

CONNECTICUT ENERGY EFFICIENCY BOARD

Evaluation Studies and Results, 2015

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



Connecticut Energy Efficiency Board Evaluation Committee
May, 2016

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
Taren O'Connor
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PREFACE FROM THE EVALUATION OVERSEERS --- OVERVIEW AND VERIFICATION OF THE 2015 EVALUATION OF CONNECTICUT’S ENERGY EFFICIENCY FUND ACTIVITIES

The evaluation efforts conducted in 2015 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 2015 add to the evaluation evidence of accomplishments from the use of Connecticut’s Energy Efficiency Fund (EEF).

The Evaluation Consultant Team² verified that the 2015 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.

Evaluation Consultant Team

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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.

Table of Contents

PREFACE FROM THE EEB EVALUATION COMMITTEE i

PREFACE FROM THE EVALUATION OVERSEERS --- OVERVIEW AND VERIFICATION OF THE 2015 EVALUATION OF CONNECTICUT’S ENERGY EFFICIENCY FUND ACTIVITIES ii

1. INTRODUCTION 4

 1.1 Definition of Evaluation Types 5

 1.2 Organization of the Report..... 6

 1.3 Completed, and In-Progress Studies 6

2. COMPLETED STUDIES..... 7

 2.1 Commercial 7

 C11- Barrier to Commercial and Industrial Program Participation with a Focus on Financing and Cancellations 7

 C17- Connecticut Commercial & Industrial Research 14

 C19- Commercial & Industrial New Construction Baseline and Code Compliance Study 17

 C20- Energy Conscious Blueprint (ECB) Impact and Process Evaluation 21

 2.2 Residential 30

 R33- Observations & Recommendations from CT Residential Program Database Interviews 30

 R84- Consumer Electronics and Potential Study..... 34

 R86- LED Lighting Market Assessment Study 39

3. STUDIES IN PROGRESS (Draft Reports) 45

 3.1 Commercial 45

 3.2 Residential 45

 R4- HES / HES-IE Process Evaluation and Real-time Research (R31, R46, and R152 also) 45

 R15- Single Family Potential Study 46

 R32- Evaluation of Persistence in the Eversource Customer Behavior Program 47

 R91- Impact Evaluation Disconnects Between Engineering and Billing Analysis, and Oil / Propane Treatment 47

 R113- Ductless Heat Pump Evaluation 49

 R151-Connecticut Home Energy Solutions (HES) Air Sealing, Duct Sealing, and Insulation Practices Study 50

 R154- Connecticut LED Lighting Study 55

 R157-Connecticut Multifamily Initiative Process Study 57

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. 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.

Research completed within the evaluation group provides many types of information. Impact and process evaluations, or the inputs to these evaluations, form virtually all of the budget for studies completed. As part of these studies, information is provided to support the development of programs for the C&LM Plan, the effective design / delivery of programs within the Plan, and updates to the PSD. Feedback on best practices on programs from other jurisdictions is provided within the context of the reports.

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 two main types of evaluation supported by EEF funding, limited to the minimum types identified in the associated legislation. 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.
- Impact Support Studies (including measure effects / performance and methods 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. Methods studies address methodological issues and develop best practices for evaluation research.
- Baseline Studies provide direct impact support by assessing pre-conditions that will no longer be measureable after program interventions have occurred.
- Work on market assessments, and protocol development are generally not included in Connecticut's current EM&V workplan, per direction from regulators.

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 Commercial and Residential Sector 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 / Draft Reports** 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.

1.3 Completed, and In-Progress Studies

Figure 1, summarizes the completed and in-progress and Regional EM&V studies addressed in this Evaluation Legislative Report. Each is described in more detail in subsequent chapters, as noted.

Figure 1: List of Studies Addressed in the 2015 Legislative Report (by category)

(R=Residential; C=Comm'l / Industrial)

COMPLETE 2015 (Chapter 2)	Report Status
C11. Barriers to Commercial and Industrial Program Participation with a Focus on Financing and Cancellations	Complete
C17. Connecticut Commercial & Industrial Market Research	Complete
C19. Commercial & Industrial New Construction Baseline and Code Compliance Study	Complete
C20. Energy Conscious Blueprint (ECB) Impact & Process Evaluation	Complete
R33. Observations & Recommendations from CT Residential Program Database Interviews	Complete
R84. Consumer Electronics & Potential Study	Complete
R86. LED Lighting Market Assessment Study	Complete
IN PROGRESS (Chapter 3)	
R4. HES/HES-IE Process Evaluation & Real-time Research (R31, R46, R152 too)	In Progress
R15. Energy Potential Study for Single-Family Existing Homes	In Progress
R32. Evaluation of Persistence in the Eversource Customer Behavior Program	In Progress
R91. Impact Evaluation Disconnects Between Engineering & Billing Analysis, & Oil / Propane Treatment	In Progress
R113. Ductless Heat Pump Evaluation	In Progress
R151. Connecticut Home Energy Solutions (HES) Air Sealing, Duct Sealing, & Insulation Practices Study	In Progress
R154. Connecticut LED Lighting Study	In Progress
R157. Connecticut Multifamily Initiative Process Study	In Progress

2. COMPLETED STUDIES

2.1 Commercial

C11- Barrier to Commercial and Industrial Program Participation with a Focus on Financing and Cancellations

Background and Objectives:

The Connecticut Energy Efficiency Fund (CEEF) supports programs and initiatives to advance energy efficiency. Connecticut Light & Power and United Illuminating administer and fund the electric programs. Connecticut Natural Gas, Southern Connecticut Gas, and Yankee Gas fund gas programs from conservation charges on the natural gas bills. The programs provide financial incentives and/or financing mechanisms, information, technical assistance, tools, and educational services to encourage businesses to undertake energy efficiency investments. Utilities and state programs around the country have often fallen short of their participation goals for these programs because numerous challenges and barriers are faced in obtaining business sector participation. This report provides a summary of commercial and industrial (C&I) market research that was undertaken to better understand the specific barriers and challenges faced by program nonparticipants and program dropouts in Connecticut and to understand the potential opportunities for increasing participation.

Study Design:

The population of interest was segmented into several groups to meet the goal of understanding the characteristics and issues faced by the various market segments. Program nonparticipants in the following market segments were sampled for the study, where small was defined as average demand of 10 to 200 kW and large was defined as average demand greater than 200 kW.

- Small nonparticipating manufacturing businesses
- Large nonparticipating manufacturing businesses
- Small nonparticipating general market businesses
- Large nonparticipating general market businesses

Program dropouts were divided into two groups for the study.

- Small dropout businesses
- Large dropout businesses

The surveys focused on the following research areas.

- Business Characteristics – business type and building ownership issues
- Decision Making – process and responsibilities for investment decisions
- Information and Awareness – how respondents learn about energy efficiency and knowledge of CT's energy efficiency programs
- Investments – criteria for energy efficiency investment decisions
- Financing – importance of financing and interest in potential financing vehicles
- Barriers and Opportunities – barriers to undertaking efficiency investments and offerings that may increase the likelihood of participation

Dropouts were not asked about their investment criteria, financing, or their decision process, but they were asked about the rest of the issues listed above as well as additional issues related to the projects dropped from program participation.

- Dropout Reasons and Follow-up Actions
- Interactions with the Utility and Contractor

Because of the low response rates and small sample sizes, this study does not provide definitive conclusions, but rather provides a range of options and a qualitative understanding of the barriers and opportunities faced in these market segments.

Results:

One of the key goals of this research study was to identify the barriers to participating in the C&I energy efficiency programs and the factors that may enable customers to participate. Program nonparticipants and dropouts (for potential future projects) were asked to rate the barriers on a scale of 1 to 5 where 1 represents "not a barrier at all" and 5 means "a very significant barrier". The research found that most nonparticipants and dropouts (ranging from 65 percent to 85 percent of the six groups) rated two or more of the following issues as a 4 or a 5 on the scale indicating that it was a significant or very significant barrier. A significant finding was that most nonparticipants had more than one barrier that would have to be overcome to invest in energy efficiency. The potential barriers investigated were as follows.

- Lack of awareness of opportunities for efficiency
- Lack of credible information on efficient alternatives
- Lack of staff resources (e.g., time) for implementation
- Lack of capital for investment
- Absence of acceptable financing mechanisms
- Lack of confidence in energy/cost savings claims
- Lack of availability or longer-delivery times for efficiency measures
- Perception that efficiency delivers less on other values, (e.g., production, comfort)
- Competing priorities taking precedence
- Lack of credit quality
- Do not plan on staying long enough in the property
- Inability to share capital costs of energy improvements with tenants
- Other specified by respondent

Program nonparticipants (and dropouts) were most likely to face logistical barriers including a lack of staff resources, a lack of availability of efficiency measures, not planning to stay in the property, and competing priorities taking precedence. Over 75 percent of most of the groups rated at least one of these barriers as significant or very significant.

This is a challenge for the program because these barriers are more difficult for the program to address. However, additional information and technical assistance may be a potential means to help overcome such barriers for some of these businesses. For example, lack of staff resources may be addressed by providing a turnkey solution. Not planning to stay in the current location may potentially be addressed if the program provides specific information on the expected payback time for the investment or providing broader information and offering of Connecticut's Commercial Property Assessed Clean Energy (C-PACE). The C-PACE program allows building owners to finance qualifying energy efficiency

and clean energy improvements through a voluntary assessment on their property tax bill. Property owners pay for the improvements over time through this additional charge on their property tax bill and the repayment obligation transfers to the next owner if the property is sold. A third potential option for some of the businesses with competing priorities is to reassess the relative value of energy efficiency with greater information on non-energy impacts for their type of business, information on project financials that might be better than they had assumed, or information on other potential combinations of program services.

When asked about factors that would encourage the company to consider an energy efficiency project in the future, both nonparticipants and dropouts were most likely to report factors that could potentially be addressed with information on the project financials, including the reduced energy bills, reduced maintenance cost, and the return on the investment. The majority of these customers identified at least one of these factors as something that would encourage the investment.

Nonparticipants and dropouts were also asked about specific program offerings that would make them significantly more likely to take future energy efficiency actions. Most of the respondents identified at least two programmatic opportunities that would make them significantly more likely to take action.

However, many of those who stated that they would be very likely to take action on energy efficiency if one of these offerings were available had barriers that the energy efficiency programs are unlikely to address. These significant barriers were as follows.

- Lack of staff resources (e.g., time) for implementation
- Competing priorities taking precedence
- Do not plan on staying long enough in the property
- Inability to share capital costs of energy improvements with tenants

A much lower percentage of customers stated they would be likely to improve energy efficiency but did not have one or more of the four barriers listed. For example, while 57 percent of small manufacturing customers stated that zero or low-interest loans would make them more likely to take on energy efficiency improvements, only three percent stated this and did not have any of those four barriers. In other words, if financing were offered to small manufacturing customers without other program interventions or the firm did not solve their reported logistical barriers, only three percent of these customers could use financing to overcome all of their barriers to adopting energy efficiency. The best case for financing to overcome all of the barriers was for the small general C&I market and that could reach less than 30 percent of the market.

In general, financing did not appear to be a key solution for the barriers. The majority of nonparticipants stated that financing was only of moderate or lower importance in their decision to move forward with an energy efficiency project. At least one quarter of each nonparticipant group except small manufacturing (13 percent) stated that they were not interested in outside financing.

Key findings from this analysis were that most nonparticipants and dropouts have more than one barrier preventing them from undertaking energy efficiency projects. This means that analyses across questions are required to understand how complicated the mix of problems are that need to be addressed to increase adoption of energy efficiency. The barriers were most likely to be logistical, which make it difficult for the utility to provide assistance to help customers.

There were several opportunities to encourage participation. Most nonparticipants and dropouts named at least one factor that would encourage the company to consider an energy efficiency project in the future, and most nonparticipants and dropouts selected two or more of the programmatic options that would make it significantly more likely for the business to take action on energy efficiency opportunities. The most important factors were information on investment payback and programmatic financial and informational support. However, it is important to understand that these businesses may still face significant challenges to energy efficiency.

The most important finding from this study is that there is a complex mix of barriers and opportunities facing C&I customers regarding energy efficient investment. The incredible challenge for program planners and policy makers is to make the tools available to mix and match to solve customers' different barriers, how to match customers to the best package to solve their barriers and use their opportunities, and when packages or tools are not cost-effective to undertake. Planners and policy makers would then need to adjust estimates of potential, goals, and program resources (staff, skills, methods and incentives) to be realistic to the vast mix of barriers and opportunities actually facing CT C&I nonparticipants.

Business Characteristics:

The majority of the businesses own the facility in which they are located, are the single tenant in the building, are owner managed, and are master metered. These are characteristics that can make it easier to participate in the energy efficiency program. However, the respondents are much less likely to have all four of these characteristics, especially small manufacturing nonparticipants and small dropouts. Most respondents had been in their current location for ten years or more. This stability is also a positive factor for program participation.

Challenges and Barriers:

Respondents who stated that they had heard about Connecticut's energy efficiency programs for businesses and who recalled that the program offered incentives or financing, were asked what prevented them from taking advantage of the program offerings. Most of the nonparticipants except larger general market nonparticipants were not asked this question because they were not aware of the assistance. Therefore, the greatest barrier to participation appears to be program knowledge. Nonparticipants who did know about the program and the benefits reported that they did not take advantage of the program offerings because it was not a priority, they did not want to take on debt, the financing was not attractive, or they did not have an opportunity.

When asked about specific barriers to energy efficiency improvements, respondents were most likely to report that competing priorities taking precedence was a significant barrier. Other common barriers that were ranked as important by most groups were the lack of capital³ and the absence of acceptable financing mechanisms.

Information Sources:

³ The research suggests that "lack of capital" may mean lack of internal corporate capital or lack of capital through outside financing. These two interpretations have very different meanings regarding the opportunities for program offerings to make a difference.

Respondents were most likely to report that they use online sources to stay informed about energy efficiency and related topics, followed by newspapers and magazines, word of mouth, trade associations, and vendors.

While most of the nonparticipants reported that they were aware of Connecticut's energy efficiency programs for businesses, most did not know that the programs offered incentives or financing. The nonparticipants who recalled that the programs offered incentives and/or financing were asked whether they considered taking advantage of those offerings. While the manufacturing customers were equally likely to report that they did and did not consider taking advantage of those offerings, all general market customers who were aware said that they did considering taking advantage of those offerings.

Respondents felt that the best way for the Connecticut energy efficiency program to reach firms was to use online sources or social media, have the utility call or email the customer, direct mail, or a face-to-face meeting.

Opportunities:

Respondents were most likely to state that the following would make them more likely to take energy efficiency actions to improve their business.

- Analysis that shows that the energy saving project will reduce energy bills enough to yield a rapid payback.
- A cash rebate for a purchase of an energy-saving measure.
- A turn-key package from the utility with a contractor to do the work and financing to make it possible.
- A discount on the purchase of energy-saving measures.
- Zero or low-interest loans.

However, many of those who stated that they would be very likely to take action on energy efficiency if one of these offerings were available had barriers that the energy efficiency programs are unlikely to address.

Most respondents felt that the utility was a very or somewhat credible source of information on energy efficiency and stated that they were very or somewhat likely to consult their utility in the next two years about ways to save energy.

Investments and Financing:

Nonparticipants were asked about their criteria for investing in energy efficiency. The most common criteria used by respondents to make decisions about investing in energy efficiency were the return on investment, followed by the simple payback period and the cost of capital.

The majority of respondents stated that financing was only of moderate or lower importance in their decision to move forward with an energy efficiency project. At least one quarter of each group except small manufacturing (13 percent) stated that they were not interested in outside financing.

Program Dropouts:

Most of the small program dropouts had begun participation in the SBEA and most large dropouts had begun participation in the Energy Opportunities program. Most of the dropouts decided to defer the project or dropped the project at a stage that they did not define.

Small dropouts had various reasons for deferring the project. Large dropouts were most likely to defer because they did not have the funds. However additional analysis shows that these dropouts had other barriers to the project. Of those who did not have the funds, 86 percent did not want to take on debt, had a lack of credit quality, or had other higher priorities.

