless Thermostats/Technologies	49
R48: Market Assessment/Performance Evaluation for Incorporation of High Performance Measures into HES and Other Residential Programs	49
R51: Codes and Standards – Examine Potential Savings from Past and Future Program Activity	50
R82: Participation in Lighting Data through the Consortium for Retail Energy Efficiency Data (CREED)	50
R84: Consumer Electronic Market and Potential Study	51
5. REGIONAL EM&V STUDIES AND OTHER STUDIES	52
5.1 Connecticut Participation in NEEP Regional EM&V Studies	52
R14: Societal Non-Energy Impacts	52
R61: Load Shape Research	53
RC63: Incremental Cost Study	53
R73: Ductless Mini-Split Performance Results – Meta Study	53
R78: Appliance Standards Support	54
R88: Measure Life Study - Estimation-based (NEEP)	54
R91: Addressing Disconnects between Engineering and Billing Analysis	54
RC109: REED Database	55
5.2 Other Studies	55
6. DIRECTION OF FUTURE STUDIES	56

1. INTRODUCTION

The Energy Efficiency Fund (EEF) and Utility Companies have a long history of providing efficiency programs to Connecticut energy consumers. An integral part of creating, delivering and maintaining quality programs is performing independent evaluations of programs and the markets they serve. The evaluators make recommendations for program modifications that are considered in prospective program development and implementation.

In 1998 the Energy Efficiency Board or EEB (previously the Energy Conservation Management Board) was formed and charged with responsibility to advise and assist the utility distribution companies in the development and implementation of comprehensive and cost-effective energy conservation and market transformation plans. Since that time, the EEB has worked closely with the Companies to ensure all evaluations are relevant, independent, cost-effective and meet the needs of program administrators and planners who are charged with achieving substantial public benefits. In 2005, the EEB formed an Evaluation Committee that works with an EEB Evaluation Consultant to oversee evaluation planning and completion. In 2009, the Department of Public Utility Control (DPUC) decided that the EEB's Evaluation Committee and their consultant would be independent from and totally responsible for all aspects of the evaluation process.

Since that time, the evaluation process and oversight have changed through additional DPUC (now Public Utility Regulatory Authority (PURA)) decisions which were adopted and extended by PA 11-80, sec. 33, amending Conn. Gen. Stat. sec. 16-245m, in 2011. PA 11-80 required an independent, comprehensive program evaluation, measurement and verification process to ensure the Connecticut Energy Efficiency Fund's (CEEF) programs are administered appropriately and efficiently, comply with statutory requirements, and programs and measures are cost effective; evaluation reports are accurate and issued in a timely manner; evaluation results are appropriately and accurately taken into account in program development and implementation; and information necessary to meet any third-party evaluation requirements is provided.

The essential information gained through studies such as those discussed in this report is provided very cost-efficiently. The \$2.82 million dollar 2013 budget for all evaluation and related research studies represented 1.9% of the program costs of \$151.6 million, which compares with \$2.95 million, or 2.1% of the \$143.0 million in 2012, based on actual 2012 evaluation expenditures.

Research completed within the evaluation group provides many types of information. Impact and process evaluations form the bulk of budget for studies completed. Additional studies support how the current and future efficiency programs are developed, supported and improved through careful research into:

- Current market opportunities for program expansion
- New end uses and equipment that may be included cost-effectively, including assessment of the associated barriers for inclusion of each
- Customer segmentation and market research, including research into ownership patterns, and
- Examination of best practices in other jurisdictions

The EEB Evaluation Committee ensures the independence and objectivity of Evaluation Measurement and Verification (EM&V). It is critical that the programs be evaluated, measured, and verified in ways that provide confidence to the public that savings are real and enable the Companies and EEB to use savings estimates and Evaluator's recommendations to improve and advance programs with full confidence.

1.1 Definition of Evaluation Types

There are many types of evaluation supported by EEF funding. Research studies assist regulators, policy makers, the EEB and program administrators to maintain excellent practices and develop new programming options to meet Connecticut's growing efficiency needs throughout program formation and evolution.

- Process Evaluations determine the efficacy of program procedures and measures. Process Evaluations assess the interactions between program services and procedures and the customers, contractors, and participating ancillary businesses. Process evaluation is essential to support development of improved program delivery, increased cost effectiveness and customer satisfaction.
- Impact Evaluations verify the magnitude of energy savings and the reasons for differences between projected and realized savings. The results and value of energy efficiency programs are reported to regulatory bodies, ISO-New England, Company management, and program planners and administrators. Many different types of impact studies may be completed including end-use metering, engineering modeling, billing analyses, participant interview, surveys and combinations of these.
- Market Assessments examine overall market conditions related to energy efficiency products and services, including current standard practices, average efficiency of equipment, consumer purchasing practices, and identification of market barriers. The assessments ascertain the extent to which efficiency programs are likely to influence customer adoption of measures and practices. Assessments are conducted to identify effective ways to influence key market players to take efficiency actions and increase the breadth and depth of the actions taken.
- Impact Support Studies assess the adequacy of engineering methodologies and background assumptions, supporting the Program Savings Document (PSD) and providing the foundation against which evaluations will assess program performance.
- Baseline Studies provide direct impact support by assessing pre-conditions that will no longer be measureable after program interventions have occurred.
- Evaluation Protocols are produced within the Regional EM&V Forum to provide direction to states new to the evaluation process and to ensure consistency to all of the states within the Forum. Cost-effective regional evaluations are coordinated through the Forum. The EEB is an active participant in the EM&V Forum, providing leadership, quality control, data and funding to its efforts.

Collectively, these types of studies are sometimes referred to as Evaluation, Measurement and Verification (EM&V; defined at the top of the page). The evaluation process is a critical tool to measure energy savings, as well as other key attributes of each program, to allow optimum program design and careful management of consumer conservation funds. The various types of evaluation studies are

utilized to support ongoing improvement in program offerings and to measure the results of those programs. The audiences for evaluation include regulatory bodies, the regional electric system operator (ISO-New England), Company management and program planners and administrators, all of whom need the information to make decisions about program design and efficacy to enhance existing cost-effective programs and redesign program that are not cost-effective to make them successful. Evaluation research provides the basis for determining program direction or focus; increasing participation and savings; expanding the reach of programs, developing messaging more relevant to the non-participating customers where appropriate; reducing costs; and fine-tuning procedures.

1.2 Organization of the Report

The remainder of this report is organized in chapters, based on the current status of the study.

- **Chapter 2 - Completed Studies** includes descriptions, costs and summary results from completed studies that were filed in the last 12 months. Findings and recommendations are summarized; links to the full reports are found at the end of each study description.
- **Chapter 3 - On-going Studies** includes study descriptions and costs for projects currently being completed. For most of these studies, reasonable estimates of completion dates can be provided as well.
- **Chapter 4 - Studies in Development** provides study goals, descriptions of the methods to be employed and costs to the extent these items are available. The studies in Section 3 will be initiated as soon as contracts are executed. The uncertainties around contracting impact the dates the projects can start, the length of time required to complete the study and, sometimes the methods that can be employed.
- **Chapter 5 - EM&V Forum** offers descriptions of studies completed within the regional EM&V Forum (Forum). Within the Forum, participating states pool monetary, data, and manpower resources to complete evaluation and other studies under the general management of the Northeast Energy Efficiency Partnerships (NEEP). For these studies, descriptions and results are available. However, individual project costs are not available because the Forum charges each state's energy Companies a yearly fee based on anticipated study costs across all studies and a management fee to fund the Forum. In Connecticut, these charges are paid through the Energy Efficiency Fund.
- **Chapter 6 – Future Studies Planned** provides a listing of the titles and budgets of the studies planned as part of the 2015 and 2016 evaluation years.

1.3 Completed, In-Progress, and In-Development Studies

The following table, Figure 1.1, summarizes the completed, in-progress, in-development, and Regional EM&V studies addressed in this Evaluation Legislative Report. Each is described in more detail in subsequent chapters, as noted.

Figure 1.1: List of Studies Addressed in the 2013 Legislative Report (by category)

Sector	Proj#	Project Name	Budget (thousands)
COMPLETED STUDIES (CHPT 2): COMMERCIAL PROCESS AND IMPACT EVALUATION AREA			
Commercial	C0	C&I Free Ridership/Spillover Report	\$165
Commercial	C01	Impact Evaluation of the Retrocommissioning, Operation, and Maintenance and Business Sustainability Challenge Programs (combined impact report)	\$375
COMPLETED STUDIES (CHPT 2): COMMERCIAL MARKET ASSESSMENT AND EVALUATION AREA			
Commercial	C13	C13. Large C&I Quick Start Market Assessment/Trend Analysis	\$25
COMPLETED STUDIES (CHPT 2): RESIDENTIAL PROCESS AND IMPACT EVALUATION AREA			
Residential	R1	R1. Evaluation of Year 1 CL&P Pilot Customer Behavior Program (HER)	\$452
COMPLETED STUDIES (CHPT 2): RESIDENTIAL MARKET ASSESSMENT AND EVALUATION AREA			
Residential	R6	R6. Housing Characterization	\$30
IN-PROGRESS STUDIES (CHPT 3): COMMERCIAL PROCESS AND IMPACT EVALUATION AREA			
Commercial	C9	C9. Small Business impact Study	\$333
Commercial	C14	C14.EO Impact and Process Evaluation	\$1,003
Commercial	C18	C18. SBEA Process Evaluation.	\$316
Commercial	C20	C20. ECB Evaluation	\$76
IN-PROGRESS STUDIES (CHPT 3): COMMERCIAL MARKET ASSESSMENT AND EVALUATION AREA			
Commercial	C10	C10. Small Business Data Mining Study	\$47
Commercial	C11	C11. Small Business Barriers Study focusing on program cancellations, financing and repeat participation	\$159
Commercial	C12	C12. Small Business Barriers Study focusing on Limited English/Low Income Businesses	\$64
Commercial	C17	C17. C&I Financing Market Assessment	\$350
IN-PROGRESS STUDIES (CHPT 3): RESIDENTIAL PROCESS AND IMPACT EVALUATION AREA			
Residential	R2	R2.CL&P Behavior (HER) Pilot Studies 2012 Yr. 2 and Persistence Add-on	\$183
Residential	R4	R4.HES Persistence and Process Evaluations (incorporating NTG, NEI, carryover)	\$293
Residential	R7	R7. Ground Source Heat Pump Study (Impact & Market Assessment)	\$338
Residential	R8	R8. Central Air Conditioning - 2 year project	\$551
Residential	R16	R16. HES/HES-IE Impact Evaluation & EUL Study	\$360
IN-PROGRESS STUDIES (CHPT 3): RESIDENTIAL MARKET ASSESSMENT AND EVALUATION AREA			
Residential	R3	R3. Regional Lighting Hours of Use	\$252
Residential	R5	R5. Weatherization Baseline 2012	\$829
Residential	R15	R15. Residential Single Family "Potential" - Oil, Natural Gas, and Electric Baseline	\$236
Residential	R86	R86. LED Market Assessment & Lighting NTG	\$300

Sector	Proj#	Project Name	Budget (thousands)
IN-DEVELOPMENT STUDIES (CHPT 4): COMMERCIAL PROCESS AND IMPACT EVALUATION AREA			
Commercial	C101	ECB Process & Impact Evaluation (including marketing and NEI research)	\$1,400
IN-DEVELOPMENT STUDIES (CHPT 4): COMMERCIAL MARKET ASSESSMENT AND EVALUATION AREA			
Commercial	C19	New Construction Baseline & Code Compliance (#10 in 2014 plan)	\$650
Commercial	C52	Assess Lighting Structure for Capability Regarding High Performance Lighting	\$75
Commercial	C104	Detailed Review of C&I PSD Existing Buildings, Free Ridership & Spillover, Load Shapes, and their Use	\$50
Commercial	C105	Evaluability Assessment of New/Major Program Changes for Strategic Energy Management	\$25
IN-DEVELOPMENT (CHPT 4): RESIDENTIAL PROCESS AND IMPACT EVALUATION AREA			
Residential	R67	Lighting Interactive Effects Study (CT-based)	\$25
IN-DEVELOPMENT (CHPT 4): RESIDENTIAL MARKET ASSESSMENT AND EVALUATION AREA			
Residential	R31	Real-Time Data Collection/telephone surveys with program participants to feed impact/process evaluation work	\$76
Residential	R38	Field test of Wireless Thermostats/Technologies	\$100
Residential	R48	Market Assessment/Literature Review/Performance Evaluation for Incorporation of High Performance Measures into HES/Residential Programs	\$30
Residential	R51	Codes & Standards - Examine Potential Savings from Past & Future Program Activity	\$200
Residential	R82	CREED Participation - Lighting Data	\$10
Residential	R84	Consumer Electronic Market and Potential Study	\$28
REGIONAL EM&V STUDIES IN DEVELOPMENT (CHPT 5)			
Residential	R14	Societal Non-Energy Impacts - Economic and Environmental NEIs/NEBs.	\$3
RC (Res & Com'l)	RC61	Load Shape Research - Primary Research/Estimation/Development (NEEP) – Deferred to 2015	\$59
RC (Res & Com'l)	RC63	Incremental Cost Estimation Study (NEEP)	\$56
Residential	R73	Ductless Heat Pump Mini-Split Performance Results - Meta Study (NEEP)	\$10
Residential	R78	Appliance Standards Support (NEEP)	\$8
Residential	R88	Measure Life Study - Estimation-based (NEEP) with initial literature work to prioritize needs/gaps	\$25
Residential	R91	Addressing Disconnects between Engineering and Billing Analysis (CT proposed to NEEP)	\$8
Residential	R109	REED Database - Regional Energy Efficiency Database (NEEP)	\$8

2. COMPLETED STUDIES

2.1 Commercial Process and Impact Evaluation Research Area

C0: C&I Free Ridership and Spillover Report

Conducted by TetraTech; Budget: \$165,000.

Objective and Principal Outcomes:

The primary objective for this evaluation was to quantify the rate of net energy savings being achieved by the three (3) largest commercial and industrial programs through the 2011 participants involved in these programs and the effects of the program on other Connecticut customers and vendor activities. The net rate is the combination of the rate from the savings from 2011 program participants that would not have occurred in the absence of the program plus the additional savings induced by the programs from other customers and vendors. The first of these refers to program participants who would have obtained energy savings without the programs as “free riders”. The latter is the savings rate from “spillover”. Per the EEB, the primary objective of the 2011 program year Free-ridership and Spillover Study was to assist the Connecticut Energy Efficiency Fund in quantifying the net impacts of their commercial and industrial electric and natural gas energy efficiency programs by estimating the extent of:

- Program free-ridership
- Early participant “like” and “unlike” spillover
- Nonparticipant “like” spillover.

The three commercial and industrial (C&I) programs evaluated include the Energy Conscious Blueprint, Energy Opportunities, and Small Business Energy Advantage programs. These programs target C&I new construction and lost opportunities, retrofits for energy and demand savings from medium and large utility customers, and small business customers, respectively.

Approach and Work Plan:

Telephone surveys were conducted in 2012 of 2011 participants in the largest C&I programs and of Connecticut equipment vendors and design professionals. The sample size from 2011 participants with electric savings totaled 641. The sample size from 2011 participants with natural gas savings totaled 39. Telephone surveys with equipment vendors and design professionals obtained a sample size of 49 of influential market actors.

The independent evaluation contractor used a state-of-the-art method for developing these net savings rates. The study used a tested, standardized net-to-gross (NTG)⁵ self-report approach (SRA).

⁵ NTG is a factor that represents the ratio of the gross (engineering-type) program savings that can be properly attributed as having been influenced by the program. The factor is used to derive the savings that are attributable to the program beyond what would have happened in the absence of the program. It is the combination of two

Results:

The net electric savings rate for the three largest 2011 C&I programs were found to be 89% for the Energy Conscious Blueprint program; 93% for the Energy Opportunities program; and 99% for the Small Business Energy Advantage program. The overall electric net savings rate across the three C&I programs was 94%.⁶

The net natural gas savings rate for the two of the largest 2011 C&I programs were found to be 86% for the Energy Conscious Blueprint program and 101% for the Energy Opportunities program. The overall natural gas net savings rate across the three C&I programs was 89%.⁷

The report also provides the electric and natural gas net savings rates by measure type (such as lighting, cooling, etc.).

Statewide Results by Program and Measure Type

This section summarizes the statewide free-ridership and participant spillover rates for each program by fuel type, followed by statewide figures by measure type and fuel type. Section 3 of the final report (link provided below) provides more detailed results for each measure type within each program. Section 3 of the full report also presents more detail on how specific equipment was grouped by measure type. Figure 2.1 and Figure 2.2 below present statewide free-ridership and spillover rates for each program for the two Companies for electric and natural gas measure types. The statewide electric free ridership rate was 10.4 percent, while the participant “like” spillover and nonparticipant spillover rates were 4.2 percent and 0.1 percent respectively. This results in an overall NTG rate of 93.9 percent. Free-ridership was lowest within the Small Business Energy Advantage program at 3.7 percent and highest for the Energy Conscious Blueprint program (18.2 percent).

