***Connecticut Energy Efficiency Board***

***Evaluation Studies Completed and Underway in 2021***

***A Report to the Energy and Technology Committee of the Connecticut General Assembly***

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Connecticut Energy Efficiency Board Evaluation Committee

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Draft Report

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# PREFACE FROM THE EEB EVALUATION COMMITTEE

The Energy Efficiency Board (EEB) Evaluation Committee is pleased 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.

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

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

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# PREFACE FROM THE EVALUATION ADMINISTRATORS --- OVERVIEW AND VERIFICATION OF THE 2021 EVALUATION OF CONNECTICUT’S ENERGY EFFICIENCY FUND ACTIVITIES

The evaluation efforts conducted in 2021 were designed and managed by third-party independent experienced evaluators.[[1]](#footnote-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 2021 add to the evaluation evidence of accomplishments from the use of Connecticut’s Energy Efficiency Fund (EEF).

The Evaluation Consultant Team[[2]](#footnote-2) verified that the 2021 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.

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LEGISLATIVE REPORT ON 2021 EVALUATION PROJECTS

# 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 the EEB 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; programs and measures are cost effective; evaluation reports are accurate and issued in a timely manner; evaluation results are appropriately and accurately taken into account in program development and implementation; and information necessary to meet any third-party evaluation requirements is provided.

The essential information gained through studies such as those discussed in this report is provided very cost-efficiently. The three-year 2019-2021 C&LM Plan budget is $751 million. The accompanying three-year evaluation budget is $8.0 million for all evaluation and related research studies, with the first year reflecting the last year of a short-term budget reduction from the Legislature. This represents an evaluation percent of 1.07%, reflecting a substantial decrease compared to figures of 1.4% in 2018, 1.9% in 2013 and 2.1% in 2012. This trend has fallen below averages in the US. In the 2022-24 C&LM Plan, a stabilizing of this downward trend is planned to assure Connecticut’s evaluation work can maintain standards commensurate with other states in the region and nationally.

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

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

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

## 1.1 Definition of Evaluation Types

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

* Process Evaluations determine the efficacy of program procedures and measures. Process Evaluations assess the interactions between program services and procedures and the customers, contractors, and participating ancillary businesses. Process evaluation is essential to support development of improved program delivery, increased cost effectiveness and customer satisfaction.
* Impact Evaluations verify the magnitude of energy savings and the reasons for differences between projected and realized savings. The results and value of energy efficiency programs are reported to regulatory bodies, ISO-New England, Company management, and program planners and administrators. Many different types of impact studies may be completed including end-use metering, engineering modeling, billing analyses, participant interview, surveys and combinations of these.
* Market Assessments examine overall market conditions related to energy efficiency products and services, including current standard practices, average efficiency of equipment, consumer purchasing practices, and identification of market barriers. The assessments ascertain the extent to which efficiency programs are likely to influence customer adoption of measures and practices. Assessments are conducted to identify effective ways to influence key market players to take efficiency actions and increase the breadth and depth of the actions taken.
* Impact Support Studies (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 measurable after program interventions have occurred.

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 programs that are not cost-effective to make them successful. Evaluation research provides the basis for determining program direction or focus; increasing participation and savings; expanding the reach of programs, developing messaging more relevant to the non-participating customers where appropriate; reducing costs; and fine-tuning procedures.

## 1.2 Organization of the Report

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

* **Chapter 2 - Completed Studies** includes descriptions and summary results from completed studies that were completed in calendar year 2021. Findings and recommendations are summarized; links to the full reports are found at the end of each study description.
* **Chapter 3 – Studies in Progress** includes brief descriptions of study background and key outputs expected from each residential, commercial, and cross-cutting study that was underway – but not completed – in 2021.

Figure 1 summarizes the completed and in-progress and EM&V studies addressed in this Evaluation Legislative Report. Each is described in more detail in subsequent chapters, highlighting objectives for all studies, and results for completed studies. In 2021, a total of 32 evaluation studies were either completed or underway, as noted below.