Dropouts reported various actions the program could have taken to help them complete participation, including larger incentives, program management assistance, better financing, and providing more information on contractors or measures. However, the vast majority stated that there was nothing more that the program could have done.

Program dropouts were likely to report that they had been very or somewhat satisfied with the program contractor and most dropouts stated that they were very or somewhat satisfied with the utility representatives if they remembered the interaction.

Additional Research:

The research found that the following opportunities for additional study may provide important information for the program managers. We would recommend that additional research be conducted through in-person focus groups rather than through surveys because of the difficulty of locating knowledgeable respondents and the low study participation rate by nonparticipants and dropouts. If a broader survey effort is pursued in the future, it should use significant incentives to encourage participation in the survey and explore other methods to obtain response from this challenging population.

Focus groups could potentially provide valuable information in the following areas.

- Exploration of which aspects of project financials are most important to customers.
- What, if anything, programs can do to help drop-outs move forward with their projects.
- Financing features that would be most attractive.
- Importance of internal versus external capital.
- How responses about C-PACE offerings relate to knowledge of this new concept.
- Packages of program interventions needed to overcome the multiple barriers to adopting energy efficiency.
- Additional probing on market barriers.
- Importance of non-energy benefits.

Information from this market research suggests that future process evaluation of the C&I programs should assess the program in view of the complicated mix of barriers and opportunities found. Some of the likely researchable process evaluation questions could include the following.

- What elements in the C&I program are available for each of the barriers expressed by non-participants? What resources are available to be packaged to meet each customer's mix of needs?
- How do the initial interaction with the customers, or outreach activities, allow for identification of the multiple barriers that the customer is facing?

- Is the program sufficiently staffed with the right skill sets to identify and package efforts to address multiple barriers found with most C&I customers?
- What level of effort for designing different packages of education, targeted technical assistance or analysis, cash incentives, financing assistance in contracting, quality assurance and other services can achieve near maximum cost-effective energy savings?

See full report at:

<http://www.energizect.com/your-town/barriers-ci-program-participation-c11-final-report-4-15-15>

C17- Connecticut Commercial & Industrial Research

The Executive Summary of this report is reproduced on the following pages.

See the full report at:

<http://www.energizect.com/your-town/ct-ci-market-research-c17-final-report-8-28-15>

Executive Summary

C17: Connecticut Commercial and Industrial (C&I) Market Research The Connecticut Energy Efficiency Board (EEB) Evaluation Committee commissioned market research in 2014 and 2015 to support the goals of the Connecticut Energy Efficiency Fund Commercial and Industrial (C&I) programs. The overall objective of this research was to provide detailed market research regarding four end use categories to the EEB, the EEB Evaluation and C&I Committees, and the Program Administrators. This market research was designed to support targeted and effective strategies to bring about broad and deep energy efficiency savings. This research included an analysis of existing data as well as the collection and analysis of primary data from manufacturers and distributors.

This study addressed the following research questions:

- What are the **four largest 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 (i.e., size, market actor characteristics, supply chain characteristics, effective marketing channels, and saturation of energy efficient equipment)?

Methods

To address the research questions, the research team used **three complementary phases of data collection and analysis**: (1) a review of customer data from C&I customers in CT, (2) a literature review of secondary data sources, and (3) in-depth interviews with manufacturers and distributors. Originally, this study included surveys with contractors/plumbers and surveys with customers. These latter activities were cancelled and this report is the final wrap-up report for this study.



Research Objectives Mapped to Data Collection Activity:

Research Objective	Customer Data Review	Secondary Data Review	Manufacturer and Distributor Interviews
Four most important end-use markets	X	X	
Size of the overall market		X	X
Market actor characteristics		X	X
Supply chain characteristics		X	X
Effective marketing channels identification			X
Saturation of current market in terms of energy efficiency		X	X

Initially, this study also included not just the secondary data review and market actor interviews, but also surveys with market actors and surveys with customers. Collectively, these tasks were part of a systems approach to this study, whereby data from multiple sources would be combined to form a complete picture of the market. Multiple sources can provide confirmation of findings or identify if there is a difference of expert opinion, suggesting that a finding should be changed or qualified. Because this study only had one source of primary data collection, we were unable to make these comparisons to form a complete picture of the market. Nevertheless, several key findings emerged.

Executive Summary (continued)

Key Findings*

Lighting



- 1. The supply chain for lighting is changing.** Traditionally, a limited number of large lighting manufacturers have dominated the market; however, the growing demand for LEDs has disrupted the traditional supply chain, and new lighting manufacturers are entering the marketplace.
- 2. Lighting designers (e.g., architects and engineers) heavily influence purchasing decisions.** This influence is exacerbated by the fact that customers tend to buy exact replacements of existing lamps.
- 3. Market adoption for LEDs is rapidly increasing.** While the DDE estimates that 42% of commercial sales and 26% of industrial sales will be LED by 2020, *Frederonia forecasted the LED share to reach closer to 65% of commercial energy efficient lighting sales nationwide by 2017* (including program and non-program states). **Manufacturers and distributors reported current CT LED sales at roughly 50% of the commercial market.** One interviewee reported that **industrial LED sales may be even higher** given LEDs being used for high and low bay lighting. When asked about sales in CT going forward, these interviewees stated **LED sales would be 60-90% of CT lighting sales by November 2015, and one interviewee stated LEDs would be 100% of C&I lighting sales by 2017.**
- 4. While lamp sales are expected to decline, sales of lighting fixtures are expected to increase.** Lamp sales are expected to decline as more efficient lamps are installed, because these generally need to be replaced less frequently. The fixture market, on the other hand, is expected to continue to grow as the new construction market expands.
- 5. Interviewees attributed the majority of current LED sales to rebate programs.** Interviewees cited direct relationships between LED sales and rebate levels throughout the country.
- 6. Ensuring that incentivized products meet product quality standards is very important.** Customers' first impressions have a great deal of influence on the market adoption of new technologies. Incenting subpar products could lead customers to avoid efficient lighting in the future, or to associate poor products with the utilities.
- 7. A small proportion of residential incentivized bulbs are likely being sold out of state by a few small businesses (not participants or lighting retailers).** Two (of 13) lighting manufacturer/distributor interviewees described instances that could undermine the lighting programs. One described finding contractors coming from other states going store to store buying the maximum incentivized bulbs to sell outside CT. Another interviewee noted that a lack of coordination between the residential and commercial lighting program incentives may be driving some businesses to purchase residential (program-incented) bulbs from big box retailers rather than purchasing C&I incentivized bulbs from CT-based mid-market firms.

Gas Space Heating



- 1. While some portions of the space heating market are changing rapidly, other portions have not changed substantially in the past few decades.** In some cases, gas heating systems are being replaced by electric heat pumps, which have become increasingly popular. Meanwhile, the average efficiency of the combustion component of most packaged rooftop units has not changed significantly.
- 2. The integration of controls provides an opportunity for efficiency gains with gas space heating equipment.** Looking beyond the energy efficiency of the equipment itself, the importance of the control and operation of the equipment emerged as an important concern by interviewees.
- 3. Interviewees generally agreed that utility programs have a great deal of influence on purchase decisions in the nonresidential gas space heating market.** Several interviewees remarked that most end users would not purchase energy efficient equipment without rebates or other incentives.

Motors



- 1. Major future gains in motor-driven equipment efficiency will come through optimized system design and implementation.** Therefore, future opportunities lie in optimizing the efficiency of the system as a whole as it performs mechanical work.
- 2. Service shops are likely in the best position to influence the efficiency of those motors that are simply being repaired or replaced by industrial customers.** It is important to ensure that these service shops are employing best practices for restoring motors to efficient levels.
- 3. Because motors standards are at maximum efficiency, utility incentives should focus on optimizing motor-driven systems.** This could be accomplished by conducting system-wide audits, providing incentives for systems optimization engineering design, incorporating controls and variable speed drives, optimizing pump or fan sizing, optimizing controls, and through other opportunities.

Refrigeration



- 1. The refrigeration market is concentrated with a few large manufacturers.** These manufacturers account for a majority of sales. Distributors often carry multiple brands of equipment and operate on a regional scale.
- 2. The flow of equipment through the refrigeration supply chain varies based on submarket category (e.g., supermarket, restaurant, retail).** The supply chain varies by end-use customer segment with different product categories for each segment.
- 3. There will continue to be an opportunity to upgrade standard efficiency refrigeration equipment with models that are more efficient, given a market emphasis on repair rather than replacement.** New standards for commercial refrigeration equipment are set to take effect in March of 2017, but the market is expected to see the largest growth in sales of refrigeration parts rather than new equipment. This presents an opportunity for efficiency programs.
- 4. Product availability and price are critical factors in customer decisions about upgrades and replacements for refrigeration equipment, especially for restaurants.** Increasing the availability of energy efficient equipment options could help to address concerns of immediate replacement needs, and rebates for more efficient models could help to offset the increased costs.

Remaining Questions*

- 1. Due to the importance of C&I lighting savings to the portfolio, additional research is warranted to verify and track that the market share of LEDs for C&I buildings may be 100%, or close to that, by 2020 (potentially reducing or ending the opportunity to obtain C&I lighting savings).**
- 2. Research is needed to examine opportunities for efficiency gains from motor-driven systems upgrades among industrial customers.** Unfortunately, this study was cancelled prior to collecting any data from contractors or customers that could have provided this information.
- 3. This research study was originally planned as a comprehensive study to include surveys with contractors, vendors, and C&I customers to understand what are the best leverage points, messages, and strategies for different types of energy efficient equipment, systems, and operation.** The study was cancelled prior to undertaking this primary data collection and could not answer the related research questions.

*Abbreviated. See report for full text of Key Findings and Remaining Questions.



ES-2

C19- Commercial & Industrial New Construction Baseline and Code Compliance Study

Background and Objectives:

The 2014 – 2016 Evaluation Plan (the Plan) of the Connecticut (CT) Energy Efficiency Board's (EEB) Evaluation Committee for the EnergizeCT energy efficiency programs proposed a study to investigate commercial and industrial (C&I) new construction practices, specifically identifying the value of improving the accuracy of the baseline used to calculate savings estimates. Increased accuracy of baseline inputs reduces the probability of under- or over-investment in energy infrastructure, inaccurate evaluation of utility programs, and ineffective program dollars. A secondary objective of this study is to produce a rough estimate of the level of compliance with energy components of the state building code in effect at the time of construction. Inclusion of this objective in the study was based in part on the State's obligation to evaluate code compliance under the terms of a federal grant and the overlap of data requirements which permits an efficient use of evaluation dollars.

The first step in this research was to inventory energy-using systems and equipment at a statistically selected sample of 45 recently constructed commercial and industrial sites. To the extent possible without intrusive investigation methods, the baseline study collected data to support analysis of code compliance at the building level by use of COMcheck™, the US Department of Energy compliance tool. Since many of the values required by COMcheck are not observable in finished construction without intrusive investigation, the evaluation contractor⁴ acquired and reviewed construction documents to supplement the onsite investigation.

Approach/Methods:

This section provides a short summary of the methodologies used in the study grouped into three phases; setup, data collection, and analysis. These phases and the activities performed therein are presented in the following image.

Figure 2-1: Methodology Overview



The project setup phase included identifying and acquiring the population data, designing the sample, developing recruiting and data collection tools, and extensive training, as summarized below:

- **Population Data.** Connecticut C&I new construction data was purchased from Dodge Data and Analytics.

⁴ DNV GL- Energy, operating as KEMA, Inc. served as the evaluation contractor for this study.

- **Sample Design.** The new construction population data was extensively reviewed and cleaned to limit it to those entries reasonably expected to meet the following criteria; 1) C&I new construction during the 2010 – 2014 time frame; 2) required to meet IECC 2006 or 2009 energy code requirements; 3) containing complete data, in particular contact information and building size. The resulting sample frame of 1,014 buildings was divided into five strata defined as by the U.S. Department of Energy’s Building Energy Codes Program (BECP) and randomized.
- **Recruiting Tool.** The evaluation contractor’s Excel-based recruiting tool was modified for this project. It incorporated the following features: the sample frame; stratification quotas; a survey to confirm information accuracy and eligibility; and tracking capabilities.
- **Data Collection Tool.** The data requirements for the two primary objectives (baseline energy efficiency of installed measures and rating of energy code compliance) of the study were not identical. An extensive review of the data requirements of COMcheck and PSD measure inputs of interest in the baseline effort was conducted. Then the evaluation contractor’s iPad based-data collection tool was adapted to meet both objectives.
- **Training.** A two-day training for field and recruiting staff addressed project objectives, customer contact protocols, safety, data collection, and exception handling.

Tools and protocols were monitored throughout project implementation by the project manager and the project sponsor and modified as necessary.

The data collection phase of the study included the recruiting of sample sites, site visits, acquisition of construction documents, data entry and quality control, and issuance of incentives.

- **Recruiting.** Trained recruiters contacted potential study participants with information about the study and the incentive, confirmed willingness to permit a site visit, asked about the availability of construction document(s), confirmed contact information, recorded the customer’s preferred time for the site visit, if provided, and passed this information on to field engineers who performed final scheduling. If requested, the recruiters provided study participants with a validation letter with contact information for a representative at their utility.
- **Site Visits.** Field engineers performed a thorough walk through inventory of all energy using equipment and systems subject to energy code requirements, administered a brief survey with the site representative to collect additional information (e.g., past participation in EnergizeCT programs), and attempted to acquire or review construction documents.
- **Document Acquisition.** If construction documents were not available during the site visit efforts the researchers attempted to acquire them through other channels.
- **Data Entry.** Analysts reviewed data collected in iPad forms, field engineer notes, and photographs to prepare comprehensive site-level data files, supplementing field collected data with additional research as appropriate (e.g., determining equipment efficiency based on manufacturer model number).
- **Incentive Payment.** The field engineers processed incentive request forms signed by study participants and sent out incentives.

Analysis:

The project design required two distinct analytic approaches. One approach was necessary to determine the level of code compliance among the buildings in the sample while the other was to estimate baseline energy efficiency for each building system, particularly those covered by the PSD. The analytic process followed a linear path as mapped out below:

- **Data Quality Control (QC).** Due to the extensive range of measures and systems covered by COMcheck™ and its rigorous data requirements, study analysts entering site level data into the tool also performed data quality analysis.
- **Data Revision and Finalization.** Gaps or errors discovered during QC were addressed either through follow up calls with personnel at sample sites, additional research of publically available data, direct contact with equipment manufacturers, or based on professional judgment supported by observations. The site level data files then were reviewed by a second individual and finalized.
- **Sample Code Compliance.** Code compliance was determined through the application of the USDOE’s COMcheck™ (version 4.0.0.2) software. Site level data was entered into the package and the analysis run. The results of the analysis were reviewed by a second engineer for validity and completeness. In some cases data revision resulted in a second run. Once the COMcheck™ analysis was finalized, the site data file was ready for measure level analysis.
- **Population Code Compliance.** Sample level code compliance was expanded using case weights to determine overall code compliance, code compliance by strata, and code compliance by other factors where sufficient sample size existed. In addition, levels of code compliance for lighting and mechanical systems were independently determined and weighted as appropriate.
- **Sample Measure-level Analysis.** The evaluation contractor aggregated site level measure data across the sample while maintaining the ability to differentiate by sample stratification and other indices where sufficient sample existed. The sample values were weighted as appropriate and the resulting values were summarized and compared to the existing entries in the PSD.

Findings:

The findings of this study are:

Compliance with energy efficiency code requirements for commercial and industrial new construction buildings permitted between 2010 and 2013 was estimated at 75% of the population when reasonable assumptions were used for missing data points and the sample was weighted by strata counts. The average efficiency of equipment in the sample subject to PSD requirements was generally higher than the current code requirements and most often in the range of the requirements of the latest version of the most widely referenced commercial and industrial energy efficiency code (ASHRAE 90.1), specifically:

- **Lighting** – The energy use of for illumination was 30% below the upper limit set by code.
- **Air conditioning** – The average rated efficiency in all capacity bins exceeded the requirements of the PSD and were close to the requirements of ASHRAE 90.1-2013 (referenced as “ASHRAE 2013”) for the majority of capacity bins.
- **Air source heat pumps** – The average efficiency exceeded code requirements.
- **Water source heat pumps** – The average efficiency exceeded current and ASHRAE 2013 requirements.
- **Combustion heating equipment** – The average efficiency of all types exceeded code requirements.
- **Domestic hot water equipment** – The average efficiency of all types exceeded current code requirements and was close to ASHRAE 2013 requirements.