The statewide gas programs had a higher free-ridership rate than the electric programs (26.5 percent) and therefore a lower NTG rate (88.9 percent). It is typical that gas programs have higher free-ridership rates which results in a lower overall NTG rate. Spillover is slightly higher with the gas programs driven by the Energy Opportunities program.

Across the different programs, measure type was assigned based on the specific type of equipment installed (see Section 3 of the full report for more details). Figure 2.3 and Figure 2.4 present the statewide free-ridership and spillover rates for each electric and gas measure type across the two Companies. The controls, other, and refrigeration electric measure types have the lowest level of free-ridership (less than three percent), while the cooling and custom measure types have the highest free-ridership rate (around 22 percent).

The full report can be found at:

http://energizect.com/sites/default/files/2011%20CI%20FR-SO%20Report%20Final_0.pdf

effects. Free-riders (free ridership) are participants who take the incentive, but would have bought the energy-efficient measure even without the incentive (they decrease the gross savings value), and the spillover factor represents those participants (and non-participants) who were influenced by the program to adopt energy efficiency measures or behavior but did not receive the program’s incentive (they add to the gross savings value).

⁶ The sampling precision for these findings are better than 2% at a 90% confidence level.

⁷ The sampling precision for these findings are better than 10% at a 90% confidence level.

Figure 2.1: 2011 Statewide C&I Electric Free-ridership and Spillover Results by Program

Program	Surveyed	Population	Population Savings (kWh)	Free-ridership Rate	Level of Precision at the 90% Confidence Interval (+/-)	Participant "Like" Spillover Rate	Level of Precision at the 90% Confidence Interval (+/-)	Non-participant Spillover Rate	Net-to-Gross Rate
Energy Conscious Blueprint	143	468	19,039,634	18.2%	4.4%	6.7%	2.9%	0.4%	88.9%
Energy Opportunities	151	784	57,067,186	11.5%	3.8%	4.5%	2.5%	0.0%	92.9%
Small Business Energy Advantage	347	1924	32,079,624	3.7%	1.5%	2.2%	1.2%	0.0%	98.5%
Total*	641	3176	108,186,444	10.4%	1.8%	4.2%	1.2%	0.1%	93.9%

*Precision of +/- 1.8% for free-ridership and +/- 1.2% for participant like spillover at the state level

Figure 2.2. 2011 Statewide C&I Natural Gas Free-ridership and Spillover Results by Program

Program	Surveyed	Population	Population Savings (ccf)	Free-ridership Rate	Level of Precision at the 90% Confidence Interval (+/-)	Participant "Like" Spillover Rate	Level of Precision at the 90% Confidence Interval (+/-)	Non-participant Spillover Rate	Net-to-Gross Rate
Energy Conscious Blueprint	34	91	346,912	23.8%	9.5%	8.7%	6.3%	0.8%	85.7%
Energy Opportunities	5	31	253,994	30.0%	30.9%	20.6%	27.2%	10.4%	100.9%
Total*	39	122	600,906	26.5%	9.6%	13.9%	7.5%	1.6%	88.9%

*Precision of +/- 9.6% for free-ridership and +/- 7.5% for participant like spillover at the state level

Figure 2.3: 2011 Statewide C&I Electric Free-ridership and Spillover Results by Measure Type

Measure Type	Surveyed	Population	Population Savings (kWh)	Free-ridership Rate	Level of Precision at the 90% Confidence Interval (+/-)	Participant "Like" Spillover Rate	Level of Precision at the 90% Confidence Interval (+/-)	Non-participant Spillover Rate	Net-to-Gross Rate
Building Envelope	0	1	20	NA	NA	NA	NA	NA	NA
Controls	1	1	75	0.0%	0.0%	0.0%	0.0%	NA	100.0%
Cooling	99	341	10,071,505	22.3%	5.8%	2.6%	2.2%	3.6%	84.0%
Custom	10	49	3,059,631	22.1%	19.3%	7.7%	12.3%	0.0%	85.5%

Heating	28	101	2,594,978	16.2%	9.7%	5.1%	5.8%	0.0%	88.8%
HVAC	0	1	6	NA	NA	NA	NA	NA	NA
Lighting	338	2,186	68,903,274	8.4%	2.3%	4.5%	1.7%	0.0%	96.2%
Motors	0	11	79,451	NA	NA	NA	NA	NA	NA
Other	24	53	2,212,378	1.6%	3.2%	0.1%	0.8%	0.0%	98.5%
Process	61	127	13,852,986	13.1%	5.1%	2.1%	2.2%	0.0%	89.0%
Refrigeration	80	303	7,214,557	2.7%	2.6%	6.7%	4.0%	0.0%	104.0%
VFDs	0	2	197,583	NA	NA	NA	NA	NA	NA

Figure 2.4: 2011 Statewide C&I Natural Gas Free-ridership and Spillover Results by Measure Type

Measure Type	Surveyed	Population	Population Savings (ccf)	Free-ridership Rate	Level of Precision at the 90% Confidence Interval (+/-)	Participant "Like" Spillover Rate	Level of Precision at the 90% Confidence Interval (+/-)	Non-participant Spillover Rate	Net-to-Gross Rate
Building Envelope	1	3	11,437	12.5%	44.4%	0.0%	0.0%	NA	87.5%
Controls	1	21	187,264	31.3%	74.4%	0.0%	0.0%	NA	68.8%
Custom	0	1	28,901	NA	NA	NA	NA	NA	NA
HVAC	33	76	309,153	24.5%	9.3%	11.0%	6.7%	0.0%	86.5%
Other	0	1	772	NA	NA	NA	NA	NA	NA
Process	3	9	48,025	12.9%	26.0%	91.7%	21.4%	NA	178.8%
Water Heating	1	11	15,354	100.0%	0.0%	0.0%	0.0%	33.3%	33.3%

C01: Impact Evaluation of the Retrocommissioning, Operation & Maintenance, and Business Sustainability Challenge Programs

Conducted by Michaels Energy and Evergreen Economics, Budget: \$ 375,055.

Objectives and Priority Outcomes:

This study was an impact evaluation of the Connecticut Retro-Commissioning (RCx) and Operations and Maintenance (O&M) programs for the 2008 to 2010 program years – a program with multiple sub-elements. The EEB requires periodic evaluations of the C&LM programs to advise and assist the utility distribution companies in the development and implementation of comprehensive and cost effective energy conservation and market transformation plans. The primary objectives of this evaluation were two-fold:

- the quantification of adjusted gross savings for both electric and natural gas savings based on several adjustment factors for the RCx and O&M programs, including the persistence of compressed air leak savings.
- the primary objective of the Business Sustainability Challenge (BSC) program evaluation is measure what behavioral changes customers have made as result of program participation, and the study presents a case study approach impact evaluation to assess the pilot program.

The RCx, O&M, and BSC programs are part of the Conservation & Load Management (C&LM) plan for electric and natural gas energy savings and are funded by the Connecticut Energy Efficiency Fund. These programs are offered by Connecticut Light & Power Company (CL&P) and United Illumination (UI). The Connecticut Energy Efficiency Board (EEB) manages the CEEF, overseeing the programs and their evaluations. Members of the EEB are from private and public entities, representing the interests of companies, environmental organizations, the Attorney General's Office, and organizations representing the interests of residential, commercial, industrial, and limited- income customers. This evaluation measured the results of projects completed from 2008 through 2010 through the RCx, O&M, and BSC programs.

Approach and Work Plan:

The contractor conducted file reviews and field verification and data collection on a complete survey of the 21 RCx projects and a statically sampled selection of 44 O&M projects. The BSC program had 15 participants that had completed the program during the evaluation period, with 9 responding to surveys.

Field personnel verified the energy efficiency measures and installed data loggers to record equipment energy usage (kW), hours of operation, and temperature profiles. Site personnel were also interviewed to determine other key parameters specific to each project.

The collected data from the on-site visits were used to analyze the kW, kWh and CCF usage for both average demand and seasonal peak demand for each of the projects. These values were compared to the reported energy savings to determine the adjustment factors and realization rates. The results were then extrapolated to all projects to determine the total savings realized by the RCx and O&M programs from 2008 through 2010.

RCx Program Results:

The original claimed savings and the evaluation measured savings for energy as well as summer and winter seasonal peak savings for the RCx program is given in Figure 2.5 and Figure 2.6. The figures also present the magnitude of the savings adjustments for each adjustment type. The evaluation was designed to achieve 90% confidence at 10% precision for energy savings, and 80% confidence and 10% precision for demand savings for each of the individual programs. The precision levels are also provided in the savings tables.

Figure 2.5: RCx Energy and Peak Savings

	Energy Savings		Summer Seasonal Peak Savings		Winter Seasonal Peak Savings	
	(kWh)	Adjustment/R R (%)	(kW)	Adjustment /RR (%)	(kW)	Adjustment /RR (%)
Program calculated Savings Estimate	5,865,555	100%	650.43	100%	378.91	100%
Documentation Adjustment	-119,226	2%	239.18	37%	50.74	13%
Technology Adjustment	0	0%	0.00	0%	0.00	0%
Quantity Adjustment	105,120	2%	12.00	2%	12.00	3%
Operation Adjustment	-593,784	-27%	-182.06	-28%	-102.27	-27%
Heating & Cooling Adj.	78,134	1%	17.46	3%	0.00	0%
Total Savings	4,335,799	74%	737.02	113%	339.38	90%
Precision Levels	At 90% conf: 0.2%		At 80% conf: 2%		At 80% conf: 1%	

Figure 2.6: RCx CCF Savings

	Energy Savings		Peak Day Savings	
	(CCF)	Adjustment /RR (%)	(CCF/Day)	Adjustment /RR (%)
Program calculated Savings Estimate	77,187	100%	928.89	100%
Documentation Adjustment	-7	0%	-3.47	0%
Technology Adjustment	0	0%	0.00	0%
Quantity Adjustment	0	0%	0.00	0%
Operation Adjustment	-30,682	-40%	-258.91	-28%
Heating and Cooling Adjustment	0	0%	0.00	0%
Total Savings	46,498	60%	665.50	72%
Precision Levels			At 80% conf: 0%	

RCx Program Findings:

Overall, the RCx program was found to be successful in identifying projects. Based on the files reviewed, the projects included measures that covered a wide range of technologies and the types of measures identified indicate that the investigation completed was of a high level of rigor. Identified measures, and the associated savings, were clearly identified based on site-specific conditions.

The savings calculations for the completed measures were also found to be in-depth and robust. Additionally, the methodology was found to be consistent and reasonable. However, input parameters were often estimated, rather than measured. Most of the projects evaluated used an assumed motor, chiller, or other equipment load factor to calculate savings. The assumed load factor was often greater than the actual load factor when determined based on the collected data.

The measure calculations also often neglected to account for interactions with other completed measures. For example, savings were claimed for several of the school projects both for scheduling the HVAC equipment and the chiller plant. For both measures, the cooling load in the baseline condition was assumed to be the existing conditions. The savings should have been calculated sequentially, with the scheduling for the HVAC units reducing the cooling load on the plant, then the turning off of the plant eliminating the remaining energy usage.

Many of the changes in the evaluation analysis were not due to calculation errors or oversimplification, but instead due to measures not being implemented as intended. For example, several of the school projects had significant savings levels claimed for the implementation of reductions in operation for equipment during the summer months. However, due to system limitations, the systems needed to be manually changed to a “summer” mode. This was not occurring, resulting in the savings not being realized.

The documentation level for the RCx projects were sufficient, however, often did not clearly indicate what changes were made to the systems. Many of the RCx measures include the replacement or repair of failed equipment. These can include replacing failed sensors that are reading incorrectly or fixing dampers that may be failed open. In the case of a failed temperature sensor, the description should include a description of how the sensor failed and the result on the system, such as: “The temperature sensor for the building was out of calibration and was reading 5°F low, resulting in the system changing over from heating to cooling mode incorrectly. This required and excessive reheating, which will be reduced.” This will facilitate both the implementation and evaluation of the recommended changes.

RCx Program Recommendations:

The report makes the following recommendations:

- Recommendation 1: The Companies should employ conservative assumptions when claiming savings for projects that require a manual change to set or maintain efficient operation.
- Recommendation 2: The Companies should require that the operational conditions before and after an operational change or repair of failed equipment are fully documented, rather than only including a description of the change.
- Recommendation 3: Load factors for motor, chiller, and other equipment should be based on collected data such as instantaneous measurements, short term metering, or BAS/EMS trended data.
- Recommendation 4: The Companies should calculate measure savings sequentially. For example, the baseline operation and energy consumption for the second measure should be calculated as incremental to the effects of completion of the first measure. Pre and post demand and energy consumption should be shown for each measure to ease the review process.

O&M Program Results:

The original claimed savings and the evaluation measured savings for energy as well as summer and winter seasonal peak for the O&M program is given in Figure 2.7. Figure 2.7 also presents the magnitude of the savings adjustments for each adjustment type. The table also provides the precision levels.

Figure 2.7: O&M Energy and Seasonal Peak Savings

All Programs	Energy Savings		Summer Seasonal Peak Savings		Winter Seasonal Peak Savings	
	(kWh)	Adjustment/RR (%)	(kW)	Adjustment /RR (%)	(kW)	Adjustment /RR (%)
Program calculated Savings Estimate	12,359,309	100%	1,112.09	100%	1,090.71	100%
Documentation Adj.	184,412	1%	-12.98	-1%	-12.98	-1%
Technology Adj.	0	0%	0.00	0%	0.00	0%
Quantity Adj.	-635,687	-5%	-135.82	-12%	-135.82	-12%
Operation Adj.	-2,990,012	-24%	-28.80	-3%	154.14	14%
Heating & Cooling Adj.	73,486	1%	3.56	0%	3.79	0%
Total Savings	8,991,508	73%	938.05	84%	1,099.84	101%
Precision Levels	At 90% conf: 3%		At 80% conf: 8%		At 80% conf: 10%	

Figure 2.8 presents the O&M CCF savings, magnitude of the savings adjustments for each adjustment type and precision levels.

Figure 2.8: O&M CCF Savings

	Energy Savings		Peak Day Savings	
	(CCF)	Adjustment /RR (%)	(CCF/Day)	Adjustment /RR (%)
Program calculated Savings Estimate	8,948	100%	40.57	100%
Documentation Adj.	0	0%	0.00	0%
Technology Adj.	0	0%	0.00	0%
Quantity Adj.	0	0%	0.00	0%
Operation Adj.	-1,139	-13%	3.33	8%
Heating & Cooling Adj.	0	0%	0.00	0%
Total Savings	7,809	87%	43.90	108%
Precision Levels	At 80% conf: 4%		At 80% conf: 0%	

O&M Program Findings:

Overall, the O&M program tended to focus on more specific areas, with compressed air leaks and PC projects comprising the vast majority of the projects and the savings.

The savings calculations were found to be simple and more general than the RCx analyses. However, in general, the analyses were reasonable and accurate, with two notable exceptions.

- First, the Wattage for the controlled computers in the PC projects was found to be overestimated. This change resulted in all of the PC projects having savings levels reduced.
- Second, one of the compressed air projects comprised of 46% of the evaluated O&M program savings and 25% of the entire O&M program savings. Several significant errors were found in the analysis which resulted in a 54% realization rate for the project. This was not representative of the remaining compressed air projects. Aside from this project, the compressed air projects were adjusted upwards by 4% during the evaluation.

While reviewing the compressed air projects, and investigating the persistence of leak repairs, it became apparent that many of the companies were not using the provided leak detectors on a regular basis. This was primarily driven by either a lack of knowledge on the use of the leak detector or the lack of a responsible person tasked to complete the leak audits. The two companies that were performing leak tests had either made it part of the maintenance program or it was driven by a single employee at the site outside of his normal responsibilities. It was clear that sites that did actively search out and repair leaks had much lower leakage rates than companies who were not actively repairing leaks.

O&M Recommendations:

The report makes the following recommendations:

- Recommendation 5: The Companies should afford greater scrutiny to the large projects that make up a significant portion of the program portfolio. This can be done by additional levels of review to allow additional people to review the project or increased metering requirements by collecting both pre and post data.
- Recommendation 6: Equipment energy specifications should be double-checked, especially for projects where equipment wattages are applied over a large number of installations.
- Recommendation 7: The customers should be required to make leak detection a regularly occurring part of the facility maintenance.
- Recommendation 8: Reinstating the distribution of leak detectors under the O&M Services program should be investigated, along with periodic education or training.

BSC Program Results:

The BSC program was evaluated into five distinct areas: sustainability staffing, establishing metrics, setting goals based on established metrics, establishing procedures and protocols and completing projects to make progress to achieve the goals. Nine of the 16 participating companies were interviewed in order to assess the impacts using these metrics. The remaining participants were not available for interviews.