**Figure 1: List of Studies Addressed in the 2019 Legislative Report (by category)**

***(R=Residential; C=Comm’l / Industrial, X=All/Both Sectors)***

|  | PROJECTS COMPLETED IN 2021 (included in Chapter 2) |
| --- | --- |
| 1 | C1901 C&I Sector-Wide Process Evaluation (Non-SBEA program) |
| 2 | R1959 Single Family Renovations and Additions Potential Analysis |
| 3 | R1973 Retail Products, Non-Lighting |
| 4 | R2023 RASS Database Enhancement |
| 5 | R2120 - Appliance Recycling Impacts Study |
| 6 | X1931-1 Industry Standard Practice for Boilers and Furnaces |
| 7 | X1931-2 Coincidence Factor and Load Shape Study |
| 8 | X1931-3 New Measure Study - Air Compressor |
| 9 | 1931-4 New Measure for PSD - Advanced Lighting Controls (ALC), Phase 1 |
| 10 | X1931-6 Hours of Use Documentation for PSD |
| 11 | X1931-7 Degree Days Update for PSD |
| 12 | X1931-8 New Measure - Updated Thermostats |
| 13 | X1939 Early Retirement Programs, Phase 1 |
| 14 | X1941 MultiFamily Impact Evaluation and Baseline |
|  | STUDIES IN PROGRESS IN 2021 (included in Chapter 3) |
| 1 | C1902 - Energy Consious Blueprint (ECB) Net to Gross (NTG) and Baseline Study |
| 2 | C1906 - Strategic Energy Management (SEM) Program Evaluation. |
| 3 | C2014 - C&I Lighting Saturation and Remaining Potential |
| 4 | C2117 Persistence Study for Retrocommissioning Measures |
| 5 | R1965 - HP/HPWH Baseline and Potential Assessment. |
| 6 | R2027 - Heat Pump and Heat Pump Water Heater Reliability Study |
| 7 | R1968 - RNC Baseline and Code Compliance (Phase 1) |
| 8 | R1982 - HVAC / DHW Performance & Potential Evaluation |
| 9 | R1983 HES & IE Process and NTG Evaluation And Impact Evaluation |
| 10 | R2015 - Low Load Residential New Construction |
| 11 | R2029 - Single Family Weatherization Metric and Update |
| 12 | 1931-4 New Measure for PSD - Advanced Lighting Controls (ALC), Phase 2 |
| 13 | X1931- 5 Commecial Refrigeration Efficiency Update Study |
| 14 | X1932 - Evaluation of Demand Reduction (DR) Programs (UI & Eversource, All Sectors) |
| 15 | X1942 - Cross-Cutting Non-Energy Impacts Evaluation |
| 16 | X2001 - Measure Life Study / EUL Update |
| 17 | X2022 - Customer Engagement, Education, and Workforce / Training Evaluation |
| 18 | R1973 - Retail Non-Lighting Evaluation |

This EM&V project list represents a portion of the projects from the adopted 3-year plan. The legislative budget sweep led to a reduction in funding for the first year of the EM&V Evaluation Plan for 2019-21, and this budget reduction leads to reductions in evaluation work that addresses gaps in the PSD and to program evaluations that will take time to make up.

# **2. PROJECTS COMPLETED IN 2021**

## **C1901 C&I Sector-Wide Process Evaluation (Non-SBEA program)**

The C1901 Study - Commercial and Industrial (C&I) Sector-Wide (non-SBEA) Process Evaluation - examined program processes and performance for three Energize Connecticut C&I programs including the Energy Opportunities (EO), the Energy Conscious Blueprint (ECB), and the Business Energy Sustainability (BES) Programs based on program participation in 2019. It also includes a separate process evaluation for the Upstream Lighting Program (a sub-program under the EO Program), which is the first process evaluation conducted for this offering.

To benchmark and provide information to assess best practices, the Energize Connecticut programs were compared to similar programs from other jurisdictions. The process evaluation relied on in-depth interviews and web-based surveys with program and implementer staff, program participants, trade allies, and for Upstream Lighting, distributors. A non-participant survey was also conducted to understand the views, opinions, and barriers of those who have not participated in Energize Connecticut programs. Extensive secondary research, including review of program documentation, evaluation reports, data, and other sources of relevant information was conducted. This study consists of the individual program evaluations and was also designed and implemented in a manner that provides insights across the entire C&I sector.

The objectives of this research were to examine key process-related issues associated with each program and to look across the C&I sector to understanding how the programs work together to deliver savings and uncover opportunities for coordination to deliver deeper and more comprehensive savings. To bolster the sector-wide perspective, this study also included a large-scale C&I Customer Profile (CIPC) activity that relied on customer population, consumption, and program tracking data, from both utilities, to describe and explore the Connecticut C&I customer population in terms of metrics such as program participation, savings achieved, and potential. An abundance of individual research objectives are addressed within this report; however, six overarching themes pervaded all this research.