Recommendations:

The researchers offer the following recommendations as supported by the data and analysis:

- That utility program administrators should consider raising baselines for energy efficiency measures supported by the program based on their review of these findings and where appropriate;
- That there is substantial opportunity for light emitting diode (LED) lighting among the sample that we note are already supported by the programs;
- That there is substantial opportunity for automated lighting control measures among the sample that we note are already supported by the programs; and,
- That the application of instantaneous gas-fired boilers for dual purposes (domestic hot water and space heat) be examined and considered for inclusion in the PSD.

The researchers also offer suggestions for an anticipated 2017 study of building energy code compliance related to sample recruitment and data collection. These address the issues of:

- Identifying the population of newly constructed buildings by building a population dataset from multiple sources, potentially including direct outreach to jurisdictional code officials;
- Identifying qualified contacts at potential sample sites and increasing enrollment rate through additional outreach efforts coordinated with the utilities and modification of the incentive structure for sampled sites; and
- Acquisition of complete data either by incorporating site visits during several stages of construction or pre-screening to limit site visits to those where construction documents provide all necessary data points.

See full report at:

http://www.energizect.com/sites/default/files/C%26I%20New%20Construction%20Baseline%20and%20Code%20Compliance%20Study%20%28C19%29%2C%20Final%20Report_11-6-15_0.pdf

C20- Energy Conscious Blueprint (ECB) Impact and Process Evaluation

C20 – ECB Impact Evaluation Report

Objectives and Principal Outcomes:

This report presents the outcomes of the evaluation of Connecticut’s 2012-2013 Energy Conscious Blueprint (ECB) Program. The evaluation contractor team (hereafter referred to as “the evaluation team”), led by EMI Consulting, designed this evaluation in collaboration with the Connecticut Consultant to the Energy Efficiency Board (EEB) Evaluation Committee.

Per the 2012 Conservation and Load Management Plan, the objective of the ECB program is “to maximize electric and natural gas energy savings for ‘lost opportunity’ projects, at the time of initial construction/major renovation, or when equipment needs to be replaced or added.”

Program stakeholders, including the EEB and the Program Administrators (PAs), are prioritizing this evaluation because a significant portion of the EEB program portfolio savings is attributed to the ECB program: 13% of energy savings for electricity and 28% for natural gas.¹ This impact evaluation verifies the savings claimed by the ECB program; reducing savings uncertainty and planning risk, and provides current information to assess needed changes to the Program Savings Document (PSD) that guides reported energy and demand savings.

The overall objective of this impact evaluation was to estimate the energy saved by the program (both electricity and natural gas) and the reduction in electrical peak demand. The impact evaluation emphasized high impact measures that account for a majority of the program savings; therefore representing the greatest aggregate risk in regards to progress toward energy savings and demand reduction goals. The evaluation research achieved the following overarching objectives:

- Evaluate the savings impacts of electric and natural gas projects to produce overall, statewide savings realization rates, relative to both gross and net savings estimates claimed from the program period beginning on January 1, 2012 and continuing through October 31, 2013;
- Characterize non-energy impacts as reported by participants;
- Calculate and recommend “forward-looking” overall realization rates using the 2015 Program Savings Document (PSD);
- Assess the accuracy of methods used by vendors in estimating savings for complex
- “custom” projects and recommend changes, if needed; and
- Undertake a pilot study to ascertain market baseline efficiencies for HVAC and lighting equipment installed by HVAC and lighting vendors in Connecticut through vendor surveys.

Impact Evaluation Methods:

The evaluation team used on-site measurement and verification (M&V) for a representative sample of projects as the primary method of data collection and to develop ex post (evaluated) savings estimates.⁵ Field staff visited participant sites to conduct interviews, measure key assumed inputs, and meter long-term usage patterns.

⁵ “Ex post” refers to the evaluated or measured savings estimate.

To complete the impact evaluation, the evaluation team first compared estimated evaluated savings values to reported savings values (estimated savings prior to evaluation) to determine realization rates for each sampled measure.⁶ Next, the team weighted and aggregated these measure-by-measure realization rates to create an overall, program-level realization rate. Finally, the evaluation team calculated forward-looking realization rates using assumptions in the 2015 PSD, as opposed to the 2012-2013 version of the PSD.

Realization rates are the most critical output from an impact evaluation for the following reasons:

1. An estimate of the evaluated savings can be obtained from the program period of interest, or any more current year, where the program’s methodology for estimating savings has not changed substantially. This is achieved by multiplying the program’s claimed/tracking system estimate of savings by the realization rate from the evaluation.
2. The realization rate provides information on how well the program is estimating savings, and it helps to identify areas where the program could improve or should investigate methods and assumptions used in estimating measure-level, measure category-level, and program-level savings claims.
3. Targeting the realization rate, rather than absolute savings estimates, reduces variability influenced by the magnitude of savings, facility type, or scope of measure. This approach also allows sampling to be accomplished in a more efficient and cost-effective manner.

Impact Evaluation Results:

The ECB program impact evaluation results presented in this report are based on a sample of 189 measures; 146 of these were electric measures and 43 were natural gas measures. The individual measure populations for each measure grouping are provided in Table 2-1. Table 2-2, Table 2-3, and Table 2-4 in this section summarize the impact evaluation’s principal findings, comparing ex post (evaluated) savings estimates to reported (utility program tracking system) savings estimates. Greater detail on adjustments made to the savings based on evaluation findings are provided in Section 4 of the complete report.

Table 2-1. Reported Annual Energy Savings by Measure Category and Corresponding Sample Points

Measure “Group”	Measures in Population	Population Energy Savings (mWh or Therms)	Sampled Measures	Proportion of Savings Sampled
Compressed Air	275	23,217	26	51%
HVAC	872	14,179	57	25%
Lighting	318	19,554	32	33%
Process	218	14,367	21	31%
High Performance Building (HPBD)/ Other	50	4,569	10	77%

⁶ “Reported” refers to the savings estimate when the project was completed; this is the value in the tracking data.

Overall Electric Savings	1,733	75,855	146	39%
Gas - Boiler	131	346,682	17	31%
Gas - Other	158	631,733	26	67%
Overall Gas Savings	289	978,415	43	54%

Table 2-2 provides a summary of the annual energy savings for the 2012-2013 ECB program. The aggregate, weighted electric energy realization rate is 84% with relative precision of $\pm 21\%$ at the 90% confidence level, while the gas energy realization rate is 78%, with relative precision of $\pm 15\%$. The forward-looking realization rates are also included, showing what the realization rates would have been if the reported calculations had been performed using the 2015 PSD. Only lighting realization rates changed, leading to a change for the overall electric realization rate. For overall annual energy savings, it is customary to target $\pm 10\%$ relative precision at the 90% confidence interval in Connecticut energy efficiency program evaluations. The impact evaluation for the 2012-2013 ECB program did not meet this goal for program-level electric or gas energy savings. The target at the measure category level was $\pm 20\%$ at the 90% confidence level, which was achieved for four of the five electric measure groups (Compressed Air, HVAC, Lighting, and HPBD/Other) and both of the gas measure groups (Gas-Boiler and Gas-Other). The precision of the impact findings is generally lower than the target as a result of very high variability in measure-specific realization rates, which were much higher than anticipated in the sample designs.

Table 2-2. Energy Conscious Blueprint Program Energy Savings – Program Period Jan 2012 through Oct 2013

Measure Group	Reported (mWh or Therms)	Evaluated (mWh or Therms)	Weighted Realization Rate	Rel. Prec. (90% Confidence)	Forward Looking Realization Rate
Compressed Air	23,217	11,376	49%	$\pm 18\%$	49%
HVAC	14,179	12,052	85%	$\pm 22\%$	85%
Lighting	19,554	21,510	110%	$\pm 20\%$	116%
Process	14,367	14,654	102%	$\pm 25\%$	102%
HPBD/Other	4,569	4,386	96%	$\pm 18\%$	96%
Electric Overall	75,885	63,978	84%	$\pm 21\%$	86%
Gas-Boiler	346,682	332,815	96%	$\pm 14\%$	96%
Gas-Other	631,733	429,578	68%	$\pm 15\%$	68%
Gas Overall	978,415	762,393	78%	$\pm 15\%$	78%

Table 2-3 presents a similar summary of summer peak demand impacts for electric projects. The electric summer seasonal demand weighted realization rate is 85% with a relative precision of $\pm 20\%$ at the 80% confidence level. For demand reduction values, sampling must achieve statistical accuracy and precision of no less than 80% confidence level and $\pm 10\%$ relative precision (80/10) in order to comply with ISO

New England’s M-MVDR. As with electric energy savings, high variability in measure-specific realization rates prevented the evaluation team from meeting this objective with summer demand realization rates for each measure group and at the overall program level. This is driven in part by a number of entries of “zero” in the Companies’ tracking databases for summer demand savings, which was the case for 20 of the 146 measures evaluated. Project measure-specific realization rates for summer seasonal demand impacts were highly variable ranging from -104% to 1157%.⁷

Table 2-3. Energy Conscious Blueprint Program Summer Demand Savings – Program Period Jan 2012 through Oct 2013

Measure Group	Reported (MW)	Evaluated (MW)	Weighted Realization Rate	Rel. Prec. (80% Confidence)	Forward Looking Realization Rate
Compressed Air	2.997	1.648	55%	± 11%	55%
HVAC	4.069	2.685	66%	± 20%	66%
Light	3.708	4.227	114%	± 16%	121%
Process	2.707	2.842	105%	± 35%	105%
HPBD/Other	0.584	0.572	98%	± 22%	98%
Electric Overall	14.064	11.975	85%	± 20%	87%

The relative precision reported in Table 2-3 is based on a two-tailed hypothesis test. Using this test, the relative precision represents the band around the mean (both positive and negative) where the actual value is likely to be in the population. The real concern with the precision of energy savings is that the actual value could be lower than the evaluated value. There is less concern if actual savings are higher than the evaluated value. Therefore, a one-tailed test that indicates the probability that the actual savings are lower than the evaluated savings is what is most critical. Using the one-tailed test we can report with 80% confidence that the actual summer seasonal demand savings could be up to 10% lower than the evaluated value (80% confidence/10% relative precision). **That is, we can say with 80% confidence that the actual realization rate is not less than 75%, given our evaluated realization rate of 85%.**

Table 2-4 summarizes the winter peak demand impacts. The electric winter seasonal demand realization rate is 90% with relative precision of ±25% at the 80% confidence level. Once again, as a result of high variability in measure-specific realization rates, which was driven in part by several entries of “zero” in

⁷ The negative realization rate (-104%) is for a measure with 50 kW reported summer seasonal peak demand savings that actually had increased summer seasonal peak demand of 52.09 kW as evaluated. The extraordinarily high realization rate is a project with 0 kW reported for summer seasonal peak demand savings that was evaluated to have 46.32 kW of summer seasonal demand savings. This measure is one where we replaced the assumed 0 kW with 1 kW in order to be able to meaningfully include it in the analysis (dividing by a reported value of 0 kW results in a realization rate of infinity). See Appendix F of the complete report for more details on treatment of negative and zero reported savings.

the Companies' tracking data where measureable winter demand savings were evaluated, winter demand realization rates do not achieve the M-MVDR objective for confidence and precision (80/10). In total, there were 52 measures (of 146) for which the reported winter seasonal demand values were zero or missing; of these, 17 were found to have non-zero evaluated winter seasonal demand values. Realization rates for winter seasonal demand impacts were highly variable ranging from -0.6% to 1137%.⁸

Table 2-4. Energy Conscious Blueprint Program Total Winter Demand Savings – Program Period Jan 2012 through Oct 2013

Measure Group	Reported (MW)	Evaluated (MW)	Weighted Realization Rate	Rel. Prec. (80% Confidence)	Forward Looking Realization Rate
Compressed Air	2.789	1.618	58%	± 11%	58%
HVAC	1.229	1.327	108%	± 36%	108%
Light	2.661	2.980	112%	± 20%	113%
Process	2.283	2.534	111%	± 41%	111%
HPBD/Other	0.805	0.362	45%	± 29%	45%
Electric Overall	9.768	8.822	90%	± 25%	91%

Similar to the summer demand savings, the relative precision reported in Table 1-4 is based on a two-tailed hypothesis test. Using the one-tailed test we can report with 80% confidence that the actual winter seasonal demand savings may be up to 13% lower than the evaluated savings (80% confidence/13% precision). That is, we can say with 80% confidence that the actual realization rate is not less than 77%, given evaluated realization rate of 90%. This still does not meet the requirements of the M-MVDR.

Recommendations/ Conclusions:

Based on these results, the evaluation team identified the following five main conclusions from this research.

1. In general, 2012-2013 ECB electric measures are performing well. However, costly calculation errors in reported savings analyses on some of the largest measures (in particular compressed air and HVAC measures) resulted in substantial downward adjustments to evaluated savings; ultimately driving down the measure group-level and overall program-level electric energy and demand savings realization rates. These errors ranged from simple math errors to failure to use prescriptive methodologies and assumptions from the Connecticut PSD. Documentation adjustments accounted for approximately 62.8% of all downward electric energy savings

⁸ The negative realization rate (-0.6%) is for a measure with 3.2 kW reported winter seasonal peak demand savings that actually had increased winter seasonal peak demand of 0.02 kW as evaluated. The extraordinarily high realization rate of 7989% is a project with 0 kW reported winter seasonal peak demand savings that was evaluated as having 79.89 kW of savings. This measure is one where we replaced the assumed 0 kW with 1 kW in order to be able to meaningfully include it in the analysis (dividing by a reported value of 0 kW results in a realization rate of infinity). See Appendix F in the full report for more details on treatment of negative and zero reported savings.

adjustments made. Documentation adjustments also accounted for approximately 50.6% of all downward electric demand savings adjustments and 39% of all downward gas energy savings adjustments. The combined effects of all downward documentation adjustments resulted in gross⁹ savings reductions of 10,590,853 kWh and 216,022 therms. Given the magnitude of these potentially avoidable adjustments, it is recommended that the program-administrator-engineering-review-process be adjusted in order to improve the accuracy and consistency of claimed savings estimates.

2. In order to streamline project qualification for Program Administrators and to facilitate ongoing evaluations, program participants should be required to submit program documentation in electronic form. In addition, as a condition for incentive payment, participants should be required to provide copies of all calculations in forms readily checked using computer-based tools without manual transcription.
3. Final building simulation files were excluded from the documentation provided for review for all five of the High Performance Building Design (HPBD) projects evaluated. In the absence of having the final simulation model for each site, the evaluation team was forced to develop its own building energy simulation model. This model was based upon project documentation and what information could be collected from the program participant as well as design architects and engineers involved on the project. The research team recommends that the program require participants to provide the final building simulation files that were used to calculate reported energy savings as a condition of payment for all future HPBD projects/measures.
4. The natural gas realization rates for energy were 78%. This difference is primarily driven by downward documentation and operational adjustments assessed on non-boiler projects (Gas-Other) resulting from baseline estimates that did not reflect previous site operations, simple mathematical errors in claimed savings estimates, and one project for which the amount of available process cooling was vastly overstated. The overall realization rate for Gas-Boiler energy was 96.2%; however, substantial off-setting documentation and operational adjustments were assessed on the projects evaluated and several recommendations have been made to improve upon the accuracy of claimed savings for the condensing boiler. These recommendations include a revision to the 2015 PSD assumptions used to estimate operating efficiency and enhancements to the existing program application form.
5. Future Energy Conscious Blueprint impact evaluations should use error ratios (*e.r.*) found in this study for all measure groups to ensure meeting the desired precision for electric energy and demand savings, as well as natural gas energy savings. The evaluation team found that the realization rates for projects in this program were highly variable. The evaluated *e.r.* values for the Compressed Air, HVAC, HPBD/Other, and Process measure groups were much higher than the a priori estimates of 0.5. The evaluation team recommends for future studies adjusting these *e.r.* values to those found in this evaluation. Such an adjustment will result in a greater emphasis on non- lighting project sites, which have higher variability.