Eight of the companies were found to have some form of sustainability group, green team, or at a minimum a staff member coordinating the efforts. However, only five of the companies had “official” green teams or responsible individuals, with defined roles. For the remaining companies, the sustainability duties were more informal in nature and less well defined within the company.

The same eight companies track energy consumption or some other metric. However, the companies have not been as successful at establishing meaningful metrics. The most common metric given by the

companies is monthly energy consumption. Companies typically do not normalize to production or any other variable due to inability to determine a useful variable for normalization or not knowing how to normalize usage to facility operation.

The same eight companies interviewed also have established either formal or informal goals with five having formal goals. However, the usefulness of the goals is diminished due to lack of meaningful metrics.

Three of the companies have completed traditional energy efficiency projects (such as lighting or HVAC equipment upgrades). Five of the companies have also implemented non-traditional energy efficiency or sustainability projects as shown below. A detailed breakdown of the recycling and waste reduction actions by company are given in Figure 2.9 below.

Figure 2.9: Recycling/Waste Reduction Measures

Company	Action
Company D	<ul style="list-style-type: none"> Implemented a single stream recycling program
Company E	<ul style="list-style-type: none"> Increased the number of recycling bins

Four of the above five companies have also increased efforts in the areas of employee training, education, or information. Although these efforts have primarily involved education for use in the workplace, two customers have expanded this effort to include information for employee use at home. A detailed breakdown of the employee training and education actions by company are given in Figure 2.10 below.

Figure 2.10: Employee Training/Education Actions

Company	Action
Company D	<ul style="list-style-type: none"> Regular newsletters to notify employees on the status of sustainability projects Make green team staff available to discuss home projects with employees
Company E	<ul style="list-style-type: none"> Send email blasts to employees to encourage sustainability and inform them of current efforts
Company H	<ul style="list-style-type: none"> Train people to shut down computers and other equipment over lunch, breaks, etc.
Company I	<ul style="list-style-type: none"> Train employees and post signs to remind employees to shut shipping doors to reduce HVAC energy usage Have annual “Green Fair” with UI representative to promote CFLS and home energy audits

BSC Program Findings:

The BSC participants did have staff dedicated to sustainability, however, only approximately half of the companies had an “official” group. The other companies incorporated sustainability into existing meetings or included sustainability as an “unofficial” duty for a staff member.

The companies did use their utility bills as a metric to gauge sustainability; however, few of the companies had progressed beyond reviewing utility bills to developing meaningful metrics, such as kWh per part produced or per square foot of area. Several specifically mentioned difficulties in developing or determining meaningful metrics for their facility as a barrier. This process is complex in nature and will be unique to each customer. By working with customers on a one-on-one basis, companies will be more

likely to be able to determine what metrics will be meaningful for them. Specifically, two customers indicated a desire to develop metrics regarding trash and recycling volumes. Both indicated that they did not know how to proceed with this task.

Several customers indicated a frustration with the lack of meetings after the completion of the course.

BSC Recommendations:

The Consultants make the following recommendations:

- Recommendation 9: The Companies should work with customers to develop a staffing plan to ensure sustainability groups or green teams are “official” positions.
- Recommendation 10: Work with customers on a one-on-one basis to develop meaningful metrics. Recommendation 11: While participants are very interested in the broad range of sustainability issues, the program appears to focus on electricity use only in developing savings metrics. To better serve these participants, the Companies should increase focus on non-utility metrics, such as recycling volumes, trash volumes, and water usage.
- Recommendation 12: The Companies should hold periodic meetings open to all BSC participants, to review successes, challenges, and tools.

See full report:

<http://energizect.com/sites/default/files/RCx-OM-%20BSC%20Final%20Report%2001-21-13.pdf>

2.2 Commercial Market Research and Evaluation Research Area

C13: Large Commercial & Industrial Research: Quick Start Market Assessment/Participant Trend Analysis

Conducted by Energy Market Innovations, Inc. (EMI), Budget: \$24,905.

Objective and Priority Outcomes:

This study focused on the aggregation and analysis of energy efficiency program-tracking data from the large commercial and industrial (C&I) programs being operated by the two major energy utilities in Connecticut. The contractors examined four years of program-tracking data from Connecticut's two major C&I energy efficiency programs:

- Energy Conscious Blueprint (ECB) and
- Energy Opportunities (EO).

These two programs are each operated independently by The United Illuminating Company (UI) and Connecticut Light & Power (CL&P), and their subsidiary natural gas companies: Yankee Gas, Southern Connecticut Gas, and Connecticut Natural Gas (together, the Companies). The ECB program is primarily directed toward maximizing electric and natural gas savings during a facility's initial construction or major renovation, while the EO program focuses on encouraging electric and natural savings in existing facilities through incentives supporting qualified efficiency improvements. Combined, these two programs account for 59 percent of electric energy savings and 87 percent of natural gas energy savings that are attributed to Connecticut's C&I program portfolio.

The purpose of this study was to provide program staff and the EEB with an understanding of the most important participation trends and developments in the EO and ECB programs in recent years, viewed on an aggregated, statewide basis. Based on these findings, the study is also intended to provide guidance to EO and ECB program staff to help them more effectively target the remaining savings opportunities and to encourage additional comprehensive energy efficiency projects among their customers. The results of this study compliment more exhaustive research activities currently underway by the evaluation team.

In conducting this trend analysis, the team reviewed program-tracking data for completeness and consistency across programs and Companies. Based on this review, the evaluation team also provides recommendations for how the Companies can improve the usability of their program-tracking data to better inform future marketing efforts and allow for more in-depth reporting and evaluation.

Approach and Work Plan:

As part of the project-planning process, the evaluation team requested and received copies of the Companies' C&I EE program participation databases. As a necessary first step in data analysis, the EMI evaluation team checked, cleaned, and merged the relevant data fields from the databases provided by the Companies into one consistent format. Once merged, this database contained records of all incented energy efficient equipment installed by participants under the ECB and the EO programs between the years 2008 and 2011. This provided the foundation for the evaluation team's analysis and highlighted any gaps in the Companies' data. In order to identify participation trends in each program, EMI produced detailed summary tables.

The measure or end-use categories tracked by each company were not identical, so the team had to define common types of, or "harmonize" project attribute definitions in the data analysis process to produce one statewide database. As detailed in Section 2, the evaluation team recoded measure descriptions into 11 commonly used categorical measure types that were identified as consistent across the Companies and programs. Likewise, the team recoded facility-type information (e.g., office, retail, and warehouse) into 10 consistent facility groups across companies and programs, again using standard industry definitions. EMI then applied these harmonized measure and facility categories in all follow-up analysis of data.

Recommendations:

Based on the evaluation team's analysis of the program-tracking data, we provide the following recommendations.

The evaluation team recommends that the Companies should continue to focus on adding improvements to HVAC systems and motors and drives in addition to any cost-effective lighting improvements (including lighting controls). Per the program-tracking database, improvements to lighting and HVAC are most likely to be installed at the same facility in both the ECB and EO programs. Our analysis revealed that between 2008 and 2011, 55% of all ECB comprehensive projects and 25% of all EO comprehensive projects contained at least improvements to both lighting and HVAC end-uses (some projects contained a third or fourth end-use). It is likely that these equipment combinations present the most cost-effective energy efficiency opportunities across the widest segment of C&I customers.

The evaluation team recommends that the Companies consider encouraging industrial and manufacturing facilities to complete additional comprehensive projects as a part of the ECB program.

The Companies should consider increasing efforts at engaging these facilities and investigate what types of comprehensive projects will be valuable for them. EMI's research identified that these facilities account for a large portion of the overall program participation and energy savings impact but that comprehensive projects are relatively infrequently; only 20% of the industrial and manufacturing facilities that participated in the ECB program improved more than one end-use between 2008 and 2011.

The evaluation team recommends that the Companies should continue to encourage institutional facilities to complete projects as part of the ECB program. The ECB program has been very successful in gaining participation of educational facilities and health care facilities, and staff should expand their engagement of these sectors. While these segments account for a smaller proportion of the ECB program participation, these customer types achieved higher-than-average kWh savings per account between 2008 and 2011. This suggests that they present additional opportunities for the program to achieve cost-effective savings by maximizing the energy savings per account. In addition, given that these facilities typically have long operating hours, high and predictable occupancy rates, and high construction and remodeling standards, they are prime candidates for comprehensive project investment.

The evaluation team recommends that the Companies consider targeting retail outlets and office buildings as part of the comprehensive initiative within the EO program. EMI's research found that the EO program frequently engages both retail outlets and office buildings and that these segments account for a significant portion of the program's energy savings. However, comprehensive projects are less frequent in both of these market segments. Given that both segments account for a significant portion of the participating projects and therefore, present an opportunity for growth, the Companies should investigate whether targeting these facilities would be a cost-effective method for increasing comprehensive projects, considering that there may be limited opportunities for comprehensive projects given the nature of retail and office building operations.

While retail and office spaces provided frequent opportunities for participation, the EO program should also consider efforts that would increase participation among industrial and manufacturing customers. While these facilities make up only 14% of the participating accounts, they represent 28% of the overall kWh savings. Likewise, the average kWh savings at each account is double the program's average. Increasing participation among this sector should allow the program to run more cost-effectively by increasing the energy savings per customer.

The evaluation team recommends that the Companies agree upon and use a single, consistent system of data classes for program tracking. Aggregation, analysis and comparison of the utilities' efficiency project databases were substantially limited by a lack of consistent reporting methods and practice, both within each program and across them. An agreement to adopt a common classification scheme and lexicon across the State for projects, measures, customers, and facility types, etc. would be very valuable in helping the EEB evaluate program outcomes and allow the Companies to market the programs more effectively. The evaluation team suggests the following improvements to consistency:

- Use consistent US Postal Service addressing standards including separate fields for facility name, street address, city, and zip code. Another option is to incorporate a premise number into the program databases that uniquely identifies facilities. This addition would eliminate the need to aggregate and manage the program data based on address information and instead, provide a clear method for aggregation and analysis of specific locations for both program managers and

evaluators. However, this addition may be cost-prohibitive due to the need to alter existing database structures.

- As much as possible, collect phone number, first name, last name, position, and email addresses of an appropriate contact for all projects.
- Record common project milestone dates including application, installation, and closed dates (as applicable).
- Consistently record a NAICS code or similar code to provide a clear, consistent, and comprehensive presentation of the nature of the facility for each project.
- Ensure quantities reflect the actual number of units of a particular measure installed.
- Present consistent measure-level information including measure or product descriptions and "measure type" classifications such as lighting equipment, lighting controls (e.g., daylight sensors, occupancy sensors), building controls, HVAC equipment, compressors, motors & drives, refrigeration equipment, building envelope improvements, process improvements, and hot-water heating equipment. This consistency might be practically implemented via data-entry lexicon controls such as the use of "pick-lists." Currently, the project tracking databases often grouped like measures together as part of the same record (e.g., both lighting equipment and lighting controls are recorded as part of the same record). This grouping artificially limits the level of detail possible for analysis of individual equipment attributes such as energy savings, quantities, and incentives. An alternative method of tracking projects would include equipment detail at the line item level as based on the application paperwork. This level of detail would allow for more detailed analysis of the project tracking data which would in turn support more targeted program marketing and more robust evaluation research.

Note that EMI did not investigate the amount of resources that would be required to implement these changes. Therefore, the Companies should balance the benefits of making these recommended changes with the costs of altering databases and data collection forms.

The evaluation team recommends that the Companies and the EEB pursue a full market assessment. EMI's analysis of these market characteristics of both the ECB and EO program participants is intended to provide high-level recommendations to guide future marketing and customer engagement efforts. These will be expanded upon as part of the process evaluation research currently underway. However, EMI believes that a full market assessment would provide greater insight by highlighting gaps in market penetration and additional potential for program savings. In addition, a market assessment could include primary research that would explore the energy efficiency needs of program non-participants.

See full report:

<http://www.energizect.com/government-municipalities/large-ci-participant-trend-study-final-report>

2.3 Residential Process and Impact Evaluation Research Area

R1: Evaluation of the Year 1 CL&P Pilot Customer Behavior Program (HER)

Conducted by NMR, TetraTech, and advisor Hunt Allcott, Budget: \$452,000.

Objectives and Priority Outcomes:

This report summarizes the analyses conducted to evaluate the first year of the Home Energy Reports (HERs) Pilot Program, implemented for Connecticut Light and Power (CL&P) by OPower. The evaluation activities describe program processes and impacts.

The results summarized in the report include the following:

- Customer reaction to, awareness of, and satisfaction with the HERs
- Behavioral changes resulting from the program
- Energy savings attributable to the HERs program
- Persistence of savings after HER cessation
- Details of the implementers experience enacting the program and program population make-up

Program Design

CL&P together with program implementer OPower has administered a behavior pilot program for the purposes of achieving residential electricity use savings, and providing value to their customers through the delivery of HERs. These reports present the treatment group with feedback on their energy use and compare that use to a group of similar households referred to as “neighbors” (see below). The HERs Pilot began in late January 2011.

One of the critical characteristics of the HERs program is its reliance on an experimental design. Using data provided by CL&P, OPower identified a study group of 48,000 CL&P residential customers that met specific criteria for account activity (i.e., had billing data for a year prior to the study period) and electricity consumption (i.e., had relatively high usage compared to the typical CL&P household). OPower then randomly assigned each of the study group households to either a treatment group (i.e., the participants) that received HERs in the mail or to a control group (i.e., non-participants) that did not receive the HERs. The treatment group was further divided into monthly and quarterly sub-treatment groups by random assignment, with the former receiving a HER every month and the latter receiving one every three months. A subset of the monthly treatment group—the persistence sample—received HERs for approximately six to eight months, while the rest of the monthly treatment group received HERs for a full year. The pilot program uses an “opt-out” design, where customers assigned to the treatment group automatically receive reports but have the option to contact program representatives to opt-out of the HERs program if desired.

Study Objectives and Methodology

The team relied on five different methodologies to assess the HERs program.

- Baseline and follow-up telephone surveys were conducted among treatment and control groups to determine treatment group utilization of the reports and overall energy saving behaviors.

- Treatment group focus group discussions⁸ were conducted to gauge reaction to the HERs program among the treatment group and to investigate questions raised by the surveys, relating to readership and recall of the information presented in the HERs, the perceived usefulness of the HERs information, customers' level of engagement with the HERs program, and behavioral changes resulting from the program.
- Participation in the HES programs was examined for HERs treatment and control groups to identify potential energy-saving behavioral changes that may have been induced by the HERs program. The result of these examinations was subjected to a chi-square test to test for statistically significant differences in CEEF program participation between the HERs treatment and control groups.
- A billing analysis (ordinary least squares modeling with controls for pre-program energy usage) was conducted to examine whether the HERs produced attributable energy savings and whether these savings persisted in the absence of reports.
- In-depth interviews were conducted with implementers and stakeholders to assess the process of initiating the program.

Key Findings

The evaluation activities provided important insights into the program objectives, and the key findings are presented below. More information on these findings can be found in the main body of the report as well as in Appendix B.

Treatment Group Experiences with the HERs Program

The examination of treatment group experiences suggests a moderate level of customer engagement and satisfaction with the program.

- Nearly all (about 95%) of the treatment group households that participated in the follow-up survey were aware that they were receiving reports, and the few households that did not immediately recall receiving reports did so after the interviewer described the reports to them. However, there appears to be only a moderate level of engagement and readership of the HERs. For example, more than 40% of the treatment group respondents could not recall any specific energy saving tips from the HERs. The two most frequently recalled energy saving tips were installing energy efficient light bulbs and shutting off appliances when not in use, actions which are widely known by most consumers.
- About 40% of treatment group households taking part in the follow-up survey were aware of the option to set up an online account for the program, but fewer than two percent of survey respondents had done so. Program records, which would capture the activity of all treatment group households and not just those sampled for the survey, also indicate that fewer than two percent of treatment group households had done so. OPower reports this rate of establishing online accounts is consistent with other HERs programs they have administered with a similar design. OPower indicates that when customers set up an online account, it provides more

⁸ Focus groups and surveys centered on examination of customer experience with and behavior changes resulting from the HERs program. Therefore in order to be part of either the focus groups or surveys, the respondent had to assert that they were aware they were participants in the HERs program. All of treatment group households contacted for the survey indicated they were aware of their program participation and that they were receiving Home Energy Reports. As a result, none of the households contacted for the follow-up survey were disqualified. The result should be a minimal, if any, upward bias toward program awareness

information about their household, enabling more tailoring of the energy-saving tips presented in the HERs.