See full report at:

http://www.energizect.com/sites/default/files/ECB%20Impact%20Evaluation%20%28C20%29%20Final%20Report%2C%2011-6-15_0.pdf

⁹ Net reduction in savings from upward and downward documentation adjustments for electric energy was approximately -9,916,727 kWh.

C20 – ECB Process Evaluation Report

Objectives and Principal Outcomes:

The objective of the Energy Conscious Blueprint (ECB) program is “to maximize electric and natural gas energy savings for ‘lost opportunity’ projects, at the time of initial construction/major renovation, or when equipment needs to be replaced or added.”¹⁰ The ECB program seeks to accomplish this by working with new construction trade allies (e.g., contractors, architects, engineering firms) to raise awareness of energy efficient technologies and whole-building design practices and assist these allies in illustrating the benefits of energy efficiency during initial construction to property developers and owners. The program also provides incentives to building owners for incorporating energy efficient equipment into building design or for using energy efficient equipment to replace equipment at the end of its usable life.

The objectives of this evaluation were to assess the program’s effectiveness in reaching its target market, assess participant and vendor satisfaction with the program, and identify barriers that could inhibit the program from achieving its goals.

Program Activity Summary:

During the sample period from April 2013 to April 2014, program participants achieved over 136,000 MMBtu in annual energy savings from 420 projects and 751 individual measures. New construction projects accounted for one quarter of projects and 37% of energy savings in the period. Process, lighting, and heating measures comprised the majority of ECB program savings, while cooling measures comprised the greatest number of measures. Heating, process, and lighting measures had the greatest average per-measure savings.

Process Evaluation Methods:

The process evaluation was based on analysis of program tracking data, surveys of 70 program participants, 13 program dropouts, and 41 vendors working with the program, and interviews with 10 non-participating customers or “rejecters.” The process evaluation also included web usability testing with 18 vendors and participants to assess how the website meets the needs of program stakeholders.

Results:

Results from the process evaluation indicated that the ECB program is functioning smoothly for participants and vendors. Participants in particular demonstrated high satisfaction with the program. Vendors partnering with the program appear to drive most equipment replacement projects through their marketing efforts, while utility and program staff appear to be the impetus behind many new construction and major renovation projects. Many vendors rely on the ECB program for a quarter or more of their business, and some requested additional support and greater responsiveness from program staff.

Customers rely on utility and program staff to learn how to participate, and vendors rely on utility and program staff to answer questions. Participating customers, dropout customers, and participating vendors all identified financial factors—lack of access to capital and financing—as barriers to completing projects.

¹⁰ Energize Connecticut 2012 Electric and Natural Gas Conservation and Load Management Plan.

Participants consult the utility websites to learn more information about the program but do not use it to figure out next steps to participate in the program. Participating vendors typically use the website to look up incentive information. The findings from web usability sessions indicate that although there is useful information on the Connecticut Light & Power and United Illuminating websites, it is challenging for both vendors and customers to find this information.

Recommendations:

Process evaluations serve a variety of purposes, including measuring key performance indicators such as satisfaction, documenting program logic and developments, and providing recommendations for program process improvements. The last of these may be the most important. It is increasingly accepted in the evaluation community that an evaluation should be judged on its usefulness, and recommendations encapsulate how findings from the evaluation can be used.¹¹

The evaluation team assembles recommendations based on the available primary and secondary data sources but in some cases, particularly in energy efficiency program evaluation, the team may have limited access to information necessary to assess the feasibility and cost-effectiveness of recommendations. The independent nature of these evaluations often means the evaluation activities occur separately from implementation and planning. In these circumstances, the evaluation recommendations should be considered potential program improvements that must be assessed by program planners to determine feasibility and cost. To be most useful to program managers, the evaluation typically provides a number of these suggestions, allowing program managers to select and prioritize among the suggestions. The details of how a recommendation would be implemented then become the responsibility of program planning.

The recommendations from this process evaluation are provided below. It is not yet known whether they are feasible or cost-effective to undertake:

1. **Promote awareness of financing sources for equipment replacement projects.** Dropout customers, participating customers, and vendors consistently identified financial factors as potential barriers to program participation. While some options are available for project financing for equipment replacement projects, these options could be more effectively communicated or expanded.
2. **Dedicate additional resources and/or develop tools to support vendors.** Vendors play a key role in promoting these programs, and while most vendors reported being satisfied they also indicated ways in which they desire more support from the utilities.
3. **Increase outreach efforts to individuals involved with new construction projects.** Awareness of the ECB program is low among some building owners, project managers, architects, and developers involved with new construction, and performing outreach to these parties, though time intensive, could help increase the number of new construction participants in the program.
4. **Verify that website changes have improved signposting to enable more effective webpage scanning.** Both utilities have new websites and the design of the energy efficiency webpages has

¹¹ Patton, M. (2008). Utilization-Focused Evaluation. Los Angeles, CA: Sage Publications.

changed considerably. Improving signposting was the primary critique of the prior websites from the web usability task in this evaluation. Both vendors and customers requested a more intuitive organizational structure within the prior websites, with the specific recommendation of using common program description titles so that they can quickly locate the information they need.

5. **Create synergies with Energy Opportunities (EO) Program.** The majority of equipment replacement participant respondents were not aware of the Energy Opportunities Program. The EO program and ECB program can be complementary and awareness of both programs should be promoted to customers and vendors.
6. **Provide data indicators to improve program evaluability.** Due to a bundling process during the data request, the evaluation team did not receive a number of key indicators that would improve evaluability of the program. The evaluation team asks that a number of specific indicators from the program tracking database (found in the full report's Recommendations chapter) be provided in future data requests to facilitate the tracking of performance indicators and to improve evaluability.

See full report at:

<http://www.energizect.com/your-town/ecb-process-evaluation-final-report>

2.2 Residential

R33- Observations & Recommendations from CT Residential Program Database Interviews

The purpose of this project was to document strategies that can improve the efficiencies of working with evaluation data from the Connecticut Companies, memorializing suggestions for both the Companies and for the evaluators. The project was conducted in three phases.¹² First, an internal review of challenges the evaluation team (NMR) have experienced working with Connecticut data from Eversource and United Illuminating (“the Companies”) were outlined, based on evaluation project experience over the last three years. Second, the evaluation team identified and proposed energy efficiency program administrators to interview for this study and compare against the Companies’ practices. Third, the team conducted interviews with Eversource and UI staff who are responsible for the Companies’ residential databases and for responding to our requests for data¹ to discuss interim findings and gather additional context and options. The Company interviews made it clear that the Companies are not in a position to establish completely new customer tracking systems, and as we explain in more detail below, many of the database issues the Team identified could be traced to difficulties of communication. The Team interviewed one other organization in addition to the Companies, a representative of the CPUC’s statewide IOU customer database.

In this report, we summarize key observations from the interviews and recommend solutions in light of the information gathered.

KEY OBSERVATIONS AND RECOMMENDATIONS

Clarifying data requests through the use of data dictionaries. The team found the variable names in the UI data to be unclear; that is for, some variables, the names did not clearly indicate to someone outside the program the type of data contained in field and the meanings of values, particularly ones that denote missing or imputed information.

Recommendation #1:

We recommend that the Evaluation Team work with the Connecticut Energy Efficiency Board (EEB) Evaluation Consultants and appropriate staff of both Companies to develop

- *Lists and descriptions of the information that are most commonly requested for (1) process evaluation and (2) impact evaluation. The lists should include the variable names under which each Company stores the information. The lists should also note what values are used to denote missing data for each variable and what special values might be found in each data field that could affect analysis. (For example, the information that an ID number of an Eversource HES or Multifamily participant that ends in -2 supersedes an ID number that ends in -1 but is otherwise identical.)*
- *Company-specific data request templates. The templates would be built on the lists of information and variable names described above. The purpose of the template would be to standardize data collection requests as much as possible.*

¹² The project was conducted by NMR, Inc.

We recommend that Eversource consider sharing its data dictionary with select UI staff to help UI staff in planning for a UI data dictionary.

- *Developing the UI-specific data request template should take UI much of the way toward putting together a data dictionary. We recommend that UI staff review Eversource’s data dictionary to assess what additional work would be needed to complete a UI data dictionary.*

Improving the tracking of measure-specific inputs and providing details regarding calculations.

Previously we have noted instances of missing measure-specific inputs and lack of details regarding calculations. In our conversations with the Companies about these instances, we found that the measure-specific inputs and calculations the evaluators thought were missing actually *do* exist in the databases. Had we communicated about the issues directly with the Companies’ staff who are responsible for the program databases, we most likely would have come to understand that the data were available and thus we would have been able to request and obtain this information in a manner more readily understood by the database managers.

In previous communications about data issues the team has suggested a need for data quality assurance checks. In their interviews the Companies described quality control processes to reduce data entry errors. To help reduce data entry errors, at both Companies HES field techs enter data on a handheld device. While HES-IE techs at both Companies still record data on paper, data entry by handheld device will soon be available for HES- IE as well.

Both UI and Eversource inspect a sample of program homes after measure installation. Errors in work or recording of data found in the inspections are corrected in the program database. How these are recorded varies by program and utility.

It appears to the team that the Companies have instituted some of the quality control measures that the team has suggested since 2011, but here are the current recommendations:

Recommendation #2:

- *Third-party evaluation staff, the EEB Evaluation Consultant, and Companies establish an expectation that each evaluation will include at least two formal meetings about data requests: (1) A meeting at the beginning of each evaluation for third party evaluation staff to communicate directly with designated Company program database staff. The purpose of this meeting would be for evaluators to learn in an efficient and timely fashion what relevant data are available for a study and provide them with the information they need to develop complete and clear data requests for the Companies. (2) A “data request kick-off meeting” promptly after the third-party evaluator delivers the data request for a project. The purpose of the data request kick-off meeting is to encourage detailed discussion of the intent of the data request, data format, and data terminology. Both meetings would include the EEB Evaluation Consultant.*
- *Oftentimes third-party evaluation staff have new questions once they begin cleaning or analyzing the data. These questions are typically time-sensitive. Once third-party evaluation staff and Company program database staff have had the data request kick-off meeting, the EEB consider allowing third-party evaluators and Company database staff to ask each other data-specific questions and provide data-related clarification as the need arises over the course of a study by*

phone and email without waiting for the EEB Evaluation Consultant to be available for these ad hoc communications.

- *During the evaluation planning stage, even before an evaluation one-page description is approved, the EEB consider allowing third-party evaluation staff and Company database staff to communicate about data in the presence of the EEC Consultant, as part of formal or informal assessments of the evaluability of particular questions or programs. Assessing a study's evaluability—including the data available that are relevant to the study—before approving work plans would help EEB spend evaluation funds more effectively. The EEB should set aside budget for these evaluability assessments to ensure that evaluators are paid for the exploratory work on projects ultimately deemed "not evaluable."*

Consistency between utility tracking systems for programs and measures. Team members have found what appear to be errors and inconsistencies within utility databases, and inconsistent data formats and terminologies between utility databases.

In the interviews the Companies noted that they already align units and terminology in their respective program databases with those that appear in the Program Savings Document (PSD), and thus with each other.

Within a Company, in some cases, the Companies may be able to make specific changes to a program database in response to a need identified by evaluators.

In the course of our conversations, the team found that some instances of what appeared to be inconsistency within or across data fields in one or the other Company's database were not inconsistencies—but the key to understanding them was not included with the data. Having the ability to communicate more readily with Company database staff about data-related questions as they arise in data analysis would help avoid future data misunderstandings.

Looking across Companies, the Companies noted that aligning other terminology—such as field names and codes for missing data, etc.—between the Companies' databases would be a difficult undertaking requiring management approval and complex and expensive reprogramming of their systems.

In California, the CPUC has addressed the issue of inconsistency among the billing databases of Pacific Gas & Electric, San Diego Gas & Electric, Southern California Edison, and Southern California Gas ("the IOUs") by establishing a statewide IOU customer database. Their system does not require the IOUs to make any changes in file format, naming convention, etc., but it does require that the CPUC hire a third-party data management company on a continued basis. The recommendation is as follows:

Recommendation #3:

- *The EEB and Companies may wish to explore establishing a statewide residential electric and gas customer billing and participation database similar to California's, to be managed by a third-party firm. This database would contain customer electric and gas use and program participation information. (For more details about California's database, see the section "California's Statewide Residential Customer Database.")*

Tracking of project data for multifamily buildings with consistent unit-level reporting. Previously the team identified issues of inconsistency unit-level data in multifamily buildings, primarily those in UI data. UI is exploring ways to match up all the units and commercial spaces within a single multifamily building, regardless of fuel type. Matching meters serving a particular building should facilitate grouping project numbers associated with particular buildings.

Accurate tracking of both electric and gas account numbers. Previously the team identified issues in the UI data with incomplete or inaccurate unit number and address information. It appears that since then, UI has addressed the issues, and there does not seem to be need for further action. UI has been working with auditors to improve the quality of the gas account information they collect, UI began to assign a unique project IDs, and UI began requiring vendors to use the Eversource project numbers. This is expected to alleviate difficulties matching electric and gas account data on projects served by these utilities.

See full report at:

http://www.energizect.com/sites/default/files/Observations_Recommendations_CT%20Resi%20Pgm%20Database%20Interviews%20%28R33%29%20-%20Final%20Report%2C%201.26.16.pdf

R84- Consumer Electronics and Potential Study

Introduction

To identify the potential for a residential consumer electronics program in Connecticut, the Energy Efficiency Board (EEB) requested that the evaluation team (NMR Group, Inc.) review relevant literature to assess the savings opportunities for the consumer electronics market. Currently, neither the United Illuminating Company (UI) nor Connecticut Light and Power (CL&P, a Northeast Utilities Company) (collectively referred to as the Companies) administers a consumer electronics energy efficiency incentive program.¹³

The primary objective of this literature review is to report estimated potential energy savings associated with consumer electronics measures. The report also includes some broad findings of how the consumer electronics market's dynamics might impact the effectiveness of program implementation.

The study focuses on consumer electronics product categories that, in 2013, represented the greatest source of potential savings from consumer electronics. Together, five product categories represent three-quarters of the total US residential energy consumption of consumer electronics: televisions (TVs), set-top boxes¹⁴ (STBs), personal computers (PCs), network equipment,¹⁵ and video game consoles (game consoles).¹⁶

The consumer electronics market is challenging to track, given the rapid development of new technologies and evolving consumer demands. As a result, some of the material presented here may become obsolete in the near term. The team attempted to limit the review only to literature published after 2011.¹⁷

In 2013, residential consumer electronics consumed 169 TWh or 12% of total residential electricity consumption for the US. Together, five product categories represent three-quarters of the total US

¹³ The Companies' current efforts for consumer electronics include guidance on the Energize Connecticut Website to visit TopTen's Website for listings of the most energy-efficient products (these include televisions, displays, and personal computers). While not formally announced, the TopTen program is expected to draw to a close in the near future so program efforts will need to be revised. *Source:* Energize Connecticut. "ENERGY STAR Retail Products: Save with ENERGY STAR Products." Accessed July 2, 2014.

<http://energizect.com/residents/programs/energy-star%C2%AE-appliances>.

¹⁴ STBs are devices whose primary function is to receive TV signals so that programs can be watched or recorded. STBs vary in type and functionality: cable, satellite, internet-protocol, media streaming, smart TV equipment, etc.

¹⁵ Residential network equipment generally refers to two primary equipment types: 1) broadband access devices, which connect subscribers with high-speed internet, and 2) local area network (LAN) devices, such as routers, that allow consumer electronics within the household to communicate with each other.

¹⁶ Fraunhofer USA Center for Sustainable Energy Systems (Fraunhofer). "Energy Consumption of Consumer Electronics in U.S. Homes in 2013." June 2014.

¹⁷ One study was published in 2010; the team used this publication due to an absence of more recent data on the topic.

residential energy consumption of consumer electronics: televisions (TVs), set-top boxes (STBs),¹⁷ personal computers (PCs), network equipment,¹⁸ and video game consoles (game consoles).¹⁹

Methodology

From June through September of 2014, NMR collected and analyzed existing literature that addressed the residential consumer electronics energy efficiency market. This literature review helps to identify the potential for a residential consumer electronics program in Connecticut. It is the first step in exploring the program and energy savings potential from consumer electronics in Connecticut.

By conducting a literature review, NMR sought to achieve the following objectives:

- To identify current factors affecting the energy efficiency of residential consumer electronics products and related savings opportunities
- To offer broad details characterizing, to some extent, the current state of the consumer electronics market—in particular for the products that account for the greatest proportions of residential electricity use
- To provide the EEB with recommendations on which products may make the strongest candidates for inclusion in a consumer electronics program, and possibly to suggest approaches for the design of a consumer electronics program in Connecticut
- To offer suggestions for a more detailed future consumer electronics potential study that will provide the EEB with greater detail on both program and energy savings potential from a possible consumer electronics program

To identify the potential for a residential consumer electronics program in Connecticut, NMR Group, Inc. (NMR) conducted a literature review for the Energy Efficiency Board (EEB).²⁰ To this end, NMR researched literature published between 2012 and 2014 and used this information to estimate potential energy savings associated with consumer electronics measures. In addition to reporting these findings, this report, to some extent, contextualizes the savings measures within the confines of market barriers that might affect willingness to participate, market trends that might increase chances of free ridership, and saturation rates that might limit the technical potential for a program to make an impact in the territory.

Findings

¹⁸ Residential network equipment generally refers to two primary equipment types: 1) broadband access devices, which connect subscribers with high-speed internet, and 2) local area network (LAN) devices, such as routers, that allow consumer electronics within the household to communicate with each other.

¹⁹ Fraunhofer USA Center for Sustainable Energy Systems (Fraunhofer). “Energy Consumption of Consumer Electronics in U.S. Homes in 2013.” June 2014.

²⁰ To date, neither the United Illuminating Company (UI) nor Connecticut Light and Power (CL&P, a Northeast Utilities Company) (collectively referred to as the Companies) administers a consumer electronics energy efficiency incentive program. The Companies’ current efforts for consumer electronics include guidance on the Energize Connecticut Website to visit TopTen USA’s (TopTen) Website for listings of the most energy-efficient products (these include televisions, displays, and personal computers). While not formally announced, the TopTen program is expected to draw to a close in the near future so program efforts drawing on it will need to be revised. *Source:* Energize Connecticut. “ENERGY STAR Retail Products: Save with ENERGY STAR Products.” Accessed July 2, 2014. <http://energizect.com/residents/programs/energy-star%20AE-appliances>.

Many of the findings suggest that the EEB may benefit from commissioning a more detailed consumer electronics potential study in the future. Ideally, a future study would provide greater detail on both program and energy savings potential through one of the following methods: 1) qualitative research involving activities such as in-depth interviews; 2) quantitative research, potentially using surveys with market actors, performing home site visits, or conducting secondary data analyses, if possible; or 3) both types of research.

NMR focused on the top five energy-consuming consumer electronics products (listed above) that could yield reasonably high per-unit or per-household energy savings. For each product category, the team found at least one measure that could be implemented in the near term. Some of the most promising measures and NMR's suggested considerations and recommendations related to these measures are as follows:

- **Televisions (TVs).** The team estimated that replacing older installed TV models with new “best-in-class” models could offer sizable savings over the installed base. Depending on size, upgrading to new ENERGY STAR® Most Efficient TVs could offer 38% savings in UEC when compared to standard new TV models (Section 3.2). If the EEB wishes to address TVs through a consumer electronics program, it might consider investigating the potential of offering TV recycling programs and incentives based on labels and recognition programs directed at end-users, retailers, and distributors. Because of high ENERGY STAR market penetration (Section **Error! Reference source not found.**), it may be preferable that models eligible for program incentives meet efficiency levels greater than ENERGY STAR's minimum specifications or leverage ENERGY STAR's Most Efficient list, which recognizes the highest efficiency TVs.
- **Set-top boxes (STBs).** The following two measures for reducing STB energy consumption stand out as potential near-term measures that do not require partnerships with groups like manufacturers or media service providers and appear realistic to implement: 1) Reconfiguring high-consuming multi-room STB configurations by replacing the non-primary devices with low-power thin-client devices that have the same functionality could potentially reduce annual UEC of those non-primary units by 52%; 2) Selecting ENERGY STAR models could offer savings of 45% over standard models (Section 3.3).²¹ NMR concludes that addressing STBs through end-user incentives, however, may be inappropriate due to certain market dynamics. First, on top of already high ENERGY STAR market penetration, an important voluntary agreement signed by media service providers will likely result in even higher market penetration of ENERGY STAR models (Section 2.3). Second, consumers may not be able to opt for energy-efficient STB models or engage in energy savings behaviors due to the level of control that media service providers have over STB model selection and time spent in off modes (Section 4.2).
- **Personal Computers (PCs).** NMR found that optimizing power management settings for the installed base of desktop PCs could possibly result in savings of 144 kWh/year among installed desktop PCs (Section 3.4) and, if successfully implemented in all households where the measure is not already implemented, it could have the technical potential to save 43.4 GWh/year in Connecticut as a whole (Section 4.3).²² If the EEB were to use this intervention, it might like to use consumer education campaigns on optimizing power management and/or use direct-

²¹ If the Companies have interest in pursuing this further, a potential next step could be to conduct interviews with media service providers operating in Connecticut to learn about the types of devices that they currently offer or provide.

²² The team emphasizes that achieving participation in 100% of households without the measure already implemented is an unrealistic scenario.

installation efforts, perhaps as part of a home energy audit visit for another program. However, some factors, such as decreasing desktop PC sales and increasing efficiency of laptop PCs, could present diminishing opportunities to claiming sizable program savings and achieving adequate participation rates for a PC program (Section 4.2).

- **Network Equipment.** Replacing the installed base of network equipment²³ with high efficiency equipment may generate notable savings (34%) (Section 3.5). Running equipment recycling opportunities and offering incentives based on labeling and recognition programs directed at end-users, retailers, and distributors could facilitate implementing this measure. Additional research characterizing common configurations and household usage patterns would offer further insight into savings opportunities at the household and state levels; further research on network equipment market trends would also be essential.
- **Video Game Consoles (Game Consoles).** NMR advises against offering incentives for the purchase and sale of energy-efficient models of game consoles. Program efforts targeting game consoles may quickly become obsolete, in part because there are few game console models and manufacturers; even if one manufacturer increases the efficiency of its only model, program efforts to incentivize the purchase of energy-efficient models could result in easy free ridership. As a near-term effort, game console efficiency might be addressed through consumer education campaigns. For example, measures to decrease the consumption of game consoles, such as disabling connected standby, could provide savings of up to 100 kWh/year (Section 3.6).

In addition to the measures listed above, it may be worth further exploring the savings opportunities that advanced power strips (APs) (also known as smart strips) could offer for each of these product categories. One study found that households could save 346 kWh/year, on average, by using highly sophisticated APs with their home entertainment equipment (Section 3.7).²⁴

NMR urges the EEB to take several influential factors into account in the process of considering or designing a consumer electronics program.

- First, while a measure might technically be able to reduce a product's energy consumption, it may be challenging to implement the measure given market dynamics. For example, the measure may have a limited appeal to market actors or may quickly become obsolete because of expected market changes.
- The EEB should keep abreast of changes in voluntary specifications and standards and factor them into any program-planning processes to reduce possibilities of free ridership and redundancy, increase savings opportunities, and streamline programs by leveraging specification structures.
- Staying informed of other relevant industry initiatives that could potentially be leveraged or could somehow diminish the importance or relevance of a potential program is also crucial to take into account in program planning. For example, during NMR's research, it came across an important collaborative effort between ENERGY STAR, program sponsors, retailers, and other

²³ Residential network equipment generally refers to two primary equipment types: 1) broadband access devices, which connect subscribers with high-speed internet, and 2) local area network (LAN) devices, such as routers, that allow consumer electronics within the household to communicate with each other.

²⁴ For more details, see <http://www.nyserda.ny.gov/-/media/Files/EERP/Residential/Energy-Efficient-and-ENERGY-STAR-Products/Power-Management-Research-Report.pdf>.

stakeholders called the Retail Plug-Load Portfolio (RPP). RPP seeks to establish a nationwide suite (or platform) of ENERGY STAR products around which to target incentives.²⁵

Researching these types of factors and staying informed could help drive decisions about which product categories to address and which measures are needed to address them.

Another essential area of future research may include a characterization of the consumer electronics equipment currently installed in Connecticut homes. The EEB may find it useful to conduct a saturation study in Connecticut like the one NMR conducted in Massachusetts²⁶ (Section 4.3) to help determine the technical potential savings for implementing measures that are estimated to yield high per-unit or per-household energy savings. This quantitative research could involve telephone surveys with customers or home site visits to collect data on characteristics like the number and types of units installed or in use in Connecticut homes.²⁷

While this report did not conduct direct research on program implementation methods, the EEB may wish to examine the program models currently employed by other program administrators if it wishes to move forward with consumer electronics. For example, one program in New York uses a direct installation method with APSs that it has found to be successful. Other program administrators have also been offering direct incentive opportunities. It is in the evaluation team's opinion that any program planning efforts in Connecticut would benefit from learning about the efforts of other programs.

See full report at:

<http://www.energizect.com/your-town/ct-consumer-electronics-potential-study-r84-final-report-2-25-15>

²⁵ For more information see www.caltf.org/s/RPP-overview-presentation_Updated-9-17-ro0t.pptx.

²⁶ In 2012, NMR conducted a consumer electronics saturation study for Massachusetts Program Administrators. For more details, see http://ma-eeac.org/wordpress/wp-content/uploads/Massachusetts-Residential-Retail-Products_Consumer-Electronics-Saturation.pdf.

²⁷ A research effort involving home site visits could potentially be performed in conjunction with another study that involves collecting data on household characteristics through home site visits, such as a socket saturation study.

R86- LED Lighting Market Assessment Study

Introduction

This report summarizes the tasks completed to assess the Connecticut (Connecticut) residential lighting market for light emitting diodes (LEDs) and to estimate net-to-gross (NTG) ratios for CFLs and LEDs for the Upstream Lighting Program. We discuss the evaluation methods used, the key research findings and takeaways, and the resulting NTG ratios estimated from relevant approaches. We also present a discussion of the relative strengths and limitations of these approaches in order to assist the Energy Efficiency Board (EEB) and Companies in determining the final NTG ratio to apply to the program and assessing program revisions for the 2016 to 2018 program cycle.

Study objectives and Approaches

The main objectives of the R86 LED Market Assessment and NTG Study were to understand consumer reactions to varying efficient bulb types and the Energy Independence and Security Act (EISA), to assess the residential LED market by describing current conditions and exploring future conditions, and to estimate NTG ratios for CFLs and LEDs. Table 2-5 provides a brief overview of the evaluation activities, which are fleshed out in the body of the report.

Table 2-5: Evaluation Overview

Activity	Summary of Approach
Demand Elasticity Modeling	Estimated the price elasticity of program lighting products with an assessment of sales without the program's incentive, thus providing a net-of-freeridership estimate.
POS Data Modeling (n=44 states)	Modeled the Connecticut program's impact on CFL and LED sales using sales data for 44 states over 5 years, along with lighting program and demographic data. Predicted bulb sales in the presence and absence of program activity to develop NTG ratios.
Examination of Connecticut socket saturation trends (n = 95 in 2009, 100 in 2012, and 90 in 2013)	Used 2012 and 2013 Connecticut saturation data to assess saturation trends, comparing those to Massachusetts and NYSERDA. 2014 Massachusetts data informed likely Connecticut saturation rates. Reporting of this task combined with comparison area research.
Supplier Interviews (n = 12 manufacturers, 3 high-level retail buyers)	Interviewed 12 lighting manufacturers and suppliers and 3 high-level retail buyers from May through June of 2014. Gained their insights into the LED market, predictions for the future market, satisfaction with the Connecticut program, and estimation program impact yielding NTG estimates.
Contribution to regional comparison area data collection (n= 78 in Georgia, 67 in Kansas)	Onsite visits in Georgia and Kansas demonstrated saturation and purchase rates in areas with less program activity. Helped to identify the impact of program activity on the energy-efficient bulb market.
Overall report	Summary report focuses on the key findings and recommendations across tasks.

Findings

The findings of the present research are summarized below. We begin by providing the NTG (encompassing both freeriders and spillover) and net-of freeridership estimates (which exclude spillover) before discussing the results of the residential market assessment.

Net-to-Gross and Net-of-Freeridership Estimates

The Team utilized three methods for estimating NTG and net-of-freeridership for the Connecticut program. The first two methods were quantitatively-oriented, employing large sets of sales and pricing data to estimate program impacts via statistical modeling. The first of these approaches, demand elasticity modeling, used sales data and bulb promotion information to measure the relationship of price and promotion to sales and to predict sales without the program's intervention. This allowed for an estimation of freeridership by comparing the modeled baseline sales to the modeled program sales. An important note regarding demand elasticity is that the models allowed for an estimation of net-of-freeridership but did not take spillover into account, so the results may provide conservative NTG ratios. The Team obtained net-of-freeridership values using the following formula:

$$\text{Net of FR Ratio} = \left(\frac{\text{Savings with Program} - \text{Savings without Program}}{\text{Savings with Program}} \right)$$

The second of the two quantitatively-oriented methods for estimating program impact was the point-of-sale (POS) modeling exercise. This approach utilized a large set of sales data across 44 states and five years (2009-2013) to understand how lighting programs across the nation influenced statewide proportions of efficient bulb sales. The Team used a given state's program lighting budget to quantify program activity. We also collected an extensive set of model inputs including statewide demographics and presence/absence of major lighting retailers to run the series of regression models that ultimately predicted efficient bulb sales. The POS modeling research provided NTG estimates for Connecticut for 2013, but for only a subset of retail channels. This reflects the fact that the sales data in the POS dataset did not represent market-level sales in Connecticut or elsewhere. Instead they captured selected retail channels – grocery, drug, discount, club, and mass merchandiser channels – but exclude home improvement and hardware stores through which Connecticut moves approximately 80% of its program bulbs. It is worth noting that other program states also move a large proportion of their bulbs through home improvement and hardware channels. As such, the associated NTG values should only be considered representative of those channels represented by the data, and not the Connecticut program as a whole. Further, the POS modeling approach also has inherent limitations for assessing the current impact of program activity on LED sales, which are still relatively new to the lighting market, and almost non-existent at the outset of the POS dataset (2009).

The formula used to estimate NTG from the POS data is shown below:

$$\text{NTG Ratio} = \frac{(\# \text{ bulbs sold with program} - \# \text{ bulbs sold with no program})}{\# \text{ of program incented bulbs sold}}$$

The final method for estimating NTG for the Connecticut program in 2013 relied on responses to questions about program attribution and sales in the absence of the program obtained through in-depth interviews with lighting manufacturers and high-level retail buyers. Interviewees included 12 lighting manufacturers and suppliers accounting for roughly 93% of the sales by manufacturers in the Connecticut program tracking database and three high-level lighting buyers who accounted for over 73% of the program sales. The NTG estimates were calculated by asking interviewees whether or not they believed certain channels sold efficient lighting as a result of the Connecticut program, and whether the Connecticut program positively influenced efficient sales. The extent to which interviewees cited the program as being influential in moving efficient bulb types would lead to higher program impacts.

Table 2-6 presents the net-of-freeridership and NTG estimates calculated from these three methods. The Team addresses the recommended NTG ratios in the Conclusions and Recommendations below.