- More than 36 percent of treatment group follow-up survey respondents found the information presented in the HERs somewhat useful, while more than 40 percent rated the HER information as not very or not at all useful. About 20% of monthly recipients and one-quarter of quarterly recipients found the HERs very useful for their household.
- The neighbor comparison group was an issue with the respondents. Most focus group attendees were not aware of the definition of “neighbor group” provided on the HER and believed the neighbor comparison group for their household was not comparable. For treatment group survey respondents who rated the HERs information as ‘Not at all’ or ‘Not Very’ useful, the perceived incomparability of the neighbor comparison was the most frequently cited reason (43%). One quarter of those who rated the HERs information as “Somewhat’ or ‘Very’ useful also believed the neighbor comparison group was not comparable to their household. Both focus group attendees and treatment group follow-up survey respondents indicated that the neighbor comparison would be more useful if the program provided more specific diagnostic information about why their household’s level of electricity usage was high or low relative to the comparison group.
- Follow-up survey respondents report a moderate level of satisfaction with the program. Forty percent of respondents report a positive overall satisfaction rating (a rating of four or five on a five-point scale) for the HERs. Thirty-four percent report a rating of three on the five-point scale, indicating an indifferent rating, while 26% report a satisfaction rating of one or two, indicating dissatisfaction.⁹

Behavioral Change Attributable to the HERs Program

The follow-up surveys and analysis of CEEF program records examined whether the HERs program had induced behavioral changes among participants.

- In the follow-up survey, 59% of the monthly treatment group and 54% of the quarterly treatment group respondents reported that household members get together for informal talks about things you can do to save energy; both treatment groups are significantly more likely to do so than the control group (44%). However, the team was unable to identify any other statistically significant energy-saving behavior between treatment and control group households.¹⁰
- The HERs program has induced participation in the Home Energy Solutions (HES) program, with a statistically larger number of treatment group households taking part in HES than control group households.

⁹ For the five-point overall satisfaction scale, where a score of five was labeled “Very Satisfied” and a score of one was labeled “Very Unsatisfied.”

¹⁰ There are several possible explanations for this finding. Focus group attendees suggested that the tips were too generic to induce behavioral changes. Another possible explanation is that both treatment and control group households each say they engage in energy-saving behavior so as to provide a socially desirable response, regardless of what their actual behavior may be. A third possible explanation is attribution bias—the tendency of survey respondents to provide an inaccurate (often unintentionally so) report of the specific factors that prompted their actions. The fact that the impact analysis shows that the program induced statistically significant energy savings among treatment households supports the possibility of attribution bias. In other words, households may be taking energy savings actions because of the HERs, but they simply do not realize that the HERs prompted them to act. It may also be that the actions are sufficiently modest that respondents do not think of them as actions at all.

Energy Savings Attributable to the HERs Program

- The HERs program was effective at inducing energy savings in the treatment group. Overall the treatment group used an average of 1.7% less energy than did the control group, translating to 388 kWh less energy used by a treatment household, compared to a control household, during the first year of the program.
- Treatment group households paying the all-electric rate (2.0% savings) and households that used the most electricity prior to the program (2.4% savings) saved more energy than did control group households with otherwise similar characteristics.
- Monthly report recipients (2.2% savings) saved more electricity than did the quarterly report recipients (1.2% savings).
- Summer energy savings were 2.1% and winter savings were 1.9%. The vast majority of households (99%¹¹) in the study group used more electricity than the average CL&P household, so the evaluators divided the study group into high-use, mid-use, and low-use groups based on their pre-program electricity use. It must be stressed that even the low-use study group still used 67% more energy than the average CL&P household (1,335 kWh vs. 800 kWh, respectively).
- Analysis of the savings achieved by these groups' shows that high-use households saved more energy (2.4 kWh daily) than either mid-use (0.9 kWh daily) or low-use households (0.7 kWh daily). The energy savings for the high-use group is statistically greater than for the mid- and low-use groups, the analyses revealed no statistically significant differences in use between the mid- and low-use groups. The greater savings among the high-use group suggests that the savings achieved by the average CL&P customer may be lower than that for the Year 1 HERs treatment group, but the evaluators cannot predict these savings as too few average use households were included in the Year 1 study group. The Year 2 program design includes a greater number of average CL&P customers, and the evaluation team will compare savings between high use and average customers after the cessation of the Year 2 program in the spring of 2013.

Persistence of Savings

In order to test how long savings persist after the cessation of reports, the study design included a persistence treatment sub-group that received HERs monthly for the first half of the program year only. The persistence group savings were determined by comparing their energy use with that of the control group households, not with monthly or quarterly treatment households. The findings demonstrate that, during the period in which persistence group households stopped receiving reports, monthly and quarterly report recipients continued to achieve statistically significant energy savings compared to the control group, but the persistence group savings dropped over time, particularly after the second month of not receiving reports. By the fifth month after report cessation, the persistence group no longer achieved statistically significant savings over the control group.

Implementation of the Program

The exploration of program implementation processes revealed the following findings:

- Less than one percent of the treatment group households asked to opt-out of the program; as of June 4, 2011 (three to four months after receiving the first HER). Data from the CL&P Call Center indicates that concerns about the comparability of the "neighbor group" was the most common reason for opting out.

¹¹ Of the 47,296 households examined in this study 368 of them used 1,000 kWh or less a month and only 61 of the study households used 800 kWh (the approximate CL&P average customer monthly usage) or less a month.

- A baseline survey review of treatment and control group demographic and household characteristics revealed no statistically significant differences between the two groups.
- In the baseline survey, treatment group households were more likely to report that their household had done all or most of the things they could think of to conserve energy in their household, but this may have reflected the fact that the treatment group respondents had already received at least one report by the time of the baseline survey, possibly biasing their responses.

Conclusions

During the first year of the program, the HERs program succeeded in achieving substantial electricity savings among the 24,000 treatment group households. While some households saved more than others, on average, the treatment group achieved electricity savings of 1.7% over the control group households. This translates into a total of 9,288 MWh savings across all the treatment households in the study group.

At the same time, it appears that the first year of the HERs pilot program also resulted in a moderate level of customer satisfaction. Treatment group households were only somewhat engaged with the program and had mixed reactions regarding its usefulness and their own level of satisfaction with the program. Treatment group households seemed particularly troubled by the neighbor comparison group—not understanding who these “neighbors” were and doubting that they were truly comparable households.

Some other important conclusions and potential implications are summarized below.

- The monthly delivery of HERs appeared to result in the greatest program savings; however, future research will be needed to determine if monthly delivery yields the most cost effective savings. High users comprised nearly all households in the Year 1 study group. The Year 2 Pilot study group will contain more average-use customers, which should allow the team to draw conclusions about program impacts on the average customer. However, the differences between the treatment groups across program years prevent the results of the Year 1 billing analysis to be extrapolated to all CL&P residential customers.
- Treatment group households wanted more individualized information about their own energy use. The low percentage of treatment group households who set up an online account is a missed opportunity to increase the level of engagement and provide more individually tailored energy-saving tips to treatment group households, and the Year 2 program may want to place greater emphasis on use of the website. Also, CL&P and OPower may consider promoting the HES and HES-IE programs more vigorously to the treatment group in Year 2, as these programs certainly will provide tailored suggestions on ways individual households can reduce energy use.

See the full report at: <http://www.energizect.com/government-municipalities/final-clp-behavioral-year-1-program-report-030613>

2.4 Residential Market Research and Evaluation Research Area

R6: Housing Characterization Study

Conducted by NMR; Budget: \$30,000.

Objectives and//Priority Outcomes:

The consultant team conducted a housing stock assessment in order to:

- help inform the Energy Efficiency Board (EEB), and
- assist the Department of Energy and Environmental Protection (DEEP) in the State's efforts to achieve 80% weatherization by 2030.

The study provided an overview of the energy-related characteristics of single-family residential buildings in the state of Connecticut based on The Warren Groups' Database of properties (a compilation of county, town, and municipal property assessment, sales, and tax records).

Approach//Method/Results:

The Database lists 822,900 single-family homes, or 85% of the 2010 decennial Census, 90% of which are owner-occupied houses (An additional 12,557 properties (1.1%) are listed as being one-to-four family residential buildings). Fuel oil represents 71% of owner-occupied and 69% of renter-occupied heating fuel (93% of single-family cases coverage). Over one-fifth of owner-occupied single-family housing units (22%) and nearly one-fifth of renter-occupied units (19%) have natural gas heat. Five percent of owner-occupied units use electric heat, compared to 9% for renter-occupied units.

A majority of the houses (63%) in Connecticut were built prior to 1970, and only about 10% of all homes are listed as having been renovated. Of the renovations that have occurred, 83% took place after 1970, which coincides with the time period in which building codes required R-11 wall insulation. However, renovations do not guarantee that the entire home has R-11 or better wall insulation. Nearly three quarters (74%) of the homes included in the Database are between 1,000 and 2,500 s.f. in size. They tend to have six or seven rooms (47%), three bedrooms (53%), and one or two bathrooms (87%). Single-family rental properties statewide are older than owner-occupied properties (61% vs 46% built before 1959). The age of single-family rentals makes them likely candidates for energy-efficiency retrofits, but the split incentive concern and the relatively small number of renter-occupied compared to owner-occupied houses will mean that residential retrofit programs will continue to serve more owner-occupied than renter-occupied households. Not surprisingly, single-family rental homes tend to be smaller than owner-occupied homes. Fifty-two percent of the 79,499 rentals were between 500 and 1,500 s.f. compared to 41% of the 734,089 owner-occupied homes. More single-family houses have fireplaces (52%) than do not (48%).

The database does not examine all variables pertinent to weatherization, and many of the existing variables suffer from missing data (i.e., the important data are available only for some homes in the database). It is very likely that the missing data are not randomly distributed: some towns and cities track these data and others do not. In short, the picture painted by the dataset is incomplete and likely somewhat biased in unknown ways. The forthcoming weatherization study adhered to a random selection process and gathered a more complete set of variables related to weatherization. The weatherization study and the data from the Warren Group will complement each other and provide critical information to help the state reach its ambitious weatherization goals.

See full report at: <http://www.energizect.com/government-municipalities/2013-housing-characterization-study-final-report>

3. STUDIES IN PROGRESS

3.1 Commercial Process and Impact Evaluation Research Area

C9: Small Business Impact Study

Objectives and Priority Outcomes:

The primary objective for this evaluation is to quantify the electric energy and demand savings achieved by the Small Business Energy Advantage (SBEA) program and the rate of evaluated savings compared to the program's estimated savings (the realization rate). The evaluation is being conducted of 2011 program participants.

An additional important objective is to provide feedback and specific information from the evaluation to be able to update the Program Savings Document used to allow the program to estimate and report expected savings.

Approach and Work Plan:

The primary impact evaluation method is an engineering evaluation approach generally regarded as a highly rigorous approach to evaluating measures of the nature installed through the SBEA Program. Using engineering methods with on-site metering is the most accepted approach for impact evaluations of C&I efficiency programs. The engineering study in this evaluation is a measure level approach that is based upon gathering and analyzing site-level data from the performance of on-site measurement and verification (M&V) of statistically selected sites. This approach incorporates M&V activities, such as metering time of use or consumption, of the measures installed in the businesses in the sample. The sample results will then be applied to the 2011 program population.

Schedule and Budget:

The C9 SBEA Impact Evaluation began in March 2012. Site visits to perform engineering measurement, metering and logging were performed on the evaluation samples. The final data collection component was measuring lighting operating hours of use through loggers placed and data collected during the summer of 2013. The draft report is being completed in early 2014. A time and materials budget (payments are calculated and paid as work is completed with a maximum budget allowed) totaling \$333,140 has been approved for the C9 SBEA Impact Evaluation.

C14: EO Process and Impact Evaluation

Objectives and Priority Outcomes:

The evaluation consists of an impact and process evaluation. The overall objective of the impact evaluation is to estimate the energy saved by the program (both electricity and natural gas) and the

reduction in electrical peak demand. The overall objective of the process evaluation is to identify how the EO Program could be improved so that it is better able to meet its goals.

Approach and Work Plan:

The C14 EO impact evaluation used on-site measurement and verification (M&V) for a representative sample of projects as the primary method of data collection. This M&V included conducting project documentation “desk reviews;” selecting the appropriate International Performance Measurement and Verification Protocol (IPMVP) option given the available data and expected variability, and developing site-specific M&V plans based on the selected IPMVP option. Once the M&V plans were approved, field staff visited the site to conduct interviews, measure key assumed inputs, and meter long-term usage patterns. This approach is standard best practice for evaluating C&I energy efficiency programs and one expected to yield rigorous results when conducted by experienced evaluation engineers using the current science employed by this approach.

Using the collected data, in most cases the evaluation contractor developed hourly energy use models for the 8,760 hours per year (referred to as an “8760 model”) to extrapolate measured energy use from a limited measurement period over the year. This provided estimates for both annual energy use and peak demand. These models incorporated all appropriate day-types. In many cases, regression models were also applied to energy and/or power use data for a site with appropriate normalizing variables (for example, including the relationship between usage and current weather to then estimate usage for the typical weather, *i.e.*, normalizing for weather) to estimate evaluated or *ex post* savings for each of the sample sites.

To complete the impact evaluation, the evaluation contractor team first compared estimated *ex post* savings values to program reported savings or *ex ante* savings (estimated savings prior to evaluation) to determine realization rates for each sample project. Next, the team weighted and aggregated these project-by-project realization rates to create an overall, program-level realization rate by fuel type and for energy and demand savings. These rates are used to provide program level evaluated savings estimates for electric energy and demand and natural gas savings for an average year and for peak periods as needed for savings that are bid into the ISO New England (NEPOOL) Forward Capacity Market by the Connecticut utilities.

The process evaluation included the following components: a detailed review of the program-tracking database, qualitative in-depth interviews and analyses by experienced energy efficiency program evaluators of the data collected and with a perspective on how similar C&I energy efficiency programs are operated and performing elsewhere in the United States. This analysis and broader experience are the foundation for the recommendations made by the evaluation for consideration by program designers, planners and implementers.¹²

The evaluation team’s database review included a detailed review of the program-tracking database, examining it for completeness and consistency in terms of project detail and contact information.

The qualitative in-depth interviews with 3 program staff, 41 EO program participants from the 2011 program year, and 19 participating vendors were conducted by interviewers with energy efficiency

¹² The evaluation, as is often done in the energy efficiency evaluation field, does not conduct post-evaluation research on how the recommendations could be implemented given current program operations and resources. It also does not conduct any cost-effectiveness analyses for implementing the recommendations.

evaluation experience and survey training for the specific interview instruments used in this evaluation.¹³ These interviews explored how participants and vendors engaged with the program and each other.

Schedule and Budget:

The C14 Energy Opportunities (EO) program Process and Impact Evaluation began in June 2012. The engineering-based site visits with interviews, verification and metering were conducted for sample sites with lighting measures in 2012 and for sample sites with non-lighting measures (electric and natural gas) in 2013. An initial draft report was completed in November 2013 and a later version of the draft report is currently under review by the EEB Evaluation Committee, EEB consultants and the utilities. A time and materials budget (payments are calculated and paid as work is completed with a maximum budget allowed) was approved for C14 EO Process and Impact Evaluation of \$1,003,000 for the two-year evaluation.

C18: SBEA Process Evaluation

Objective and Primary Outcomes:

The project will evaluate the following SBEA program attributes with the objective of recommending means for improvement where appropriate:

1. Program design for alignment with sponsor goals and market conditions;
2. Program administration for efficiency and effectiveness;
3. Program delivery for efficiency and effectiveness; and,
4. Program outcomes such as the creation of stakeholder satisfaction and self-reported changes in behavior and attitudes.

The criteria for these analyses include best practices, consistency with discovered market conditions, and stakeholder perspectives.

Approach and Work Plan:

The project includes primary data collection and will use data collected from four other research efforts underway in Connecticut. These are C10 – Small Business Data Mining Study, C11 – Barriers to Commercial and Industrial Program Participation with a Focus on Financing and Cancellations, C12 – Low Income Limited English, and C17 – C&I Market Research.

Primary data collection methodologies within this project will include in-depth interviews and computer aided telephone interview (CATI) surveys. In-depth interviews will be used for utility management, utility program staff, and program financial services providers. CATI surveys will be used to collect data from participating vendors/contractors and end-use customers. The perspectives of the stakeholder groups selected for this effort are essential for understanding program operations and were selected to complement the data collected through the research reference above. The sample sizes for each stakeholder category will be sufficient to support strong confidence in the findings and recommendations of the study. This data collection and its analyses are the most common method used in process evaluations in energy efficiency program evaluation.

¹³ The 2014 EO evaluation did not include any interviews with non-participants and as such, their perspective is not included in this report. Upcoming C&I market research will focus on nonparticipating customers and vendors in order to capture their experience with energy efficient equipment purchases.

This process evaluation is more expansive than most by drawing upon data being collected for the other C&I research efforts occurring at the same time. Information on motivations, attitudes, decision factors and process, perspectives on financing and characteristics will be available on participants from this project, and from other C&I populations through the aforementioned studies. This evaluation will synthesize the findings for the SBEA eligible population from this cluster of research efforts.