Table 2-6: Net-of-Freeridership and NTG Estimates

Measure	Connecticut Currently Assumed	Demand Elasticity	Supplier Interviews	POS Modeling	Simple Average	Range
LED Specialty	100%	71%	74%	87%	70%	49% to 87%
LED Standard		49%				
CFL Specialty	81%	47%	55%	29%	50%	29% to 68%
CFL Standard		51%	68%			
Notes	From the 2014 PSD, Appendix 3; net realization rates are 82% for LEDs and 51% for CFLs. ²⁸	Net of freeridership, partial or missing data required team to make assumptions for some products, stores	Subject to biases of responding manufacturers and retailers	Partial market estimate, home-improvement/hardware channels not included. Limited applicability for program LEDs.		

Market Assessment Methods and Takeaways

The market assessment portion of this study had three primary purposes:

- Examine trends in LED and CFL socket saturation in Connecticut and comparison areas between 2009 and 2013 and extrapolate 2014 socket saturation rates for Connecticut,
- Assess the state of the LED market, and
- Determine supplier satisfaction with the program

To accomplish this, the Team analyzed lighting saturation data collected in 2009, 2012, and 2013, interpolating and extrapolating data for the years 2010, 2011, and 2014 when no saturation visits occurred in Connecticut. Data from Connecticut was also compared to three other areas of the country, Massachusetts, Georgia, and Kansas, all areas for which the Team had access to prior saturation data, allowing for comparisons in trends over time. The areas also displayed varying levels of program activity, with Massachusetts having a long history of strong program support for CFLs and LEDs, Georgia only recently providing incentives for CFLs and LEDs, and Kansas not having ever provided incentives for

²⁸ The United Illuminating Company and Connecticut Lighting and Power Company. 2014. *Connecticut Program Savings Document: 10th Edition for 2015 Program Year*. See page 289.

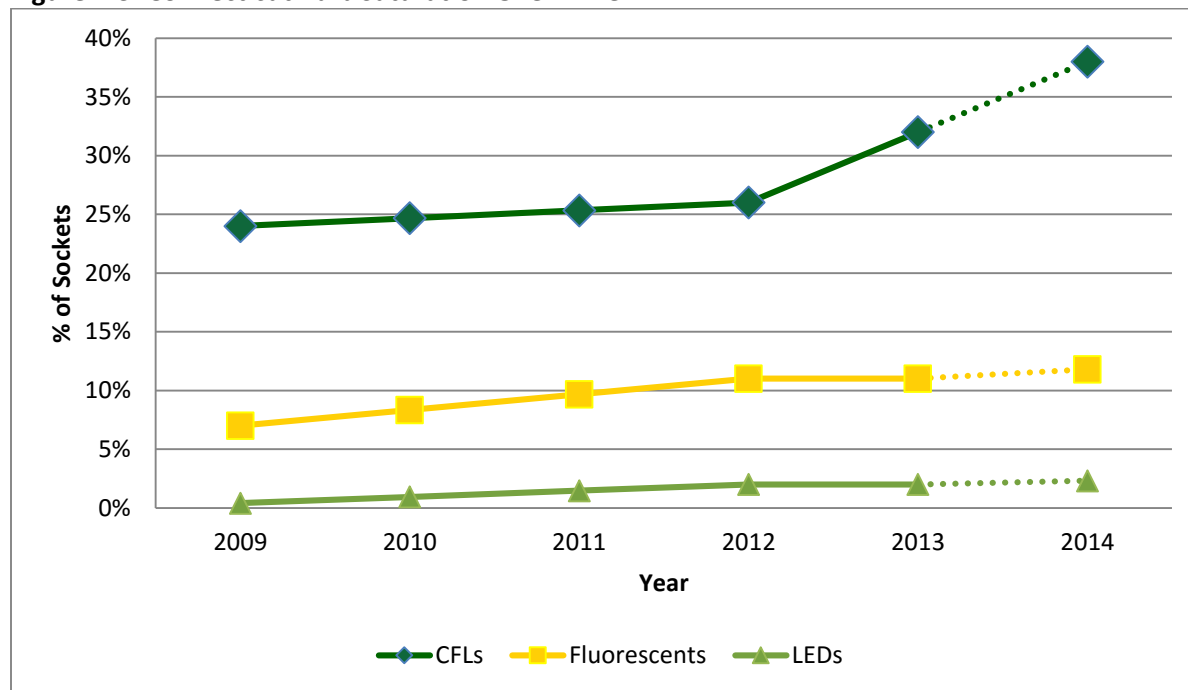
efficient lighting. Finally, the suppliers provided assessments of their program satisfaction during the in-depth interviews described above in the NTG section.

Socket Saturation Trends

The analysis of socket saturation trends in Connecticut and comparison areas demonstrated an interesting and, from the perspective of efficiency, optimistic set of findings. Figure 1 displays socket saturation of CFLs, LEDs, and fluorescent tubes in Connecticut over time (the dotted lines from 2013 to 2014 represent the extrapolated 2014 values). The full body of the report provides more detail on saturation trends in Connecticut and beyond. Finding of particular note include the following:

- CFL saturation displayed gains over time, increasing from 24% in 2009 to 26% in 2012, followed by a 6% increase from 2012 (26%) to 2013 (32%) (Figure 1-3). Due to wide confidence intervals, the saturation levels are not statistically different at the 90% level (see Table 20 in Appendix C of the main report).
- Connecticut CFL saturation increased by 8% between 2009 and 2013 compared to 6% in Kansas and 3% in Georgia during the same time period. The difference in saturation was not statistically significant between Connecticut and Kansas but was between Connecticut and Georgia.
- Nine out of ten Connecticut households used at least one CFL (a 90% penetration rate).
- LED saturation in Connecticut more than doubled from less than 1% in 2009 to over 2% in 2013.
- LED penetration increased from 1% of homes in 2009 to 23% of homes in 2013.

Figure 1-3: Connecticut Bulb Saturation Over Time



LED Market and EISA Impacts

The current LED market and the impact of EISA were prioritized topics throughout each of the study methods. Although the Team did not interview Connecticut store managers directly, we do draw on

insights leveraged from Massachusetts store managers when applicable. Below are some of the key takeaways from all lines of inquiry.

- Market actors expected LED prices to drop, due to both: 1) advances in LED technology; and 2) increased scales of LED production due to greater consumer demand spurred by both utility rebate programs lowering the LED price point and the EISA legislation's phase-out of incandescent bulbs opening up some new market share. More suppliers thought LED prices would decrease than CFL or halogen prices.
- Respondents indicated strong LED sales in the past year; the majority of store managers classified sales as "excellent" or "good."
- Respondents cited high costs as the factor preventing greater LED lighting sales; the only barrier reported by all three market actor groups.
- Respondents expected LED bulb prices to decrease over the next year, but not LED fixtures.
- Respondents most frequently cited providing larger rebates and customer education for increasing LED bulb sales.
- Every lighting manufacturer and retail buyer reported that EISA contributed to increased sales of LED and halogen bulbs and, to a lesser extent, CFLs.

Supplier Program Satisfaction

Manufacturers and retailers interviewed for this study voice high levels of satisfaction with both program and implementation staffs and the program overall (ratings of eight or higher on a zero to ten scale). When asked about potential program improvements, comments tended to say that the Connecticut program could be more flexible in its program design and requirements regarding deadlines, ability to modify agreements, and length of memoranda of understanding (MOUs) with the current MOUs being too short in duration. They respondents preferred three-year contracts to one-year ones.

Conclusions and Recommendations

Based on the findings of the current evaluation, the Team offers the following recommendations for the Connecticut Upstream Lighting program, discussed in more detail in Section 6 of the full report.

- **Recommended NTG estimates for 2013 and 2014; looking ahead to 2016 to 2018:** Based on the range of NTG estimates developed for this study and their relative strengths and weaknesses in light of program characteristics, the Team recommends applying a CFL NTG of 51% and LED NTG of 82% for 2013 and 2014. The CFL NTG falls between the estimates developed for this study. The LED NTG is higher than those developed for this study, but each method had shortcomings for addressing LEDs. The team ultimately recommended values because they match the current *net realization rates* from the 2014 PSD, but lower than what the Companies currently assume for NTG (using the equation $100\% - \text{Free Ridership} + \text{Spillover}$), 81% for CFLs and 100% for LEDs. In addition, the rapid changes in the lighting market give these NTG estimates a short self-life. While estimating prospective NTG ratios for 2016 to 2018 is not in this project's scope, the Team believes the CFL NTG ratio will not change much over the next few years, while the LED NTG will remain high through 2016 and then begin to drop off gradually. Exact deemed values should be decided after determining the program design for 2016 to 2018. The main body of the report provides additional justifications for these recommendations.
- **Continue regular estimation of NTG using a multi-pronged NTG approach:** Although we have made recommendations about prospective NTG ratios, the uncertainty in these estimates suggests that the EEB should continue regular measurement of this important impact value.

NTG ratios will likely change as consumers set their preferences for light bulbs in the post-incandescent period, and as LED prices fall and the bulbs become more widely adopted by consumers without price supports, suggesting the need to “check-in” with NTG every couple years. Additionally, all approaches to estimating lighting NTG have strengths and limitations, and using different methods allows for triangulation that reduces bias from any single method. The EEB may also consider setting NTG ratios separately for specialty and standard LEDs as well as exploring NTG ratios for CFL and LED adoption among households often considered to be “hard to reach” (e.g., low income, non-English speaking, etc.). To arrive at final values, the EEB may consider supporting a consensus building approach to determining recommended NTG values, similar to one recently used in Massachusetts (report June 19, 2015).

- **Continue practice of increasing support for LEDs while gradually reducing support for CFLs:** LEDs show high levels of customer satisfaction and were viewed by suppliers as a bulb type that will continue to be popular, especially when incentivized. NTG and net-of-freeridership values for LEDs are also likely to remain high in the post-incandescent period, suggesting they should remain an important program focus. While the Team supports the current plan to shift program focus toward LEDs, we also believe that CFLs represent a familiar technology, and maintaining some degree of program incentives for them will help offset the concerning trend observed in other states of consumers moving toward less efficient halogens in the absence of CFL incentives (i.e., “backsliding” in efficient bulb sales).
- **Consider shifting some incentive support from Home Improvement to other channels:** Research in Massachusetts and results from the current demand elasticity modeling (and research conducted in other states) reveal that NTG and net-of-freeridership values differ between various retail channels.²⁹ In particular home improvement channels tend to receive lower estimates than those serving hard-to-reach customers. Providing increased support in non-home improvement channels, particularly bargain/discount stores, is likely to bring about greater program impacts.
- **Cease specialty CFL incentives:** The present research suggested declining NTG and net-of-freeridership values for specialty CFLs, even more so than standard CFLs. The EEB and Companies should continue their plan of ceasing support for specialty CFLs.
- **Increase customer education toward LEDs:** LEDs are widely considered the future of residential lighting, demonstrating high levels of customer satisfaction, long lifetimes, and strong opportunities for energy savings. In order to promote the bulb for those who have not yet installed LEDs, and to ward off competition from less efficient halogens, the Team suggests educational campaigns toward LEDs to highlight their advantages over other bulb options.

See full report at:

http://www.energizect.com/sites/default/files/CT%20Residential%20LED%20Lighting%20Market%20Assessment%20and%20Lighting%20NTG%20%28R86%29_Final%20Report_06.19.15.pdf

²⁹ DNV-GL, NMR, Cadmus. 2015. *Massachusetts Upstream Lighting Program Net-to-Gross Ratio Estimates Using Supplier Self-Report Methodology* Available at: <http://ma-eeac.org/wordpress/wp-content/uploads/Upstream-Lighting-Net-to-Gross-Estimates-Using-Supplier-Self-Report-Methodology.pdf>

3. STUDIES IN PROGRESS (Draft Reports)

3.1 Commercial

No studies at this time.

3.2 Residential

R4- HES / HES-IE Process Evaluation and Real-time Research (R31, R46, and R152 also)

NMR Group, Inc., and its partner The Cadmus Group were contracted by the Connecticut Energy Efficiency Board (EEB) to conduct a process evaluation of its Home Energy Solutions (HES) and HES Income Eligible (HES-IE) programs—known as the R4 Project. This evaluation included assessments of program processes, short-term persistence, net-to-gross analysis (NTG), non-energy impacts (NEIs), health and safety concerns that could limit service provision, contractor development, and database and document quality. The EEB also contracted the evaluation team to conduct a separate study (R31), included in this report, which piloted the effectiveness of performing participant surveys addressing program processes and decision making in a timeframe closer to their dates of participation. The R31 study addressed not only HES and HES-IE, but also end-user rebates obtained outside of HES. Finally, the report also includes two additional projects leveraged with R4 and R31: the R46 Project, which examined decision making and financing, and the R152 Project, which assessed the impact of the Connecticut Clean Energy Communities (CCEC) program on HES participation and deeper-measure uptake. These four studies collectively included eight modules that focused on critical issues related to HES, HES-IE, rebate programs, and the CEC program.

While this report assumes that readers have some familiarity with four programs described in this study, brief descriptions are as follows:

- Home Energy Solutions is the “flagship” program funded by the Connecticut Energy Efficiency Fund (CEEF). Program vendors perform energy assessments of single-family and multifamily residences, providing “core services” measures such as efficient light bulbs, faucet aerators, showerheads, air sealing, and duct sealing for a nominal fee (currently \$99). Vendors provide recommendations to participants on add-on measures that are not core services that they could adopt to achieve deeper energy savings. These measures are usually eligible for rebates, zero- or low-interest program financing, or both.
- Home Energy Solutions – Income Eligible shares many characteristics with HES, but services are limited to low-income households. Participating households receive the same core services as in HES, but they are not subject to a co-pay; add-on measures are generally provided for free to owner-occupants, although landlords may be subject to co-pays. The list of add-on measures differs somewhat between HES and HES-IE (e.g., HES-IE does not include central air conditioning), and some HES-IE participants simultaneously receive services from the Department of Energy’s Weatherization Assistance Program (WAP).

- Rebates are available for some measures outside of the HES and HES-IE umbrella. For example, households could adopt central air conditioning or ductless heat pumps without going through the HES programs. Participants buy these measures on their own or through a contractor and submit forms for a rebate. The study did not examine any upstream rebate programs (e.g., those for lighting, water heating, and other measures) in which rebates go to manufacturers, retailers, or contractors.
- Clean Energy Communities works with community groups to promote energy efficiency and renewable energy in towns across Connecticut. Towns sign Clean Energy Communities Municipal Pledges and engage in outreach activities that encourage energy efficiency and renewable energy in municipal buildings, residences, and small businesses. Towns earn “points” based on the number of participants and the types of measures they install. Once they have earned 100 points, towns are eligible to apply for grants to fund additional energy-efficiency and renewable energy projects.

The findings will be available in 2016.

R15- Single Family Potential Study

This project is being revisited with new costs and other inputs in 2015 / 2016.

Background:

In the first draft of the potential study the evaluation team screened all measures for cost-effectiveness using full participant costs and early retirement savings. Full costs represent the price a homeowner would have to pay to install any of the measures being evaluated in the potential study. Early retirement savings represent the modeled savings (using REM/Rate) of the new measure being assessed compared to the existing measure.

There were a number of public comments requesting that the evaluation team use incremental costs and lost opportunity savings, as opposed to full costs and early retirement savings, to screen the following measures for cost-effectiveness: heating, ventilation, and cooling equipment, domestic water heating equipment, and appliances. The evaluation team is re-screening the aforementioned measures for cost-effectiveness (using both the TRC and UCT tests) and adjust the economic and achievable potential chapters of the report accordingly.

Interactions and feedback:

Although no new data requests were needed, before proceeding with the revisions the evaluation team met with the EEB evaluation consultant and other key stakeholders, following the revised evaluation roadmap, to ensure that all parties were on the same page and that key inputs/assumptions were consistent with the client’s expectations. This interaction was conducted consistent with Roadmap procedures and ensured the work provides the greatest possible value.