Schedule and Budget:

The SBEA process evaluation began in November 2013. One of the largest early inputs into the evaluation schedule is in obtaining program data and the ability to complete the initial interviews with program staff. Throughout the evaluation the completion of interviews, surveys and analysis and reporting as expected can allow the evaluation to be completed in less than a year. Delivery of the Review Draft report to the EEB Evaluation Committee and program administrators is scheduled for September 2014. The budget for this evaluation is \$290,000. This time and materials budget is based on several assumptions: the results of C10 and C17 do not indicate the need for additional strata; the ratio of screened candidates to completed responses will be four to one; and reporting will meet the requirements specified in the Evaluation Road Map, section 1.5.2.

C20: Energy Conscious Blueprint (ECB) Evaluation

Objective and Priority Outcomes:

The overall objective of this research is to evaluate the energy savings impact of the ECB program, the effectiveness of its procedures and processes as they relate to meeting the program's goals, and customer reports of non-energy impacts. This expands to the following objectives:

- Evaluate the electric and natural gas energy savings impacts and realization rates of 2012¹⁴ projects.
- Estimate the non-energy impacts as reported by participants.
- Calculate and recommend changes to the PSD (as needed) and "forward-looking" realization rates using the most current PSD at the time of this analysis task.
- Assess the accuracy of methods used by the engineering firms (vendors) in estimating savings for complex "custom" projects and recommend any changes.
- Identify the documented and undocumented goals of the program.
- Identify barriers or issues that will inhibit the Companies from achieving these goals.
- Provide recommendations for overcoming the identified barriers and improve program performance.

The evaluation is divided into two phases since developing the sample design and selecting impact evaluation methods depend upon the evaluation team's analysis of the program database. As the sample development and impact methods selection have a major impact on the final evaluation budget and timeline, the Phase 1 includes the work to develop these important parameters. The evaluation team will then provide a Phase 2 project description that includes the description of the sample design, impact evaluation methods, and all the remaining work to complete this ECB evaluation.

¹⁴ The evaluation may also include projects in the first half of 2013. This is to be determined from the program database analysis.

Approach and Work Plan:

As described above, the first phase of this research consists of establishing the foundation of the evaluation by examining the current program participant data and conducting in-depth interview with program managers. To complete the sample design, the evaluation team will aggregate and examine 2012¹ program participation data to identify the types of projects that were completed, their relative size, and what end use measures were included as part of the projects. By examining these three parameters, the evaluation team can determine the appropriate sample stratification needed to meet both program and ISO-NE requirements for impact evaluation and plan the needed M&V activities (*e.g.*, metering, building simulation) to complete the evaluation. Second, the evaluation team will use interviews with program managers to refine process evaluation objectives and issues for investigation, which will ultimately determine the data collection needs of the process evaluation research (and its corresponding sample design).

Schedule and Budget:

This project began in December 2013. The schedule for the final report will depend on the scope of Phase 2 research and will be provided in the Phase 2 project description. The budget for the Phase 1 research is \$76,177. The final budget will depend on the scope of the Phase 2 research and will be provided in the Phase 2 project description.

3.2 Commercial Market Research and Evaluation Research Area

C10: SBEA Data Mining Evaluation Objectives and Approach

Objectives and Priority Outcomes:

The primary objective of this evaluation is to help program administrators make more informed decisions about how to garner deeper and more comprehensive energy savings through an examination of what has and has not been accomplished through the SBEA program over the years. This project was originally scoped in 2012, but was revised as part of the 2013/2014 Evaluation Planning work. CL&P has been conducting analysis of billing data from C&I customers, which has revealed itself to be a better source for customer market studies than using D&B (Dun and Bradstreet) data. To accomplish a deeper and more comprehensive energy savings study for SBEA, the evaluation will:

- Assess which market sectors are highly represented among the SBEA participants over the last five years, which sectors are underrepresented and which are missing.
- Determine how the market sector distribution of program participants compares to those of nonparticipants.
- Characterize the mix of measures installed in the program, including an examination of the nature and frequency at which measures beyond lighting are installed (measure diversity).
- Explore the levels of savings tracked in absolute and normalized terms (such per square foot, per rebate dollar, etc.) as available from the tracking system. This analysis will be performed by sector.
- Provide a general profile of customer experience with the program; including information available on measures recommended but not installed.
- Examine how often customers who engage with the SBEA Program engage for a single participation event versus participate multiple times and explore the nature of installed measures in those subsequent participation events.

- Perform other cross tabulations and tracking data explorations at the direction of the EEB Evaluation consultant.

Approach and Work Plan:

The overriding theme of these tasks is to examine the profile of program participants over the past five years, including repeat participants, and utilize D&B data to discern how they might differ from the broader population of small businesses. In addition, these tasks will be used to evaluate the areas in which the program has been successful, trends in measure installation activity and participant characteristics and remaining opportunities. Tasks include: Program Database Analysis; Dun and Bradstreet Database Analysis, and Report.

- *SBEA Program Database Analysis:* The evaluation contractor team will obtain a copy of the SBEA program databases over the last 5 years. The evaluation contractor team will analyze the program database to characterize the program participants, measures, and project comprehensiveness. In addition to other issues that might become of interest once the final program dataset is received, issues including Business sector (from NAICS code), geographic location (service territory areas with greater participation by small businesses), measure installation frequency patterns, savings, and repeat participation will be examined.
- *Dun and Bradstreet (D&B) Database Analysis:* Using D&B database of small businesses in CT (including revenue and number of employees), the contractor will assess the numbers of different types of small businesses that are present in different parts of the service territory to compare with participation statistics.
- *Report:* The final report will describe the research questions and research conducted, key findings, and program recommendations. The report will evaluate the quantitative data extracted from the various databases to help the Companies grow and improve program performance.

Schedule and Budget: This project is expected to be completed in 2014, and the budget is \$47,000.

C11: Barriers to Commercial and Industrial Program Participation with a Focus on Financing and Cancellations

Objective and Priority Outcomes:

Market research focused on the use of financing for energy efficiency investments and the reasons for participation cancellation (dropouts) in the commercial and industrial (C&I) market with demand between 75kW and 750kW will be undertaken with the objective of supporting program improvements.

The primary researchable questions will include:

- Customer needs and perspectives on financing and incentive mechanisms;
- Customer awareness of energy efficiency and program offerings, including sources and trust levels;
- Customer decision-making processes; and,
- Drivers, motivations, and barriers experienced by customers with regard to energy efficiency investments, including organizational resources, economic climate, investment criteria, risk perception and reasons underlying participation cancellation.

Approach and Work Plan:

The project will include computer aided telephone interview (CATI) surveys with small and medium-sized customers across the CT utilities to obtain the data needed to allow analysis to meet the above objectives.¹⁵ Data will be collected through 15-minute telephone surveys. This sample design is based on the interests expressed in a round of preliminary interviews with eight key stakeholders and with budget considerations. There will be sampling and reporting to provide strong confidence in results for 7 groups with one being the overall CT small-medium sized C&I market and the others being overall by small versus medium, manufacturing and drop-outs with these also being reported by small versus medium.

Schedule and Budget:

The start date began in October 2013 as authorization and program and customer data were received from the program administrators. Surveys will be fielded and the Review Draft Report will be distributed in February 2014. The budget for this evaluation is \$158,845.¹⁶ The budget is based on the following assumptions: sample will be derived from program administrator data sources with no purchase cost; the ratio of screened candidates to completed responses will be four to one; and reporting will meet the requirements specified in the Evaluation Road Map, section 1.5.2.

C12: Small Business Research Area Limited English and Low Income Barriers Project (Phase 2)**Objective and Priority Outcomes:**

The goal of this study is to help program administrators make more informed decisions about how to increase participation of limited English and low/limited income small business owners in the SBEA Program through the identification and mitigation of barriers to program engagement. The primary objectives are as follows.

- Understand the characteristics of low-income and limited English business owners who may potentially be interested in the SBEA Program.
- Develop a better understanding of barriers that limit participation of these businesses.
- Identify organizations that work with these businesses.
- Determine whether such organizations may facilitate the participation of such businesses.
- Assess procedures that may assist the program management to overcome participation barriers.

Approach and Work Plan:

- Develop interview protocol for organizations that work with low-income and limited English businesses,
- Identify potential organizations for interviews,
- Conduct in-depth telephone interviews with organizations,
- Develop report with findings from in-depth interview, including two rounds of edits and a presentation as needed, pursuant to the CT roadmap,
- Develop confidential memo with organizational data and contact information (if applicable)

¹⁵ The sample will be stratified at the demand level cap of SBEA so data can also be used within the SBEA Process Evaluation.

¹⁶ Additional market segments may be added for analysis and reporting at an incremental cost of \$22,227 per every two new subgroups added.

- If there are not sufficient organizations willing and able to provide services to increase SBEA participation, conduct focus groups with low-income and limited English business owners (optional), and
- Reporting includes Focus Group findings (if conducted).

Schedule and Budget:

Phase 1 was conducted May through July 2013. Phase 2 started in October 2013. Surveys will then be fielded, and the draft review report will be distributed in February 2014, with some schedule flexibility depending on whether optional Focus Groups are conducted. The project’s maximum budget, including Phase 1 and Phase 2 with optional focus groups, is \$177,934.

C17: Connecticut Commercial and Industrial (C&I) Market Research

Objective and Priority Outcomes:

The overall objective of this research is to provide the Connecticut Energy Efficiency Board and the Companies with detailed market research regarding three end use categories so that the Companies can create targeted and effective strategies that effect broad and deep energy efficiency savings. This research will consist of an analysis of existing data and the collection and analysis of primary data from market actors and customers.

At a high-level, this research will answer the following research questions:

- What are the three most important energy end-use markets - defined as a group of products with similar function – with potential to meet the increasing C&I energy savings goals?
- What are the characteristics of these markets currently, including size, energy efficiency market share, and effective marketing channels?
- What are the characteristics of the market actors involved in these markets?
- How do Connecticut C&I customers interact with these markets including decision-making and barriers to energy efficiency?
- What is the market saturation for energy efficient technologies in these markets?

Approach and Work Plan:

Initial phases of the work provide the analyses for selecting the market research targets. The customer classifications used in the analysis will correspond to the recommendations derived from the preliminary interviews conducted under the project and budget considerations. Publicly available data and the CT utility customer data will be used to develop a cross-reference on consumption. The analysis will develop estimates of end-uses with the greatest impact for C&I customers in Connecticut and select the top three end-use groups as the research targets. Secondary data will be used to develop an understanding and description of the important characteristics of the selected end-use markets in Connecticut and compare them to similar markets found in New England and nationally.

In-depth interviews and surveys will be used to develop an understanding of the supply chain, marketing and customer interactions for the 3 targeted markets.

Customer surveys will be used to gather information on purchase decisions, equipment selection, program awareness, and barriers to energy efficiency, and to develop an understanding of the relative importance of different factors on the decision making process. Overall results will be presented by selected market.

Schedule and Budget:

The project began in October 2013; surveys will follow. The Review Draft is anticipated to be available for review in May 2014. The current budget assumes the overall C&I market for each selected end-use would also be reported for three customer sectors. The maximum budget allotted for this market research with the four quota groups (3 customer sectors and overall) is \$410,000.¹⁷

3.3 Residential Process and Impact Evaluation Research Area

R2: CL&P Behavior (HER) Pilot Studies 2012 Year 2 (and Persistence add-on)

Objectives and Priority Outcomes:

This process and impact evaluation of CL&P's Home Energy Reports Behavior Pilot Year 2 was started in 2012 and continues to 2014 with the addition of an analysis of persistence of the savings estimates. The work is designed to evaluate the performance of the Year 2 HER program, which was delivered to a more standard-usage group of customers than Year 1's program (which was delivered to high-users).

The priority outcomes from the project include:

- Estimated net savings associate with the HER program participants compared to control group,
- Process evaluation information on average CL&P residential customers, and
- Persistence of savings for short-term report recipients, one-year recipients, and long-term recipients (including what happens during report hiatus).

Approach and Work Plan:

Identical to the Year 1 study described above (R1, completed studies), CL&P (and program implementer OPower) is working to achieve residential savings through behavioral through delivery of HERs reports. These reports provide feedback to household on their own energy use over time, and provide comparisons to various groups of "neighbors". These peer comparisons are intended to encourage behavior change.

This project differs from R1 in the make-up of the participant group; R1 included higher-usage customers, and R2 includes a higher proportion of more average-use residential customers. OPower randomly assigned households to either a treatment group (i.e., the participants) that received HERs in the mail or to a control group (i.e., non-participants) that did not receive the HERs. The pilot program uses an "opt-out" design, in which customers assigned to the treatment group automatically receive reports but have the option to contact program representatives to opt-out of the HERs program if desired.

The tasks for the project are similar to the Year 1 research, and rely on the following key steps to assess the program.

¹⁷ Reducing the customer sectors receiving analysis and reporting would lower costs but also lower the amount of detail provided by this research. Developing sampling and reporting at only a market-level for each of the selected markets could reduce the research costs to less than \$350,000. Increasing the number of customer sectors analyzed and reported would increase costs in a similar manner.

- Literature review to identify basic issues, results from other locations, and other contextual information.
- Baseline and follow-up telephone surveys conducted among treatment and control groups to determine treatment group utilization of the reports and overall energy saving behaviors.
- Treatment group focus group discussions to gauge reaction to the HERs program among the treatment group and to investigate questions raised by the surveys (HERs report readership and message recall, usefulness of the HERS, engagement with HERS, and behavioral changes from the program).
- Analysis of participation in the HES programs for treatment and control groups to identify potential energy-saving behavioral changes that may have been induced by the HERs program.
- Billing analysis, including statistical analysis of pre-post energy usage (with controls) to examine whether the HERs produce attributable energy savings and whether these savings persisted in the absence of reports.
- In-depth interviews with implementers and stakeholders to assess the process of initiating the program.
- Presentation and report.

Schedule and Budget:

This project will complete in 2014, and the combined budget is \$183,000.

R4: HES/HES-IE Process Evaluation and Effective Useful Life Study (incorporating 97/24)

Objective and Priority Outcomes:

HES & HES-IE are major residential programs, and critical to achieving the 80% Weatherization goal. A process evaluation has been underway to identify program strengths and weaknesses, and identify issues that can be used to help the program perform more effectively and cost-effectively. In addition, the Evaluation Team has committed to exploring methods to coordinate projects to maximize the value from evaluation expenditures. To that end, we are refining the scope of this project, and integrating it with follow-on work planned in the 2014-2016 Evaluation Plan (project 97). Its original scope included a process evaluation plus on-site work at a sample of HES-IE homes to check the retention of faucet aerators, CFLs and a few other small-dollar portable items. More long-term program value is provided through reallocating dollars. The refined approach leverages the process evaluation telephone survey work to also gather information on net savings (net-to-gross, NTG, 2014’s project 24), measure lifetimes (EULs¹⁸ for one or two measures), and non-energy impacts (NEIs¹⁹). To make sure questionnaires do not become too long, we are sub-setting the sample to ask randomly-selected halves, the questions about NTG and EUL vs. NEI. We are augmenting the sample with a small additional “older” sample of participants, which supports better lifetime analysis (greater time for “failures”), and spillover estimation, which does not fully develop immediately after participation.²⁰ This maximizes the value of

¹⁸ EUL or effective (or estimated) useful lifetime is defined as the year after installation at which half of the measure will be expected to still be in place and operating (the median lifetime).

¹⁹ Non-Energy Impacts (NEIs) or Non-Energy Benefits (NEBs) are effects beyond energy savings that are delivered as a result of an energy efficiency program. This may include societal effects (e.g. jobs, greenhouse gas savings), utility effects (e.g. enhanced reliability, better bill-payment behavior), and participant effects (e.g. comfort, water bill savings, etc.)

²⁰ We will skip the “process” questions for these respondents.

the phone interviews, and achieves the EUL, NTG, and EUL objectives of the 2014 plan most cost-effectively.

The project's outcomes include:

- Traditional process evaluation for the project, including strengths, weaknesses, satisfaction, performance, and information useful in improving efficiency, effectiveness, and cost-effectiveness of program delivery. The project has committed to incorporating questions targeted at financing and finance instrument information, which is one particular area of interest for 2013/2014 work.²¹
- NTG, or net savings factors, examining free ridership and program spillover effects, so we can more fully examine the attributable effects of the programs.
- NEIs, or non-energy impacts, to more fully identify attractive features of the program and quantify barriers to participation (to understand the participation decision associated with the programs). In addition, we identify marketing opportunities, and quantify the non-energy effects from the program.
- EULs, or retention of measures from the program. We are still reviewing the program measure data to allow selection of the appropriate measure(s), and will inform and discuss with the committee the recommended measure(s) at an upcoming Evaluation Committee Meeting. Statistically-derived, defensible EULs are a weak area in the industry, in Connecticut and nationally. These factors are critical elements of the computation of program benefit-cost estimates.

Approach and Work Plan:

The process evaluation has been underway, with preliminary scoping work and structural interviews conducted in 2013. It has completed the stakeholder interviews and described high-level results and implications for the process evaluation design and next stages of the project in a memo to the EEB evaluation technical consultant. Work has also been conducted toward the planning/integration of the EUL, NTG, and NEI work. The stakeholder interview work identified additional program issues to explore in the interviews, and preliminary participant/non-participant customer interview guides have been developed. The project work includes: telephone surveys, EUL analysis (using traditional protocols with hazard functions); net-to-gross using question batteries and analysis methods to latest industry standard (with corroborating questions, etc.), and the NEI work is to latest industry standards, including survey and analytical work. The data to be used include: project/program data (including measures), and customer surveys.

Schedule and Budget:

This project completes in 2014, and the budget is \$293,000.

R7: Residential Ground Source Heat Pump Evaluation Study

Objective and Priority Outcomes:

The primary objectives of this study are to quantify energy and peak demand savings and improvements in air quality attributable to the GSHP program, assess the program for potential improvements and the market for GSHPs in Connecticut.

²¹ We are coordinating with / requesting input from others to assure we are covering important financing issues.

Approach and Work Plan:

The study is using a metering- and modeling-based analysis that uses post-installation electric billing data to calibrate the engineering savings. Participants' pre-installation fuel bills and consumption data were incorporated into the calibration to the extent feasible. This analysis includes both long-term metering (to capture the full seasonal and off-season impacts) and spot metering (to measure the performance of units during winter periods and to assess the issue of loop sizing and ground temperature). A metering-based engineering analysis allows for the direct measurement of GSHP operation and the creation of calibrated DOE 2 models that can be used to calculate demand and energy savings with a high level of rigor. This method would be consistent with Independent System Operator of New England Forward Capacity Market Monitoring and Verification (ISO-NE FCM M&V) Manual option D calibrated model approach.

The methodology includes on-site sampling and recruitment of spot metering visits among 40 participants (a Model-Based Statistical Sampling (MBSS) techniques to develop samples that are efficient, accurate and reliable). The spot metering will be done as an audit of the GSHP system and of the home in general. Ten of the 40 sites will be randomly selected for long-term metering. The objective of the long-term metering will be to measure the performance of the GSHP in both the cooling and heating seasons. The data will be used to determine seasonal performance factors (effectively field-measured SEER and HSPF ratings) and will be inputs into the DOE 2 models that will estimate weather-normalized summer and winter savings, winter and summer savings load shapes, and peak demand savings. The contractors will conduct an additional on-site visit at up to ten of these participants' homes in order to perform spot measurements of the loop sizing and ground temperature.

Assessment of system design will be based on data collected during the testing at the 40 spot metering visits. The study will use a Manual J calculation to determine the load for the home and assess whether GSHP units, the condenser loop of the system and field size were properly designed. The first step in the task will be to compare the estimated load from the Manual J calculation used by the HVAC contractor to size the GSHP system to the results based on home shell characteristics collected during the on-site visits (Task 2.1). Comparison of these two data sources will enable us to determine whether the Manual J calculations are being performed correctly and are being used to properly determine the load requirements.

The savings analysis will be performed using a DOE 2 model that is consistent with the ISO-NE option D calibrated model approach. We will utilize the on-site data collected from the 40 sites to construct four prototype models based on the type of program participants and the baseline heating system types. We expect the four prototypes will include Retrofit projects (electric and non-electric) and New Construction projects (electric and non-electric). The results of the energy and demand saving analysis will serve as the basis for calculating the environmental impacts.

The information collected in the study will help the sponsors determine if the promotion of GSHP can be done in a way that minimizes free riders and yields energy, peak demand and environmental savings in a cost effective manner. We propose to conduct a participant telephone survey as well as in-depth interviews with participating contractors to help assess the market for GSHPs.

Schedule and Budget:

The majority of the work, including data collection, analytics, and report writing, was performed in 2013. The final draft of this report will be completed in Q1 of 2014. The budget for this task is estimated to be \$337,885.

R8: Residential Central Air Conditioning Study

Objective and Priority Outcomes:

The primary goal of the CAC study is to provide the EEB and the Companies with information necessary to determine energy- and demand-savings. This goal has multiple objectives, including the following:

- Program electric energy savings (+/-10 precision at 90% confidence) and program electric demand savings coincident with summer on-peak and seasonal peak periods (+/-10 precision at 80% confidence).
- The provision of CAC load shapes.
- A characterization of CAC units as installed (including size, airflow and rated efficiency).
- Understanding the process by which customers decide whether to take advantage of rebates or low-interest financing offered for CAC units, including a comparison of this process between those recommended to retire an existing CAC early (eligible for a \$500 incentive) versus those recommended to replace a CAC that near or past its expected useful life (eligible for a \$250 incentive).
- Determination of methods to better induce early retirement of CAC units.

Approach and Work Plan:

The primary objective of estimating energy and demand savings will be achieved through the performance of monitoring and verification (M&V) during the summer cooling seasons of 2012 and 2013. Understanding the process for deciding whether or not to take advantage of rebates to replace existing CAC models with energy-efficient ones will be achieved using two approaches: Focus groups with customers who were recommended a change in CAC unit—and offered a rebate—as part of their HES participation, including both those who did and did not use the rebate to replace the unit, and telephone surveys with customers who were recommended a change in CAC unit as part of their HES participation and were offered a rebate to adopt a more efficient unit, including both customers who used the rebate to install the recommended CAC unit and customers who did not do so. A summary of the primary objectives and the methodology used to address the objectives is listed in the table below.

Objective	Methodology
Estimate program electric energy savings (+/-10 precision at the 90% level of confidence)	On-sites with post M&V (1/2 in summer of 2012 and 1/2 in summer of 2013). Individual regression equations.
Estimate program electric demand savings coincident with summer on-peak and seasonal peak periods (+/-10 precision at the 80% level of confidence)	Statistical sample selection, on-sites with post M&V. Coincident demand savings will be derived from load shapes that are established from the individual regression equations cited above.
Provision of CAC load shapes.	Addressed through the aggregation of the individual load shapes discussed above.
Characterization of CAC units as installed.	On-site work. Perform air flow testing and will gather information on the installed unit.
Customers rebate behavior for CAC units; compare retiring existing CAC early vs. replacing a CAC that near or past its expected useful life.	Four focus groups and participant surveys
Ways to induce early replacement of inefficient units.	Four focus groups and participant surveys

Schedule and Budget:

The scheduled completion date for this project is early 2014. The budget for this evaluation is \$550,702. This budget is based upon the performance of 91 site visits, which is our estimated sample size to

achieve +/-10% relative precision at the 80% confidence interval for summer peak and seasonal demand impacts.

R16: HES/HES-IE Impact Evaluation and Effective Useful Life Study

Objective and Priority Outcomes:

HES & HES-IE are major residential programs, and critical to achieving the 80% Weatherization goal. It is vital to estimate program impact, particularly factors that influence energy and demand savings. An updated and reliable impact evaluation study covering these programs is a high priority and urgent project (time-wise). To provide in-field (and budget) efficiencies, we are crafting the project to incorporate the measure life study, but schedule for the impact work will not be sacrificed for the persistence work.

The project's outcomes include:

- Savings estimates for major measures (by heating fuel type to the extent feasible) for the HES & HES-IE programs, including homes heated with natural gas, electricity, and delivered fuels.
- It will cover single and multi-family, and low income households. This analysis is to be completed in First Quarter of 2014.
- Retention of portable measures for HES-IE participants (and processes to increase their retention). In addition, to leverage evaluation resources and increase the usefulness of the study, we will coordinate the (phone & on-site) survey work to gather data for additional equipment (more items including appliance persistence) and develop estimated EULs.

Approach and Work Plan:

This impact evaluation would provide, to the extent feasible, savings estimates for major measures (by fuel type - including fuel oil) that are incentivized by the HES & HES-IE program. The cornerstone of the analysis is a statistical billing analysis, supplemented by engineering estimates. This approach will allow for timely delivery of an impact evaluation report. The billing analysis will use a fixed effects savings regression model, with paired pre/post participation months, to estimate measure-level saving for the programs. The method to be used will incorporate weather normalization, detailed measure data, home characteristics, and appropriate control groups to account for macro factors affecting the results. The engineering analysis uses two engineering approaches to estimate measure-specific savings for the most common fuel types (electric, natural gas, propane, and heating oil). Both engineering approaches are informed by measures data and home characteristics used in the billing analysis. Interactive effects will be addressed in the analysis, and the work will incorporate both DOE-2-type simulation modeling (a widely-used building energy use model) and standard industry-engineering algorithms.

The timeline for the measure life study varies based on additional discussions concerning the methodology and the measures included, but should also be completed in early 2014. The (short-term, limited measure) persistence study is already approved, but the scope has been expanded to consider additional measures and longer-term EUL estimation work to take advantage of the survey work needed for the impact work. The data to be used include: project/program data, customer survey, and billing data.

Schedule and Budget:

Work on an initial whole building billing analysis-based impact evaluation/net savings estimate is due First Quarter of 2014, with the measure-based estimates and program roll-out completed in second quarter. The approved budget is \$410,000 (as amended).

R86: Residential Lighting Net-to-Gross Study**Objectives and Priority Outcomes:**

The goal of this study is to estimate net-to-gross (NTG) ratios for key product types incented in the Connecticut Residential Lighting Program and to assess the associated strategic implications for the CT Companies. The study seeks to develop several estimates for NTG for this upstream program using different methods, including an integrative approach that takes the results from the methods into account and a discussion of the implications for the future of residential lighting programs in CT.

Approach and Work Plan:

There are several options offered in the work plan with which to estimate net-to-gross ratios. The Evaluation Team is working with the evaluation contractor to determine the recommended approaches, which will likely not include all the methods described here. The study will also be conducted in close coordination with a similar study being conducted in Massachusetts at the same time, by the same contractor as the work in Connecticut.

Method 1: Supplier Self-reporting: Administer interviews with participating lighting manufacturers and lighting buyers for large chain retailers as well as CATI surveys with local store managers. Use the percentage change in sales of various bulb types they attribute to the program. A NTG ratio estimate for each channel will be calculated.

Method 2: Demand Elasticity Modeling: Quantify relationship of price and promotion on quantity sold (elasticity). Determine the likely level of sales without the program's intervention (baseline sales), estimate free ridership by comparing modeled baseline sales with actual sales.

Method 3a: Point-of Sale Data Analysis Option 1: Purchase IRI (formerly Symphony IRI)²² data and compare point-of-sale data (grocery, drug, mass merchandise, dollar stores) in Massachusetts to similar data in several other states (New York, California, and other areas with varying levels of support). Investigate the impact of program support on purchasing behavior.

Method 3b: Point-of Sale Data Analysis Option 2: Use the "big data" alternative point-of-sale approach to estimating NTG. This approach would model the effect of the Massachusetts program on CFL sales by using IRI data described in Task 3b Option 1 above for 2011 to 2013 from all 50 states.

Method 4: Saturation and Market-level Sales Analysis: Compare saturation and market-level sales estimates in Connecticut and other states. This effort provides background information and indicators of NTG.

²² IRI, or Information Resources, Inc. provides lighting point of sale (POS) data.

Method 5: Delphi Panel: A Delphi panel may be convened to integrate the results of the other NTG estimation methods and develop one or more final recommended NTG estimates. The panel will consist of approximately 20 lighting experts from across the United States and Canada.

Schedule and Budget:

The project started in January 2013. Then modeling and analytics will take place over the next several months with the Draft Report going out for review in second half of July 2014. The Delphi panel task would push the final completion date to early 2015 to close the study. The budget for this evaluation is \$300,000, but actual spending will depend on which options are selected. Coordinating with MA on the evaluation will lead to significant economies of scale.

3.4 Residential Market Research and Evaluation Research Area

R3: Regional Lighting Hours of Use Study

Objective and Priority Outcomes:

The purpose of this study is to provide updated information to the Connecticut Energy Efficiency Board, the Massachusetts Program Administrators (Cape Light Compact, National Grid Massachusetts, Northeast Utilities, and Unitil), National Grid Rhode Island, and the New York State Energy Research and Development Authority (hereafter “the Sponsors”) to assist in the calculations of demand and energy savings for lighting programs. Specifically, this report will present load shapes, coincidence factors (CFs), and daily hours of use (HOU), and also will present a separate analysis of the effects of “urban canyons” on the lighting use of high-rise apartment dwellers in Manhattan.

Approach and Work Plan:

The following are the principal tasks that are associated with this project:

Sample design and recruitment: This study included data collected in four separate states: Connecticut, Massachusetts, Rhode Island, and New York. The evaluation team will identified households for the onsites in three different ways: random-digit dial (RDD) telephone surveys, customer lists, and an address lookup. We have accounted for sample attrition due to data cleaning and the treatment of outliers.

Onsite data collection: For this evaluation, the Team collected data through onsite visits to 848 homes located throughout Connecticut, Massachusetts, New York, and Rhode Island. All sites visited required two visits. During the first visit, the Team collected detailed lighting inventory data and installed time-of-use light meters (loggers). The second visit consisted of removing the loggers installed during the first visit. Altogether, over 5,730 loggers were installed between December 2012 and March 2013.

Analysis: To account for differences in demographics and lighting inventory in the final sample and the population, the Team applied a complex weighting scheme that is discussed in greater detail in the report. For the modeling of the HOU, the following steps were used:

- **Creating Annual Datasets:** Since each logger was installed for only a portion of the year—between five and nine months—we had to annualize the data, and we did this by fitting a sinusoid model to each logger.
- **Adjusting HOU Estimates:** Using the annualized estimates, we performed a weighted regression analysis to estimate the adjusted HOU for each room in each area of the study.

- Applying a Hierarchical Model: Due to the similar use patterns in four of the areas (CT, MA, Upstate NY, and RI), we sought a way to leverage data from each of these areas to refine area-specific estimates. To accomplish this, we fit a multi-level hierarchical model.
- Derivation of Load Curves: For any months lacking sufficient data, we applied two techniques to estimate additional load data: an equivalent-dates technique and modeling lighting usage as a function of average hours of daylight.
- Solar Shading: The Team collected glazing and solar shading data for 130 sites in high-rise apartment units in Manhattan to determine if the availability of direct sunlight or ambient light has an effect on lighting use.

Schedule and Budget:

The majority of the work, including data collection, analytics, and report writing, was performed in 2013. The final draft of this report will be completed in Q1 of 2014. The budget for this task is estimated to be \$251,887.

R5: Weatherization Baseline Study

Objectives and Priority Outcomes:

The state of Connecticut has set the ambitious goal to have 80% of all homes in CT weatherized by 2030. That goal is made more ambitious because of lack of information on the weatherization status of homes at this time. This study provides information crucial to identifying the size of the challenge, including:

- Number and percent of residences in Connecticut that are currently weatherized?
- How the measurement differs for fuel oil users versus other heating types; for home owners vs. renters; for low income versus non-low income customers.
- Identifies levels of equipment and measure efficiencies in place in CT homes, including levels of wall insulation, floor insulation, air infiltration, and efficiencies of HVAC, water heating, and other appliances and equipment.
- Identifies other change-outs needed to save energy (e.g. appliances).
- Provides data and support for the 2014 IRP (due in January 2014) and future IRPs
- Provides the groundwork for an initial potential study for oil heat and natural gas customers at very low incremental cost, and supports the single-family potential study (conducted as project R15).

Approach and Work Plan:

The weatherization study will estimate baseline efficiency of single family homes across the state. The study will conduct a detailed inspection and measurement process (called HERS, and which requires specialized training and certification) in 180 homes. HERS inspections requires qualified technicians to collect all of the data necessary to model the energy usage of each building in REM/Rate. At every home, an HES vendor and HERS rater will take detailed measurements in order to calculate conditioned floor area, conditioned volume, and all thermal boundary areas. Absent any problematic or unsafe conditions (such as the presence of asbestos insulation), the HES vendors, under evaluation contractor supervision, will conduct blower door tests at all homes, and will perform duct leakage tests in all homes with ducts. HES vendors will then provide all core services in HES-eligible homes.

While the HERS rater collects other information necessary for determining the weatherization status of the home. The HERS rater will identify the key efficiency-related characteristics of the building. These

include, but are not limited to, insulation types and R-values for key shell measures, mechanical equipment types and efficiencies, and lighting fixture and appliance characteristics. Data on mechanical equipment, lighting fixture and appliance characteristics are necessary to model each home in REM/Rate and therefore are an important piece of the weatherization assessment. Models comparing the 180 homes with reference homes will be statistically assessed to extrapolate the data collected to the full population of single family homes in Connecticut.

The study is constructed to be delivered using a hybrid approach. By delivering the HES concurrently, the cost was reduced by one person's time per site (about 90 person-days labor), plus the costs of maintaining infiltration detection equipment. The approach also is capturing savings, including savings from customers who would not otherwise seek out HES.

Schedule and Budget:

The project began in 2012 and a draft report was prepared in 2013 for review. The report will be finalized in early 2014. The project's budget is \$829,000.