R32- Evaluation of Persistence in the Eversource Customer Behavior Program

This report updates findings from two prior evaluations of the Home Energy Reports (HERs) Pilot Program, implemented for Eversource by OPower. The study had two main objectives:

- Explored the degree to which savings extend after the delivery of HER reports is discontinued – continuing a time series of persistence analyses for samples of HER participants conducted over the past few years. This is the third year of persistence work for at least one of the subpopulations.
- Examined whether the (awareness or other effects from) HER reports help increase participation in other Connecticut Energy Efficiency (EE) programs, or whether the HER reports have a side benefit of increasing investment in “deeper” measures, a desirable outcome of the HES and other programs.

The study in progress has found:

- Savings continued for the various discontinued groups – with somewhat different results depending on which group (frequency and duration of reports received initially). However, on an overall basis, the results indicated that savings degradation was between 21-34% (about 24% overall) for each year after the reports were stopped.
- Statistically-significant savings remained at least two and up to three years after HER reports were stopped (depending on the study group). This indicates that measure lifetimes for this behavioral program may exceed 3 years in life – although of course, the savings multiplier is affected by the degradation factor noted above.
- The program is cost-effective as it is currently delivered; however, these results imply that there may be more cost-effective ways to deliver this program other than repeating full-cost treatment continuously. Several scenarios in the report indicate that “cycling” customers off the program may lead to more total savings at a lower cost per kWh than the traditional program delivery. Examples and implications are provided in the report.
- The analysis of participation in other programs found that the HER program boosted participation in HES slightly, but the results were statistically significant (4.7% vs. 4.0%).

The analysis in progress also found that one of the HER sub-groups studied (high-use extension) installed insulation at a higher rate than the control group (8.9% vs. 7.1%, with a savings effect of about 0.03%). Changes in investment in other “deeper” measures was not found.

R91- Impact Evaluation Disconnects Between Engineering and Billing Analysis, and Oil / Propane Treatment

Introduction and Priority Outputs

This project is concentrating on the following aspects:

- Reviewing the best approaches for impact evaluations – billing analysis and engineering approaches – and describing / discussing the causes of differences in results, and using illustrations from other utilities as possible;

- Drilling down into the case of Connecticut’s R16 impact evaluation study, assessing the disconnects between the engineering and billing analysis performed in the study, focusing mostly (but not solely) on cases where realization rates for gas measures are low.
- Additionally, the evaluation team is reviewing the oil and propane treatment in the impact evaluation and assess alternative approaches – theoretical / proposed or in use elsewhere – to provide advice to future Connecticut evaluation work.

The priority outcomes include:

- Advice on best practices for impact evaluation approaches, including evaluations of oil and propane customers.
- Feedback on the drivers or causes for the gas realization rates in Connecticut’s recent impact evaluation – and information useful to planning and PSD inputs.

Review best practices in impact evaluations, including engineering and billing analysis:

- Provide background / context for the proper application of each method; identify best practices, innovations, etc. Use examples / citations from the literature and practices from other states and protocols where appropriate.
- Identify the theoretical causes of differences in results derived from each approach, and recommendations / cautions that arise from the analysis.

Apply the analysis to Connecticut: Determine root cause(s) for the disconnects between engineering and billing analysis where realization rates for gas measures are low:

- Identify gas measures with low RR’s
- Request additional background information and supporting analysis from the Companies for those measures
- For each measure:
 - Review assumptions for key inputs into engineering estimates and compare to known information about participating homes
 - Identify key differences in assumptions and actual values for participating homes
 - Assess engineering estimates sensitivity to variances in assumptions
 - Specify root causes as those key inputs that drive estimates and have high differences between the assumed value and the actual values

Review of Oil/Propane treatment in impact evaluation:

- Review the treatment of oil and propane impact evaluations in other states, and approaches that have been proposed or explored in the literature.
- Review how oil/propane estimates were developed in the R16 study
- Review the oil/propane engineering estimates in the PSD
- Assess whether PSD engineering estimates could have been leveraged differently to derive oil and propane estimates
- Assess how the output from best practices in impact evaluations affects engineering estimates for oil and propane for the measures included above.

Analysis and Reporting: The final report synthesizes the findings from all of the above data collection elements to provide an integrated assessment of key research objectives. It also assesses discrepancies in realization rates for specific measures and works to identify key drivers for these differences (i.e.,

attributed to planning estimate/input or differences based on evaluated assumptions). The report also assesses methods used to estimate oil and propane savings.

R113- Ductless Heat Pump Evaluation

This study was undertaken to identify the lower than expected realization rates for ductless heat pumps (DHPs) reported in the R16 Impact Evaluation of the 2011 program year, “Impact Evaluation: Home Energy Services—Income Eligible and Home Energy Services Programs (R16).” A secondary objective of the study was to provide forward looking information to assist the utilities and EEB in getting the most impacts from DHPs. In 2014, the EEB published the final report for the R16 Impact Evaluation, a comprehensive evaluation that estimated the program impacts for multiple measures installed through the HES and HES-IE programs. The evaluation found mixed results for the realized energy savings from the DHP measure, which yielded a 46% realization rate.

The R16 Impact Evaluation identified several potential reasons as possible culprits of the low realization rate:

- Differences in participant types between those that were used in the study that informed the PSD and the R16 study.
- Other factors that may be attributed to customer behavior, for example, “takeback effects” occurring due to an increase in room temperature or operating hours in anticipation of lower operating costs, or changes in equipment operations resulting in the switch to a handheld remote control from a traditional thermostat.

Program Description

DHP rebates are available to all Eversource and UI residential customers via whole house retrofit and HVAC rebate programs. DHPs are eligible measures in Energize Connecticut’s Home Energy Solution (HES) and Home Energy Solutions Income Eligible (HES-IE) programs. They can also be rebated independent of these direct install initiatives when installed by a contractor certified by the manufacturer of the product and that has attended an EnergizeCT training seminar. Customers with income at or below 60% of state median income that have not participated in weatherization services in the previous 18 months are eligible for the HES-IE Program and may qualify to receive a DHP at no cost to them. As an example, the Butter Brook Hill Apartments in New Milford, pictured in Figure 1, provides seniors with independent living options and was one of many multifamily properties to receive DHPs with funding from the HES-IE Program in 2011.

Study Methods

The study employed a variety of quantitative and qualitative methods. Given the study objectives, it was necessary to collect data from both 2011 participants evaluated in the R16 Impact Evaluation and recent participants from the 2013– 2014 and first quarter of the 2015 program years.

One hundred and twenty four computer-aided telephone surveys were completed. DNV GL conducted the telephone surveys during the fourth quarter of 2015 with residential customers of Eversource and UI who had participated in the Connecticut HES program and had installed DHPs with program support. A subset of 20 telephone survey respondents were recruited to participate in an on-site survey. The inclusion of on-site surveys provided more detailed and granular data than could be collected over the phone.

DNV GL conducted in-depth vendor interviews. Although this effort produced limited interviews, those completed gained vendor perspectives on their program experience, education and instruction, the customer's decision making process, methods for system sizing and the influence of ARRA funding.

The study reviewed the 2012 Connecticut PSD used in the R16 impact study as well as the current (2015) PSD. The PSD reviews assessed the pre and post installation heating and cooling assumptions that informed the PSD savings factors and provided a high-level comparison of the DHP PSD calculations for with ex-ante calculations from other cold climate states such as Massachusetts, New York, New Jersey and the Mid-Atlantic Technical Reference Manual. Finally, this report contains a billing analysis case study and a brief literature review. The case study offers recommendations on possible ways to improve precision of the savings estimates. The literature review includes results from several DHP evaluations and other published technical reports.

R151-Connecticut Home Energy Solutions (HES) Air Sealing, Duct Sealing, and Insulation Practices Study

Introduction

This report presents the results of the Connecticut Home Energy Solutions (HES) Air Sealing, Duct Sealing, and Insulation practices study (R151). Working with the EEB consultants, NMR designed this study with the primary objective of identifying opportunities for the program to increase savings related to these three measures through the HES program. This study does not include HES Income Eligible households due to the divergent ways in which participants enter the program and the vendor and householder decision-making process regarding which measures to install. For similar reasons, particularly related to the complexity of landlord decision making, multifamily projects are not included in this study. NMR Group, Inc. (NMR) conducted this study at the request of the Connecticut Energy Efficiency Board (EEB). The study results draw on the following eight research tasks:

1. Program data tracking review
2. In-depth interviews with program staff
3. In-depth interviews with participating vendors
4. In-depth interviews with program administrators for leading programs
5. In-depth interview with program QA/QC vendor
6. On-site visits with program participants
7. On-site in-depth interviews with program participants
8. On-site in-depth interviews with participating vendors

Program Background

The HES program is Connecticut's flagship residential program designed to help customers lower their energy bills and improve their homes' safety and comfort. The program serves as the entry point for many Connecticut residents seeking to increase the efficiency of their homes.³⁰ The HES program is fuel

³⁰ The sister program—HES-Income Eligible—was not included in this study due to the divergent ways in which participants enter the program and the vendor and householder decision-making process regarding which measures to install.

blind³¹ and offers single-family homeowners a thorough home energy analysis, installation of core program measures that result in immediate energy savings, and, if eligible, recommendations for deeper energy-saving measures to put the homeowner on a pathway to increase the overall efficiency of their home.

A program vendor provides “core services” in the home. For \$99, residential customers can have an energy audit conducted that will help them improve their home’s energy efficiency. During that initial visit, technicians conduct an assessment and provide core services, which include installing efficient light bulbs, faucet aerators, and showerheads, and performing instrumented air-sealing and duct-sealing services.³²

At the end of the core services visit, vendors engage participants in the “kitchen table wrap-up” in which they discuss potential energy efficiency upgrades to the home that would result in deeper savings. Many of these upgrades, including insulation, are eligible for Connecticut Energy Efficiency Fund (CEEF) rebates and both CEEF and Connecticut Green Bank financing. Such upgrades are installed at a later date, and homeowners can choose to hire a different installation contractor than the HES vendor. The program offers some limited assistance for customers to address health and safety issues that might preclude energy efficiency upgrades, including requiring vendors to provide a list of third-party remediation contractors and working with finance partners to ensure that financing is available for remediation. In some cases, customers may be able to bundle the cost of remediation along with other rebated measures.

Figure 2-1 displays the number and percentage of 2014 HES participants who received any combination of air sealing, duct sealing, and insulation.³³ The majority (63%) of HES participants received air sealing only. Less than one-fifth (18%) of participants received air sealing and duct sealing, less than one-tenth (8%) received air sealing and insulation, and 2% received all three services. Five percent of 2014 HES participants did not receive air sealing, duct sealing, or insulation.³⁴

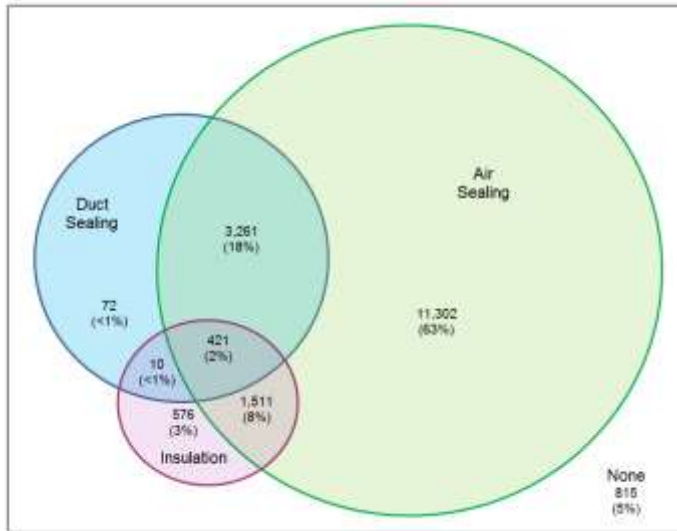
³¹ The program is not targeted to a specific fuel/heating source, and customers of any heating fuel type are eligible to participate.

³² The core services may in some cases be provided across two separate visits. For example, if an HES vendor identifies a potential health and safety issue, they may postpone completing the core services until the homeowner remedies the issue.

³³ Neither the Eversource database nor the UI database included a variable indicating whether participating homes had ductwork. As a result, percentages of ductwork services are calculated from all participating homes, which vastly underestimates the actual levels.

³⁴ It is important to note that homes that reportedly did not receive any of the measures of interest for this study may have received courtesy air sealing (limited weatherization services performed typically in the conditioned space without the benefit of a blower door test, such as weather stripping, installing door sweeps, performing caulking around window frames, etc.) as well as other direct-install measures such as efficient lighting or water saving measures.

Figure 2-1: HES Services Provided in 2014



Error! Reference source not found.-1 below presents air sealing, duct sealing and insulation services by utility and overall.

Table 1-1: Air Sealing, Duct Sealing, & Insulation Services Provided in 2014

	Eversource		UI		Total	
	Count	%	Count	%	Count	%
Total HES Visits	12,432	100%	5,536	100%	17,968	100%
Air Sealing Only	7,568	61%	3,734	67%	11,302	63%
Air Sealing & Duct Sealing	2,229	18%	1,032	19%	3,261	18%
Air Sealing & Insulation	1,508	12%	3	<1%	1,511	8%
None	549	4%	266	5%	815	5%
Insulation Only	97	1%	479	9%	576	3%
Air Sealing, Duct Sealing & Insulation	421	3%	0	0%	421	2%
Duct Sealing Only	50	<1%	22	<1%	72	<1%
Duct Sealing & Insulation	10	<1%	0	0%	10	<1%
Air Sealing Total	11,726	94%	4,769	86%	16,490	92%
Duct Sealing Total	2,710	22%	1,054	19%	3,764	21%
Insulation Total	2,036	16%	482	9%	2,518	14%

Study Objectives

The R151 study was developed for the EEB with the objective of identifying opportunities for the program to increase savings related to three specific measures through the HES program: air sealing (core service), duct sealing (core service), and insulation. The evaluation had the following research questions:

1. Opportunities

- What opportunities exist to refine program implementation to capture greater savings and increase quality of implementation?
 - What effect do health and safety concerns have on opportunities?
- 2. Participation patterns**
- What proportion of eligible participants receive air sealing, duct sealing, and insulation?
 - Are there any patterns by utility, vendor, or home characteristics?
- 3. Vendor practices**
- What are vendor practices related to recommending measures?
 - Are all savings opportunities being identified?
 - Are all cost-effective savings being captured?
 - What are vendor practices related to air and duct sealing installation?
 - What are contractor practices related to insulation installation?
- 4. QA/QC protocols**
- What vendor-specific and program-based QA/QC protocols or procedures are followed to ensure quality installation?
 - Are current QA/QC protocols adequate? If not, what opportunities exist to improve QA/QC?
 - What tools or resources would help vendors increase measure quantity or quality?
 - What QA/QC practices are other leading program administrators engaged in?
- 5. Drivers, motivations, obstacles, and barriers**
- What barriers or obstacles prevent recommending or implementing measures?
 - What drivers or motivations lead customers to implement measures?
 - What barriers prevent customers from implementing measures?
 - How have other PAs leveraged drivers and motivations to achieve greater savings?

Methodology

The R151 study collected and analyzed data from eight sources, outlined in Table 3-2. For ease in identifying the data source of findings, in the detailed findings sections of the report we adhere to a color coding scheme included in the table below.

Table 3-2: Evaluation Tasks

Task	Description	Data Source	Quantity
1	Program data tracking review	Data Tracking and Program Documents	17,968 homes
2	In-depth interviews with program staff	Program Staff	2
3	In-depth interviews with vendors	Vendors	23
4	On-site quality inspections	Quality Inspections	70
5	On-site in-depth interviews with program participants	Participants	70
6	On-site in-depth interviews with participating vendors	Vendors	10
7	In-depth interviews with program administrators from leading programs	Program Administrators	5
8	In-depth interviews with Quality Assurance and Quality Control (QA/QC) Vendors	QA/QC Vendors	2

Research Task Descriptions

Program data tracking and program document review: An analysis to explore patterns of air sealing, duct sealing, and/or insulation by utility, vendor, and home characteristics for 2014 program participants, as well as a review of relevant program documents including HES Implementation manual and QA/QC vendor manual.