R15: Residential SF Potential Study – Oil, NG, and Electric Baseline

Objectives and Priority Outcomes:

This study is designed to provide estimates of the “potential” fuel savings from single family homes in Connecticut. The study estimates potential savings from fuel oil, natural gas, and electricity use, and develops estimates of both energy and demand savings associated with:

- Technical potential, assuming efficiency measures that can be installed are installed;
- Cost-effective potential; assuming efficiency measures that are cost-effective can be installed;
- Achievable potential, taking account of economics and behavior. This also accounts for codes and standards and the impact they have on savings.

The study considers fuel switching within the analyses. It is important to note that this will be a separate analysis—fuel switching is not included in technical potential, cost-effective potential, or achievable potential and therefore any savings from fuel switching should be viewed independently from the other three scenarios to avoid double counting.

Approach and Work Plan:

To develop the estimates, the study will use the 1) Household prototypes developed in the weatherization baseline report (R15), and 2) the REM/Rate energy modeling software. Primary tasks include:

- Preparation: develop & revise approach, and conduct secondary research for upgrade assumptions
- Model measure upgrades using data collected through weatherization study
- Transcribe & QC upgrade results
- Analysis: Analyze savings data for technical potential; assess fuel switching, screen measures for cost-effectiveness, and estimate achievable potential
- Draft and final reporting and presentations

To determine the intensity of energy use in Connecticut single-family homes, the 180 homes that were audited for the Weatherization Baseline Study will be modeled using REM/Rate™ home energy modeling software. REM/Rate is a residential energy analysis software that is commonly used to model the

performance of residential buildings—the software is most notably used by the ENERGY STAR® Homes program. REM/Rate accounts for interactive energy effects between the various facets of a house, and thereby provides a highly accurate picture of a homes’ projected annual energy use irrespective of occupant behavior. For example, a house with inefficient lighting will normally use slightly less heating fuel than it otherwise would because incandescent light bulbs produce more heat than more efficient lighting technologies.

A total of 43 possible home energy upgrades related to the building envelope, HVAC (heating, ventilation, and air conditioning) systems, water heating equipment, lighting, appliances, and solar technologies will be modeled. Most upgrades will be applied to homes that have a given feature but do not meet the efficiency level specified for the upgrade. In addition, upgrades to features not commonly found in homes—photovoltaics, solar hot water systems, heat pumps, and dehumidifiers—will be applied to a sample of homes, and savings from three upgrades for which there are no inputs in REM/Rate—low-flow showerheads, faucet aerators, and pipe insulation—will be calculated using equations found in the 2013 Connecticut HES Program Savings Document.²³ Overall, about 22 upgrades will be applicable to any one site. For each of the 180 homes, the following REM/Rate models will be created to assess potential savings:

- A baseline model that includes all of the characteristics and efficiencies identified during the site visits. This model represents the baseline or “as-is” condition of the home.
- A unique upgrade model for each applicable measure upgrade where all other features are held the same as the baseline model. For example, if a home was deemed eligible for a gas furnace upgrade then the only item upgraded in the model was the gas furnace—all other items remained the same.
- A comprehensive upgrade model in which all applicable measure upgrades will be modeled together to account for interactive effects and to estimate the total technical potential savings. In the few cases where upgrades conflict (e.g., instantaneous gas water heaters vs. condensing gas storage water heaters), the upgrade which resulted in the greatest savings in the individual measure runs was applied.

This process resulted in 3,579 REM/Rate models for which the consumption data was exported to Microsoft Access for querying and analysis.

Schedule and /Budget:

This project began in 2013, and a draft was reviewed in early 2014. The project will be complete in early 2014. The project’s budget is \$236,000.

²³ Clothes washers, which are an input into the REM/Rate software, will also be modeled outside of REM/Rate because the software’s model for clothes washers requires complete data on the machine from the Energy Guide label, which is not always available.

4. STUDIES IN DEVELOPMENT FOR 2014

4.1 Commercial Process and Impact Evaluation Research Area

C101: ECB Process/NEI & Impact Evaluation

A significant portion of the EEB program portfolio savings is attributed to the ECB program (41.1 million kWh in 2012). This study consists of two components: a process evaluation and an impact evaluation. The priority objectives of the study are evaluated savings and process improvement recommendations.

- The process evaluation focuses on identifying the goals of the program (both long term and short term), assessing the effectiveness of the program towards achieving those goals, and providing recommendations for how the program can improve. The process evaluation will highlight components of the program that are working well and provide recommendations for realistic improvements in program delivery. The process evaluation incorporates survey inquiries for several potential non-energy impact (NEI/NEB) areas, benefits and costs, and for program marketing.
- The impact evaluation will verify the savings claimed by the ECB program, reducing program uncertainty and planning risk. The impact evaluation will estimate the adjusted gross energy savings (both gas, electric, and demand) and net energy savings and demand. The final component will provide an assessment of the C&I new construction elements of the PSD and provide recommendations for these that work well with all of the utility programs (i.e., takes into account the different program databases at a detail level.)

The research will primarily consist of engineering on-site M&V, desk review, and interviews with program participants and trade allies, and program rejecters (i.e., customers that contacted the program, or were contacted by the program but did not participate). Rejecters provide information on barriers to participation versus barriers to efficiency adoption.

The impact evaluation component will be coordinated with, and rely on, a new construction baseline study. The study incorporates database reviews, process evaluation telephone interviews with participants, trade allies and rejecters/drop-outs; on-sites (split between low and high complexity and two strata – electric and gas); and literature review and data collection for PSD adjustment.

4.2 Commercial Market Research and Evaluation Research Area

C19: New Construction Baseline and Code Compliance (incorporates Study 10)

Industry experts have cited that the greatest source of uncertainty in our impact evaluations may be what we use for baseline. Differences between code and actual baseline practices can affect savings

estimates, and, as a consequence, program cost-effectiveness. This problem can benefit from a quantitative assessment of how adequately state building codes reflect actual new construction building practices in the small business market.

This study will gather data on baseline construction practices and test to see how well they line up with the newly implemented 2012 building codes upon which PSD savings estimates are based. This effort would involve on-site visits and be comprehensive enough to assess the baseline assumptions contained in the PSD, and address code compliance, concentrating on lost opportunity measures. The study will likely address separately the small C&I versus the medium and large C&I markets.

C52: Assess Lighting Structure for Capability Regarding High Performance Lighting

Comprehensive retrofit of commercial buildings is a major tool to meet Connecticut's Energy Efficiency goals. Following several years of lighting retrofits, achieving deeper savings in the changing lighting market may require moving to high performance lighting. However, the next generation skills and market operation for high performance lighting are different from most prior types of lighting retrofits. Continued progress requires understanding how the customers and contractors can work together to achieve the major components, with lighting being the largest. This in turn requires an understanding of the existing capabilities and business models of the contractors who deliver lighting services, and the investment framework, resource, needs, and drivers of customers. This market research will address whether the lighting market in Connecticut is set up and ready to achieve deep savings through high performance lighting. The study will include literature review, best practices analysis, and in-depth interviews (IDIs) with:

- trade allies and lighting contractors to assess current business models, interest in engaging in deeper design-based retrofit as a new business line, training and certification levels, and their view of the customer market, and
- customers who are motivated to invest in lighting efficiency to assess their ability to consider deeper investments, possible roles of financing, ability to manage more complex projects, and the type of incentives and services that could lead to success.

Federal standards will be creating a much more efficient baseline for lighting retrofit; stick fluorescent and high performance T8s are soon likely to be the minimum available efficiency. However, national program experience shows even greater savings are available from maturing technologies (e.g. Light Emitting Diodes/LEDs, wireless controls, and other technologies) and more sophisticated design and control regimens, even for existing buildings. While these are great advancements in efficiency, they challenge programs to take the next step. Leading states seem to be forging ahead on program design without the market research to reliably set direction. For this reason, the project may also be of interest to other NEEP states. The outcomes of the market analysis will include needs assessment for the program to help build widespread capability for high performance lighting retrofits based on maturing technologies, and recommended program design elements (for EO and other programs) to transform the leading edge of the lighting retrofit market (customers and vendors) to more comprehensive practices to avoid lost market opportunities. This research will help incentive/high performance design initiatives already in the field succeed at the next level of savings.

C104: Detailed review of C&I PSD Existing Buildings – FR, SO, load shapes, and their use

The PSD is the interface between evaluation work and program planning and savings reporting. To ensure comfort in the unbiased application of evaluation results requires a PSD that can be workable for the utilities to use and accommodate differences in program databases. This study will update the PSD by:

- Conducting a detailed review of the C&I PSD for existing buildings and its applications, how it is updated, and when it was last updated on various topics, and what further updates or greater clarification/specification in their use is needed,
- Reviewing the commercial and industrial evaluation research performed by Connecticut and NEEP over the last few years, including work on free ridership, spillover, and load shapes incorporating updated information into the PSD, and provide detailed recommendations of changes to PSD (potentially for small C&I versus medium/large C&I) that work for each utility and their databases),
- Identifying other (“next”) elements of the existing PSD for which it is cost-effective to update with additional evaluation work, including an assessment to direct future evaluation efforts to improve the PSD, by identifying remaining gaps, areas with old work, or elements of the PSD that should differentiate between use for large C&I versus small C&I..

The study will include updates based on evaluations for programs including EO, SBEA, and others.

C105: Evaluability Assessment of New/Major Program Changes for Strategic Energy Management (SEM)

Major changes are being developed for the series of programs within Strategic Energy Management/ BES/O&M: O&M Services, Retrocommissioning, PRIME, and BSC. Savings cannot be reliably claimed if the program databases or procedures are not well designed to be able to reliably evaluate the programs. This project will conduct an evaluability assessment to provide recommendations early-on to assure that new programs incorporate goals, logic, data collection/tracking, and other procedures that can help support impact evaluation and other evaluation work. The project involves in-depth interviews with involved staff to assess or create an implementation plan diagram, review data collection and databases to assess the ability to support program evaluation in a rigorous manner.

4.3 Residential Process and Impact Evaluation Research Area

R67: Lighting Interactive Effects Study

Lighting has been one of the most important contributors to savings from Connecticut programs, but lighting has interactive effects with other installed measures (especially heating/ventilation/air-conditioning, or HVAC), complicating evaluation and attribution. Interactive effects are examined for most lighting programs now around the country, but have not been estimated specifically for Connecticut residential programs. This research works to enhance the reliability of estimates of savings from this measure going forward. The study will leverage:

- significant work that has already been conducted to collect market penetrations of various HVAC technologies, building shell characteristics, and run times for both the lighting and HVAC measures impacted,
- existing building simulation modeling work to estimate interactive effects, and
- estimates of the interactive effect savings impacts from lighting measures on other measure savings.

The project will research, quantify and develop an approach to the interactive savings effects of reduced wattage of common residential light measures using methodologies explored and demonstrated in other studies (residential and commercial). Using information on prototypical homes already available and accepted engineering methods, the project focuses on developing, if possible, a common set of interactive factors for demand and energy savings based on typical HVAC systems, the most up-to-date efficiencies and run times for common residential lighting measures. The research will focus on market penetrations of various HVAC technologies, building shell characteristics, and run times for both the lighting and HVAC measures impacted.

4.4 Residential Market Research and Evaluation Research Area

R31: Real Time Data Collection

Evaluations often contact participants months – or sometimes more than a year - after they participated in the program. Participants' ability to recall program procedures, their own decision making process, and the program's impact on their other behavior becomes less reliable as time after participation passes. In addition, programs run the danger of contacting customers multiple times for different evaluations.

The study will review surveys currently conducted by utilities and identify coordination opportunities with surveys already being conducted by the utilities. The project organizes integrated regular and timely phone interviews (delivered every three to six months) to program participants to gather data and track critical process and impact indicators to be used in evaluation work. Real-time surveys conducted within several months of participation will provide higher quality inputs than information provided by recall one or two years after program participation. The survey will be expected to include a core group of questions focusing on such things as program experience and satisfaction, the decision-making process, and motivations to participate in order to track such critical indicators as satisfaction, net impacts, etc. -- data necessary to support process and impact evaluations.

The project will provide timely information on program progress, but will be complicated to implement because funding from each program will need to be set aside each year, even if an important evaluation for that project is not due that year. This work cannot meet all evaluation needs; additional surveys will be needed because spillover cannot be captured right after program participation, so it would need to be examined separately from other net impacts.

R38: Field Test of Wireless Thermostats/Technologies

The new generation of thermostats holds the possibility of significant energy savings across all homes; a few percentage points of savings across all homes could equal a significant gas and electric efficiency resource. These new wireless thermostats can operate through the interface of preference for most customers (the phone or internet) and can turn down heat or AC remotely, so there is a reasonable argument for their ability to generate energy savings. In addition, recent products cost \$100-\$250, instead of the \$1000 for some home control systems, improving the cost-effectiveness potential. However, additional features come at a price; an assessment of the costs and benefits of adding features to the basic wireless programmable thermostat concept is needed to clarify incremental value of added features and assess cost-effectiveness and optimal program design. For example, this measure could be delivered through existing programs for new and existing homes and possibly also through equipment programs run through retail channels. This study will include a series of field tests to assess energy and demand savings from:

- wireless thermostats controlled by owners (which can provide a significant share of the demand savings that would result from utility dispatch),
- wireless thermostat with added energy management features such as simplified programmability, learning motion sensor, and outdoor temperature cut out (for heat pumps), and
- added demand management services offered by some thermostat providers.

The study will assess potential savings from intelligent home thermostats that have shown considerable promise in early research. The study will be based on real-world field data, involving a staged series of tests that would take 2-3 years. Alternative research designs are possible: pre/post billing data; using smart meter data and/or data provided by thermostats themselves (through coordinated evaluation with providers) for impact evaluation; or use of on/off tests. Customer surveys will provide information on satisfaction, comfort impacts, and help understand interactions with thermostats. Some thermostats have sufficient market appeal that utility costs may be reduced through consumer investment in the technology. If possible, the study will be leveraged with work from a few other participant states. EPRI is planning one study of home controls, a consultant is working to develop another multi-utility study, and others are exploring similar devices in Massachusetts and nationwide, so there are significant opportunities for leverage, at some risk of losing design focus and climatic relevance.

R48: Market Assessment/Performance Evaluation for Incorporation of High Performance Measures into HES and Other Residential Programs

This study uses literature review, market assessment, and performance evaluation techniques to assess “next” measures for incorporation into Connecticut residential programs. The project is expected to include:

- a benchmarking study to compare to programs similar to HES and assess impacts of program components.
- an impact evaluation (or review of impact evaluations) to provide information regarding potential savings from new program components/measures for HES or standalone programs.

Evaluations are used to assess cost effectiveness and help determine whether measures should be retained or added to programs. Decisions on refrigerators and other measures have been examined in the past, and as a result of analysis, refrigerator recycling was not added to CL&P's portfolio, but replacement/retirement of this measure was suggested for HES. This project examines measures systematically to identify their potential for addition to residential programs, with an eye toward informing 2014 program planning.

R51: Codes and Standards – Examine Potential Savings from Past and Future Program Activity

The CEEF programs have played a significant role in supporting national and state codes and standards through training and outreach, skill development in the design/construction trades, and the overall raising of the efficiency performance baseline for the equipment, design, construction and remodeling industry. Currently the CEEF Programs do not document these savings or provide strong support for their quantification. In order to make effective policy, regulatory, and program design decisions, it is critical for Connecticut to have a clear understanding of the direct and indirect contributions of the CEEF Programs to Connecticut's overall strategic energy efficiency goals. This study will identify appropriate methodologies for codes and standards (C&S) savings accounting and attribution from CEEF Program support for codes and standards and market transformation effects. The goal is to provide direction for how to attribute C&S savings to program activity, and (if possible) to provide an accounting and defensible attribution of CEEF Program savings from codes, standards, and other market transformation effects not currently accounted for by CEEF Programs.

Codes and standards studies are complicated, and significant recent work has been conducted, so the design of the study will be mindful of the budget and scope limitations. The Evaluation Committee's expert Consultants are well positioned to advise on appropriate methodologies for savings accounting and attribution from CEEF Program support for codes and standards and market transformation effects. The work will refer to previous savings attribution studies including: Massachusetts and California work on building codes, Energy Trust of Oregon work on federal lighting standards, and Northwest Planning and Conservation Council work on codes and overall market transformation initiatives.

R82: Participation in Lighting Data through the Consortium for Retail Energy Efficiency Data (CREED)

Lighting continues to represent substantial program savings in Connecticut, and this data source helps track information critical to assessing performance, informing exploration of opportunities, and assessing the impacts of EISA.²⁴ The Consortium for Retail Energy Efficiency Data (CREED) is a consortium of program administrators, retailers, and manufacturers working together to collect the necessary data to better understand lighting decision making and purchase patterns. CREED uses third party agents to collect market point of purchase/point of sale (POS) data on lighting, data that is helpful in assessing impacts related to EISA. Having POS data is important for retrospective attribution analysis, and for existing prospective LED market effects. Lighting point-of-sale data is used to estimate program attribution/impacts, as well as incremental costs (e.g., for LEDs). In addition, even with savings from

²⁴ EISA is the Energy Independence and Security Act, passed in 2007, which establishes a number of energy management goals and regulations.

lighting programs decreasing, it will be important to identify the remaining opportunities, and POS data is critical to this purpose. The data source is a multi-agency consortium, so costs are shared, and agreements with data sources have been negotiated to provide better access to data than is possible if Connecticut were to work to acquire data on its own.

R84: Consumer Electronic Market and Potential Study

Consumer electronics are a growing industry and account for an increasingly greater proportion of residential electricity load. The project examines the market for consumer electrics to determine program savings/impact potential and identify future program offerings and enhancements. This evaluation will be a two-step process. First, the evaluation will examine available literature and perform in-depth interviews to scope what primary research, if any is needed. The study then may include a saturation study to determine detailed program savings potential for consumer electronics and identify best practices for such programs.

This area changes very quickly, so scope and budget will need to be carefully crafted; the project could focus on specific measures or focus on limited aspects of the range of questions related to these measures. Project design elements may include in-depth interviews with manufacturers, retailers, internet and cable service providers, other program managers, and others associated with the defined measures (potentially televisions, computers, power strips, and related peripheral devices or other appliances), depending on the ultimate scope of the project.

5. REGIONAL EM&V STUDIES AND OTHER STUDIES

5.1 Connecticut Participation in NEEP Regional EM&V Studies

The Northeast Energy Efficiency Partnership (NEEP) established a regional EM&V forum that provides the opportunity to partner in evaluation and market research studies that have regional relevance. The Forum determines, in consultation with its membership, the studies that will be completed and the budgets for each project. Ten states and the District of Columbia participate in the forum, but not all subscribe to every study commissioned by the Forum. Connecticut's participation over the years has varied, based on the studies proposed by NEEP and the perceived benefit to Connecticut ratepayers. The traditional planning process at NEEP was modified in 2013 to conform better to Connecticut's timing and more formalized prioritization and input/coordination/feedback process. Connecticut participated in a limited way in 2013; partly as a result of NEEP's adoption of planning changes, Connecticut participates in a more enhanced way in 2014.

The studies in which Connecticut is participating, assuming the scopes continue to provide the desired outcomes for Connecticut as the year progresses, are described below. Several of the studies cross sectors (residential and commercial), so the studies are not presented separately by research area. Note that, in addition to the studies below, Connecticut had anticipated participating in a study of load shapes, but NEEP budget concerns have led to a deferment of that project until 2015.

R14: Societal Non-Energy Impacts

The project will provide quantitative estimates of the societal non-energy effects deriving from investment in energy efficiency -- including economics/jobs multipliers in the first year, and potentially environmental or other priority NEIs in the second year. This project supports improved estimates for use by Connecticut in planning and marketing; the impacts of NEBs are more complicated -- and more reliably estimated -- than the current expressions used, which are in terms of added cost per kWh. The NEEP project to estimate jobs-related NEIs will use IMPLAN or REMI or other vetted input-output models to develop regionally-appropriate estimates of the multipliers association with investment in energy efficiency. These analyses will allow quantification of impacts in terms of dollar amounts, which can then be added to cost-effectiveness assessment, and used to explore environmental adders (like other states), etc. Environmental impact analysis will explore reduced emissions associated with offset generation, as well as other environmental effects (e.g., water-savings, landfill reduction). The purpose of this project is to employ one methodology (selected with regional input or consensus) to develop current estimates of job impacts at the regional and state levels. The deliverable from this research will include results that can be used as inputs to REED, as well as a report that can inform regional energy policy discussions and can provide a comparison with any available results from various program administrators' existing job impact studies. NEEP is seeking to leverage other funding sources to minimize project costs.

R61: Load Shape Research

Loadshapes are expensive to obtain, but are critical to estimating impacts and energy savings potential. A "shareable" database/inventory would be a valued resource, and the NEEP project will conduct primary research to identify loadshapes that are as regionally-appropriate as possible. The purpose of this project is to fill data gaps in the region. The product will deliver sets of regionally-appropriate loadshapes that can be used/referenced in evaluation, market research, "potential" analyses, and other applications. The deliverable will be 8760 load shapes with peak coincidence factors, and a spreadsheet "tool" that allows users to calculate customized factors for one measure type. To minimize cost and maximize product, the project leverages costs, sampling efforts, and previously collected data across multiple funders. The studies are designed to satisfy PJM and ISO-NE M&V requirements.

RC63: Incremental Cost Study

This study leverages contributions from multiple states in the Northeast to provide primary-sourced data to develop incremental cost estimates and cost curves (costs at varying efficiency levels) for measures and/or program types (gas and/or electric) beyond those previously studied. The goal is to provide regionally-appropriate incremental cost values for key measures in both the residential and commercial sector. The deliverable will be cost curves, worksheets and a summary report. The project began in 2013. The 2014 project budget will cover a number of priority measures that will presumably be of interest to Connecticut; follow-on work in 2015 and possibly beyond will add additional measures to the study. The types of measures to be included are common prescriptive measures, and new/emerging measures, and the study will also update costs periodically as markets change. Development of cost curves, rather than measure by measure estimates, is more economical and flexible. Incremental costs are important, but expensive to obtain, so many studies rely on data from California's DEER (Database for Energy Efficient Resources). However, it is far more useful to be able to refer to more regionally-appropriate sources. Because data on costs of baseline and efficient measures can be difficult to obtain, and are likely to be similar within sub-regional markets rather than obeying state boundaries, the regional Forum is an attractive entity for conducting the study, and can apply a consistent analytical method across jurisdictions.

R73: Ductless Mini-Split Performance Results – Meta Study

This study of ductless heat pumps/mini-splits (NEEP) is to update Forum members on this rapidly evolving technology, including new products (e.g. multi-head cold climate systems and integrated controls) that are coming onto the market within a year. This will be conducted as a meta-study, identifying the latest information from studies conducted regionally and nationally. The work will focus on understanding and updating impact/market/performance assumptions for existing and evolving technologies. The deliverable is a report updating impact/market/performance assumptions from previous studies with the most updated results.

R78: Appliance Standards Support

The region's energy efficiency and environmental goals benefit from improvements in federal standards, and changes in standards have a large influence on baselines and evaluation results. Program administrators are uniquely qualified to help inform the research to advance standards. The purpose of this project is to engage the EM&V community on market research/characterization of market share, price trends, and consumer response to products. This research will use a combination of existing information and new data to provide results that can be used in support of rulemaking processes as well as informing program administrators about program design and marketing. The focus of the work follows the schedules of potential standards analyses, with early attention on water heaters, including research on impacts on HVAC energy, consumer satisfaction with heat pump water heaters (HPWH), and in-field energy use in colder climates (the DOE proposal is due April 2016). Because CT can have its own appliance standards, it is important to understand where the Companies can best influence/direct new standards, and identify how CT can best play a supporting role for savings from codes.

R88: Measure Life Study - Estimation-based (NEEP)

Measure lifetimes are a key input to all benefit-cost computations for programs and measures, but, although impact estimates are well-researched, few of the estimated useful lifetimes (EULs) used are derived from defensible sources/methods. The purpose of this project is to improve measure life estimates used in the region and produce defensible measure lifetimes for priority measures (including an early focus on remaining useful lifetime methods/results), with more to follow in later years. The earliest phase of the NEEP project involves work by the Committee to select the target measures (work supported in 2013 by MD, DC, CT, MA, RI, and VT), and the product for 2014 is to produce defensible measure lifetimes for priority measures, based on field data collection and estimation work. The deliverable is a report with estimates of measure life for equipment replacement projects for one or two measure categories, which may include residential or commercial measures, depending on the prioritization. The project will conduct in-depth surveys of program participants who qualified for early replacement incentives to gain a better understanding of the factors that influence equipment replacement decisions, early replacement of existing equipment with more efficient equipment, and examine existing equipment life, new equipment life, and other information used to estimate remaining useful life or to qualify measures, such as the efficiency of the existing equipment. Baseline assumptions pertaining to future efficiency standards or other factors that determine the timing and efficiency of “normal replacement” will also be documented. Measure lifetimes are a key input to all benefit-cost computations for programs and measures, but few of the EULs (estimated useful lifetimes) are well- or statistically-derived; this study (and follow-on work) addresses that gap.

R91: Addressing Disconnects between Engineering and Billing Analysis

There are two main methods used in the industry to estimate program savings – billing analysis and engineering/model/simulation approaches. A key question in impact evaluation research is the best practices to use in reconciling differences or disconnects that may arise in savings estimates when two different impact evaluation methods develop different estimates of attributable savings. In this project, we conduct:

- a literature review of the best impact evaluation studies (of each and both types) around the nation,
- interviews with industry evaluation experts on their current practices and thoughts about emerging strategies for addressing the issue, and
- detailed analysis to explore whether/how often differences in impact results arise between billing versus engineering analysis approaches.

The project will examine alternatives and develop justifiable best practices for instances when two different impact evaluation methods develop different estimates of attributable savings to help improve methods associated with impact evaluations to provide additional guidance for billing and impact analyses of CT programs.

RC109: REED Database

The NEEP has assembled the REED database (Regional Energy Efficiency Database) to provide a source for utilities and other researchers to warehouse and use results from programs across the Northeastern states. The database provides easily accessible data for benchmarking and identifying best practices for similar regional programs. Economies are realized as the project will be working with other EE data collection efforts (by CEE, LBNL, ACEEE and others) to use consistent definitions for key terms (such as program types), will coordinate data collection with ISO-NE and explore similar coordination with NYISO and PJM (supporting air regulators' data needs). The database provides benchmarking data to inform CT programs, providing information more efficiently and in "apples to apples" formats. The purpose of this project is to maintain/update the Regional Energy Efficiency Database (REED) to assure its continued value and use, specifically to update to include program year 2013 data from all 10 states, add new report features/data (including possibly measure-level data), and provide an annual report. The project incorporates program year 2013 data, potentially new report features, additional data elements (potentially measure level data), and an Annual REED Report.

5.2 Other Studies

To allow flexibility to meet the changing needs of evaluation and study planning, the Evaluation budget has incorporated a small (5%) contingency fund to support the development of responsive studies on an as-needed basis.

6. DIRECTION OF FUTURE STUDIES

As part of the development of the Three-Year Evaluation Plan developed in 2013, the SERA Evaluation Team reviewed the prioritization, timing, and opportunities for efficiencies and coordination among studies. The current three-year plan envisions impact/process evaluations generally on an every-other-year basis. Where possible, process evaluation surveys are coordinated to support robust analyses including non-energy benefits, net-to-gross, and potentially, measure lifetime work. Figure 5.1 and Figure 5.2 below present the list of studies envisioned for the years 2015 and 2016 (subject to future refinement). The primary additions to this work will be:

- Those large or later-year 2014 projects that carry over to 2015, and
- Several studies that were originally part of the 2014 Plan that have been identified as being deferred to 2015.

Figure 5.1: 2015 Evaluation Project List from 2014-2016 EEB Evaluation Plan

Sheet #	Project Name	Budget 2015 (thousands)
RESIDENTIAL IMPACT AND/OR PROCESS EVALUATIONS & ELEMENTS		
111	Residential New Construction Impact and Process Evaluation (with potential for NEB & NTG analysis)	\$320
46	Energy Efficiency Financing Evaluation, addressing effects/improvement of financing initiatives	\$65
45	Market Assessment/HPWH and Water Heating Impact and Process Evaluation	\$144
113	Ductless Heat Pump Impact Evaluation	\$155
61	Load Shape Research - Primary Research/Estimation/Development (NEEP)	\$38
88	Measure Life Study - Estimation-based (NEEP) with initial literature work to prioritize needs/gaps	\$26
RESIDENTIAL MARKET AND MEASURE EFFECTS/PERFORMANCE		
26	HES Market Assessment	\$41
28	HES-IE Market Opportunities and Barriers	\$41
84	Consumer Electronic Market and Potential Study	\$253
80	Gas Potential Study - Natural Gas in New England (NEEP)	\$31
89	Advanced Market Share Tracking (NEEP)	\$23
82	CREED Participation - Lighting Data	\$10
109	REED Database - Regional Energy Efficiency Database (NEEP)	\$8
64	Emerging Technologies Primary Research (NEEP)	\$31
38	Field test of wireless thermostats/technologies	\$103
30	Potential for Asbestos and Mold Abatement (Not NEEP; Maybe in future)	\$41
71	Behavioral Programs and their results - Meta Evaluation (NEEP)	\$8
110	Non-Energy Impacts Assessment - Participant Beneficiaries Analysis (not Societal or Utility Sectors)	\$40

Sheet #	Project Name	Budget 2015 (thousands)
14	Societal Non-Energy Impacts - Economic and Environmental NEIs/NEBs. (NEEP Support)	\$20
108	Studies To Be Identified - including Market Research, Baseline, and Outer Year	\$125
RESIDENTIAL EVALUATION METHODS AND PSD SUPPORTING INFORMATION		
31	Real-time data collection/telephone surveys with program participants to feed impact/process evaluation work	\$50
63	Incremental Cost Estimation Study (NEEP); Half included under Residential, and Half under Commercial.	\$16
90	Oil/Propane Treatment in Impact Evaluation (CT proposed to NEEP)	\$30
78	Appliance Standards Support (NEEP)	\$8
92	NEEP Baseline Costs - CT Contribution	\$47
COMMERCIAL IMPACT AND/OR PROCESS EVALUATIONS & ELEMENTS		
57	Process Evaluation & Market Research of the Integration of Financing and C&I Efficiency Programs	\$268
41	EO Process and Impact Phase 1 (2015) & Phase 2 (2016); (including information for program marketing & NEI)	\$670
36	Large Projects Evaluation	\$412
102	SBEA Impact Evaluation	\$525
106	Early Process Evaluation of New/Major Program Changes for Strategic Energy Management	\$77
103	C&I Measure Life - Update PSD & Assess Need for Other C&I Measure Life studies (Possible NEEP)	\$25
COMMERCIAL MARKET AND MEASURE EFFECTS/PERFORMANCE		
107	Market Research on EE Investments Over Time versus Deep Savings at Once	\$283
COMMERCIAL EVALUATION METHODS AND PSD SUPPORTING INFORMATION		
63	Incremental Cost Estimation Study (NEEP); Half included under Residential, and Half under Commercial.	\$16

Figure 5.1: 2016 Evaluation Project List from 2014-2016 EEB Evaluation Plan

Proj #	Project Name	Budget 2016 (thousands)
RESIDENTIAL IMPACT AND/OR PROCESS EVALUATIONS & ELEMENTS		
34	HES and HES-IE Impact and Process Evaluation	\$398
99	HER or Other Behavioral Programs Impact & Process Evaluation Study	\$265
61	Load Shape Research - Primary Research/Estimation/Development (NEEP)	\$38
88	Measure Life Study - Estimation-based (NEEP) with initial literature work to prioritize needs/gaps	\$27
RESIDENTIAL MARKET AND MEASURE EFFECTS/PERFORMANCE		

Proj #	Project Name	Budget 2016 (thousands)
48	Market Assessment/Literature Review/Performance Evaluation for Incorporation of High Performance Measures into HES/Residential Programs	\$106
82	CREED Participation - Lighting Data	\$11
109	REED Database - Regional Energy Efficiency Database (NEEP)	\$8
108	Studies To Be Identified - including Market Research, Baseline, and Outer Year	\$350
RESIDENTIAL EVALUATION METHODS AND PSD SUPPORTING INFORMATION		
31	Real-time data collection/telephone surveys with program participants to feed impact/process evaluation work	\$50
63	Incremental Cost Estimation Study (NEEP); Half included under Residential, and Half under Commercial.	\$16
25	HES and HES-IE Deemed Savings Recommendations and updated measure information for PSD	\$37
78	Appliance Standards Support (NEEP)	\$8
92	NEEP Baseline Costs - CT Contribution	\$49
COMMERCIAL IMPACT AND/OR PROCESS EVALUATIONS & ELEMENTS		
101	ECB Process & Impact Evaluation (incl. info for program marketing, NEI)	\$1,484
100	SBEA Process Evaluation (incl. info for program marketing, NEI)	\$159
53	ECB - Strategy for advanced commercial building & renovation design	\$133
41	EO process and impact Phase 1 (2015) & Phase 2 (2016); (incl. info for program marketing & NEI)	\$644
60	Load Shape Research - Catalog/Secondary Research (NEEP)	\$31
COMMERCIAL MARKET AND MEASURE EFFECTS/PERFORMANCE		
98	Studies To Be Identified - including Market Research and Outer Year	\$300
COMMERCIAL EVALUATION METHODS AND PSD SUPPORTING INFORMATION		
63	Incremental Cost Estimation Study (NEEP); Half included under Residential, and Half under Commercial.	\$16