In-depth interviews with HES program staff: One from Eversource and one from UI. These provided background on program goals, program design, program implementation, QA/QC protocols, and barriers to and opportunities for increasing savings.

In-depth interviews with participating vendors: Coordinated with R4 HES/HES-IE Process Evaluation and R157 Multifamily Initiative Process Evaluation. Questions focused on vendors' practices related to air sealing, duct sealing, and insulation; barriers and opportunities for deeper energy savings; and the program's QA/QC activities.

On-site quality inspections: NMR HERS Raters assessed the quality and completeness of the air sealing, duct sealing, and insulation work performed at HES participant homes. Most inspections lasted about an hour and focused on attic, basement, and interior work. NMR auditors inspected these homes without the benefit of having a blower door fan running during the tests; thus, these inspections were visual, and the amount of air leakage at these penetrations could not be quantified. However, NMR auditors are experienced HERS Raters and building scientists and are trained to identify signs of air leakage, even without the use of diagnostic fans. NMR targeted homes where HES vendors were willing to accompany us on-site, homes with multiple services performed, and those with low air and duct sealing improvements. Of the 70 homes visited, 70% were located in Eversource territory, and 30% were in UI territory.

On-site in-depth interviews with program participants: A 20- to 30-minute in-person interview conducted with the homeowner during the on-site quality inspection. The interview discussed removal of measures, non-energy benefits, health and safety issues, financing options, recommendations, drivers of and barriers to participation, and customer satisfaction.

On-site in-depth interviews with participating vendors: Employees of the HES vendors that performed work at a given home accompanied NMR auditors to the site and, together, they inspected the work for quality and completeness. HES vendors provided candid feedback about their real-world practices and experiences with the HES program.

In-depth interviews with program administrators for other programs: Reviewed best practices from comparable programs, including reviewing program materials and interviewing program administrators in Massachusetts, Rhode Island, Maine, Vermont, and New York. The interviews focused on increasing participation and uptake of add-on measures, and QA/QC strategies.

In-depth interviews with program QA/QC vendors: The interviews discussed program strengths and weaknesses, the quality of vendors' work, and drivers and barriers the vendors face in participating in the program. NMR conducted one interview with UI's vendor and another interview (in two parts) with the vendor Eversource started using in 2015, which was after the homes that NMR visited had been serviced by the HES program.

Table 3-3 provides a brief overview of which research tasks and methods map to research questions.

Table 3-3: Research Questions and Tasks

Research Question	Tasks	Methods
1 – Opportunities	Tasks 1 – 7	<ul style="list-style-type: none"> • Data tracking and document review • Staff interviews • Vendor interviews • Customer interviews • Benchmarking • On-site visits • QA/QC interviews
2 – Participation patterns	Tasks 1 and 2	<ul style="list-style-type: none"> • Data tracking review • Staff interviews
3 – Vendor practices	Tasks 2-6 and 8	<ul style="list-style-type: none"> • Staff interviews • Vendor interviews • On-site visits • QA/QC interviews
4 – QA/QC	Tasks 2-6 and 8	<ul style="list-style-type: none"> • Staff interviews • Vendor interviews • QA/QC interviews • Customer surveys • Benchmarking • On-site visits
5 – Drivers, motivations, obstacles, and barriers	Tasks 2, 3, 5, and 8	<ul style="list-style-type: none"> • Staff interviews • Vendor interviews • Customer interviews • QA/QC interviews

R154- Connecticut LED Lighting Study

Introduction

This report presents the results of the Connecticut LED Lighting Study (R154), which was designed to assess the current residential market in Connecticut with a special emphasis on light-emitting diodes (LEDs). NMR Group, Inc. (NMR), conducted this study at the request of the Connecticut Energy Efficiency Board (EEB). The study results draw on telephone surveys completed with random sample of households in Connecticut and on-site lighting inventory visits completed with a subset of survey participants.

Background

Energize CT’s Retail Lighting Program is part of the Residential Retail Products Program, the objective of which is “to increase consumer awareness, acceptance and market share of ENERGY STAR® lighting, appliances and consumer electronics.”³⁵ The Lighting Program specifically promotes the sale of ENERGY STAR lighting products. The program continues to support both CFLs and LEDs, but has shifted focus increasingly toward LED bulbs. In 2015, the program discontinued incentives for specialty CFLs because,

³⁵ 2015 Annual Update of the 2013-2015 Electric and Natural Gas Conservation and Load Management Plan – Public Act 11-80 Section 33.

<http://www.energizect.com/sites/default/files/2015%20C%26LM%20Plan%20Update%20FINAL%2012-22-14.pdf>

as stated in the 2015 annual update, “There are better performing LED alternatives on the market at good price points.” In addition, the recent ENERGY STAR V2.0 revisions make it unlikely that any CFLs will be eligible for ENERGY STAR designation moving forward.

Incentives are applied at the wholesale level to manufacturers, allowing consumers to pay a discounted price at the point of purchase. Historically, the Retail Lighting Program has concentrated on home improvement and big-box stores, but it has made recent efforts to expand to hard-to-reach retail stores.

The EEB, Eversource, and the United Illuminating Company (UI) have been tracking numerous lighting market indicators through on-site lighting inventories since 2009. Over time, the purpose of lighting inventories has shifted focus from simply tracking CFL adoption to incorporating metrics for all types of bulbs—program-supported and non-program-supported, efficient and non-efficient. The current effort (R154) continues to track metrics for all bulb types but, in deference to the shift in program focus, this study had a special focus on the market for LEDs.

Study Objectives

The R154 study was developed for the EEB with the overall goal of assessing trends in the Connecticut lighting market, with special emphasis on LEDs, and providing information to inform updates to parameters used in the calculation of energy and demand savings for the 2016 to 2018 program cycle. These same estimates could also be incorporated into future program savings documents (PSDs) and could inform the EEB’s decisions regarding the future of residential lighting programs.

The R154 study had the following four main objectives:

- To provide a basis for reliable estimates of the current use of various bulb types and updated calculations of Connecticut socket and savings lighting potential. These results will be used in combination with inputs from previously conducted Connecticut studies.
- To provide data on baselines and delta watts suitable for the PSD, savings estimates, and program planning.
- To provide data on first-year in-service rates suitable for the PSD, savings estimates, and program planning.
- To provide the customer, product, and market data needed to support program targeting and planning needs.

Methodology

For the R154 study, NMR collected data through 151 telephone surveys of a random sample of homes throughout Connecticut and 81 on-site lighting inventories conducted with the subset of those telephone survey respondents who agreed to the visit. The phone survey was fielded between July and August of 2015, and the on-site visits took place between July and September of 2015.

In addition to data from the 2015 R154 study, in order to better understand the market in the state and examine trends, this report also includes information from previously completed on-site lighting studies in Connecticut from 2009, 2011, and 2013.³⁶ The methods for the 2015 study differed slightly from previous efforts, differences that are outlined in the appendix to the Report. This report also explores

³⁶ NMR, R86: Connecticut Residential LED Market Assessment and Lighting Net-to-Gross Overall Report, 2015. <http://tinyurl.com/R86-Study>

the saturation of energy-efficient residential lighting products in Connecticut over time *in reference* to eight comparison areas: California, Georgia, Kansas, Maine, Massachusetts, Rhode Island, and New York (Upstate and Downstate). While the timing of visits in these comparison areas does not directly align with those conducted in Connecticut, the trends observed provide useful context.

Additional methodological details related the consumer survey and the on-site saturation survey—including sampling error and weighting schemes—can be found in the appendix to the report.

R157-Connecticut Multifamily Initiative Process Study

Introduction

The Multifamily (MF) Initiative is designed to provide a customized approach to serving multifamily property owners and managers and their tenants. Many measures in the multifamily sector are common to both residential single-family homes and commercial buildings. As such, the MF Initiative coordinates with the HES and HES-IE programs for in-unit measures and with commercial programs, such as C&I Retrofit and Small Business Energy Advantage, to address common areas. If a property is eligible to receive common-area upgrades and under a residential revenue code, Program Administrators (PAs) use C&I savings methodologies, but generally apply residential program guidelines and funding. From the customer’s perspective, the upgrades are offered seamlessly as a single package that puts them on a pathway to increase the efficiency of their building.

Evaluation Objectives

The Energy Efficiency Board (EEB) contracted with NMR Group, Inc., to conduct a process evaluation of the Multifamily Initiative. The primary objectives of this process evaluation are as follows:

- **To document initiative implementation**
 - How is the initiative intended to operate and how, if at all, does that differ from how it currently works in practice?
 - What goals do program stakeholders plan to achieve through the program?
- **To assess participant response**
 - Are customers satisfied with their experience with the initiative? Specifically:
 - How satisfied are customers with the measures they have installed, or services they have used?
 - What are their reasons for participating? Why did some customers start the process and fail to complete participation?
 - What is driving the interest in participation? What are the barriers to participation? What are the barriers to measure installations?
 - What might be done to improve satisfaction and initiative engagement?
 - Are vendors satisfied with their experience with the implementing the initiative?
 - What challenges or barriers have they encountered in implementing the initiative?
 - What might be done to improve satisfaction and initiative engagement?
- **To identify and recommend initiative improvement opportunities**
 - What changes can be made to the initiative to:
 - Increase customer satisfaction?
 - Increase vendor engagement?
 - Overcome barriers to participation and increase participation and savings?

Methodology

The evaluation draws on multiple perspectives from program staff, implementers, and participants to provide feedback on various aspects of the initiative. The following tasks were completed for this evaluation:

- Task 1: In-depth interviews with program staff
- Task 2: In-depth interviews with program vendors
- Task 3: Focus group with HES landlords/property managers
- Task 4: In-depth interviews with HES-IE landlords/property managers

Data collection for these different tasks was closely coordinated with other research efforts, including R4 HES/HES-IE Process Evaluation and R151 Air Sealing, Duct Sealing, and Insulation Practices Evaluation. This coordinated approach endeavored to maximize efficient outreach to program stakeholders and minimize respondent fatigue.

Program Staff Interviews

An initial task of the evaluation included in-depth interviews with three program staff—one from Eversource and two from UI. These interviews served as the primary method of understanding the program goals and objectives, providing information on the structure of the MF Initiative, and informing subsequent research tasks. The structured interviews with program staff addressed a number of topics, including the following:

- Overall program goals and objectives, including those specific to the MF Initiative
- Linkages between the MF Initiative and the single-family and multifamily portions of HES/HES-IE, as well as any coordination with the small C&I program
- Structure of the MF Initiative, including components, processes, staffing, and resources
- Initiative marketing and promotion
- Impact on the market in terms of initiative awareness and participation
- Drivers of and barriers to customer participation
- Initiative strengths, challenges, and opportunities for improvement

Vendor Interviews

Given the relatively small pool of vendors and overlapping research objectives, in-depth interviews with program vendors were coordinated with the R4 HES/HES-IE Process Evaluation as well as R151 Air Sealing, Duct Sealing, and Insulation Practices Evaluation. Vendors who completed the initial R151/R157 questions received a \$50 incentive.³⁷ Fifteen of the 19 participating vendors completed interviews.³⁸ Most of the vendors interviewed reported that they work in both the HES and HES-IE programs. Four of the vendors stated that 5% or less of their projects are in the multifamily sector, five indicated that multifamily projects make up between 5% and 50% overall work, and four reported that more than 50% of their work in HES and HES-IE involved multifamily properties.³⁹ The in-depth interviews covered a range of topics, such as the following:

³⁷ Vendors who participated in follow-up research activities related to R4 and R151 garnered additional incentives, but they are not relevant to this study.

³⁸ Respondents included two vendors whose work in the multifamily sector is very limited (<5% of their projects are in this sector) as well as one vendor who only installs add-on measures.

³⁹ Two vendors did not provide an estimate of what proportion of their work is in the multifamily sector.

- Vendor roles and responsibilities, including marketing and outreach, customer enrollment, audits, project application and approval, and measure implementation
- Initiative processes, tracking, and reporting
- Satisfaction with initiative procedures
- Participation barriers and drivers
- Perceptions of customer value and satisfaction
- Overall initiative strengths, challenges, and suggestions for improvement

HES Landlord / Property Manager Focus Group⁴⁰

The process evaluation also included a focus group with landlords/property managers, these attendees participated in the HES program between July 2013 and April 2015. Using program participation data from Eversource and UI, 56 landlords/property managers with available contact information were recruited for the focus group.⁴¹ The attendees were landlords, property managers, and condominium association representatives of buildings with five or more units that participated in HES. Eleven contacts, all of whom were involved with at least one participating multifamily site, agreed to attend the focus group; nine of them ultimately attended the focus group.⁴² Prior to the focus group, attendees received a scorecard (i.e., handout), included in Appendix D, asking them to rate their level of satisfaction with various aspects of the program. Their ratings were used as a starting point for discussing the various focus group topics. In some cases, through the conversation, attendees realized that they should change their scores,⁴³ the average satisfaction ratings in this report use the final ratings that the attendees provided. The focus group addressed the following topics:

- Program satisfaction
- Program awareness
- Participation decision-making
- Audit processes
- Audit report
- Measure installations
- Rebates and incentives
- Energy and non-energy benefits

⁴⁰ See HES Landlord/Property Manager Focus Group Participants in Appendix A for more information on the sample of HES landlords/property managers who contributed to this evaluation.

⁴¹ Program vendors were contacted in an effort to obtain participant telephone numbers. In the instances where vendors were not reachable, online searches (i.e., reverse lookups) were conducted to find as many telephone numbers as possible. This resulted in 56 unique contacts.

⁴² One additional landlord expressed interest in attending the focus group, but was unable to attend. The interviewee reported having a high volume of participation in the program. An in-depth interview was conducted with this individual using the same questions planned for the focus group, but over the course of that interview, it became clear that this interviewee's experiences were with HES-IE, not HES. As a result, the evaluation uses this interviewee's responses as inputs into the R4/R157 HES-IE landlord in-depth interview analysis.

⁴³ For example, further discussion of particular topics informed attendees that they may not have included all dimensions of a topic when considering the satisfaction rating that they had initially recorded. The direction in which attendees changed their scores varied based on their particular experience with the different facets of the program.

HES-IE Landlord/Property Manager Interviews⁴⁴

Thirty HES-IE landlords/property managers participated in in-depth interviews designed to obtain information about their experience with the program.⁴⁵ This task was also coordinated with data collection for the R4 HES/HES-IE Process Evaluation.⁴⁶ Interviewers asked each landlord and property manager about one of their projects served by the program (referred to as their “key project”) between July 2013 and April 2015. If the landlord or property manager was involved with more than one participating project, interview questions focused on the project with the largest amount of gross electric savings as reported in the program database. The interviews explored issues similar to those covered in the focus group, including the following:

- Satisfaction with the audit, audit report, and measures installed
- Satisfaction with the effects of the energy conservation measures on their energy bills
- Overall satisfaction with the program
- Motivations and barriers to participation
- Recommendations for program improvements

It is important to note that, while landlords/property managers who participated in HES and HES-IE were asked questions on similar topics through the two separate data collection efforts, not all of the individual items and results are comparable across the two groups. Although it is likely that landlords in both programs had similar experiences with these two programs, there are key differences in how they are implemented and in the populations who are served by them. As a result, unless otherwise noted, the findings for the two groups are reported separately throughout this report.

⁴⁴ See HES Landlord/Property Manager Focus Group Participants in Appendix A for more information on the sample of HES-IE landlords/property managers for this evaluation.

⁴⁵ The evaluation included an interview with one property manager in person because when the study attempted to recruit him for the R157 Multifamily Initiative Process evaluation HES focus group, the contact reported participating in the program a great deal. A scheduling issue prevented the property manager from attending the actual focus group, but it was determined that it would be important to interview this contact to learn more. During the interview, it was gleaned that the interviewee had participated in HES-IE, not HES, and as a result, the study uses the responses from that interview (which did not follow the same question structure, yet did touch on the same themes) in the analysis of these HES-IE landlord in-depth interviews.

⁴⁶ Topics from the R4 evaluation include program processes, decision-making and financing, short-term persistence, free ridership, spillover, non-energy impacts, and health and safety.