* **Program Satisfaction**. The portfolio of Connecticut C&I programs is mature and long running. Overall, all market actors—including participants, trade allies, and distributors—are quite satisfied with their experiences. Though respondents did provide some small recommendations for improvements to program implementation, nothing rose to the level of being a systematic issue or concern.
* **Market Penetration**. Increasing market penetration is going to be a function of increasing program participation, which should be focused on two strategies: (1) increasing general customer awareness of available rebates and programs, and (2) more deeply engaging existing participants to facilitate repeat participation. In general, programs have wisely targeted large customer accounts but moving ahead the potential from the smaller accounts representing 99% of the C&I population (and roughly half of energy consumption) should be considered.
* **Depth and Comprehensiveness of Savings**. In Connecticut, depth and comprehensiveness of savings are a big focus. A tiered incentive structure was put in place to better incentivize customers to conduct projects targeting more than one end use. While the tiered system does seem to be stimulating some comprehensiveness, the evaluation team argues that a project-level view of comprehensiveness is limiting. If the goal is to drive deeper and more comprehensive savings in the C&I sector, comprehensiveness might better be viewed and incentivized at the customer level (i.e., over time), particularly among larger customers who are most suited to repeat participation.
* **Customer Equity**. Customer equity has arisen as a dominant theme in the energy efficiency industry in the past few years. The evaluation team found that customers in both distressed and non-distressed and urban and rural communities appear to be being served (i.e., receiving program incentives and savings) in proportion to their contribution to consumption. These results provide partial information toward assessing equity; additional metrics may be developed over time as commercial customer research evolves.
* **Optimizing Program Expenditures**. Lighting dominates the Connecticut C&I portfolio throughout the period studied in this evaluation. The evaluation team estimates that almost three-quarters of 2019 C&I population savings (73%) were associated with lighting. However, the high percentage of LED products carried by distributors that meet DLC/ENERGY STAR specifications and the high levels of free ridership for Upstream Lighting suggest this market is transforming. Two additional Connecticut studies are exploring the remaining potential for lighting and can provide additional insight into measures to target and incentive levels to further guide the program going forward.
* **Upstream Lighting May Demonstrate an Effective Delivery Path for Some Non—Lighting Measures**. While lighting remains an important contributor to small and micro business savings, delivery of lighting savings has shifted to the upstream delivery pathway. For example, micro-business accounted for 20% of non-upstream lighting in 2017 but declined to 13% by 2019. Similarly, small business made up 39% of non-upstream lighting savings in 2017 but declined to 35% in 2019. Offering more nonlighting measures such as hot water, kitchen and HVAC measures through the upstream delivery pathway may provide an opportunity to improve non-lighting savings from small and micro-business.1
* **Data Review and Management**. Acquiring and processing utility data to facilitate the process evaluations and participation and equity analyses was a significant task in accomplishing this study. Through that process, the evaluation team identified specific changes the utilities and contractors should make in data tracking that will make the assessment of program performance and targeting by the utilities and other parties more comprehensive and efficient. In particular, the evaluation team highlighted specific data fields that should be added to utility tracking systems, as well as areas where data quality issues should be addressed (e.g., account tracking and infographic information).

Key findings and a wide array of detailed recommendations arising from this work are provided in the body of the report.

## **R1959 Single Family Renovations and Additions Potential Analysis**

The R1959 Single-Family Renovations and Additions Potential Analysis study examined the renovation and addition (R&A) market in Connecticut to inform the design and work of the Energize Connecticut (EnergizeCT) Additions, Renovations, and Retrofit Initiative (the program). The program provides financial incentives to builders, remodelers, and homeowners to offset some of the cost of incorporating energy-efficiency upgrades into R&A projects.

At the time of the study, the program was in a pilot phase and had only completed three projects. The study estimated the market size, project scope, and gross technical potential (GTP) savings associated with the single-family R&A market. The study also included a limited process evaluation of the participation for the first three pilot projects. To estimate the market size, the study used regression-based equations developed for Massachusetts using Connecticut-specific inputs.

To describe typical R&A projects and decision-making, the study included a web survey of 73 contractors, a web survey of 104 homeowners, and in-depth interviews with ten market actors. The study calculated GTP savings using results from the web surveys and 48 prototype energy models; the GTP calculations do not predict real-world outcomes.

EnergizeCT offerings do not currently target the large R&A market. Typical R&A projects are not eligible for the Residential New Construction offering, which targets new homes and gut rehabs. Home Energy Solutions (HES) vendors improve existing homes, but not R&A projects specifically. Contractors in the R&A market are often different people from those primarily serving the new home and HES markets. Along with costs, awareness of and interest in energy-efficiency from homeowners and market actors limit the uptake of energy-efficient practices in R&A projects. While GTP savings represent an upper bound of savings, higher than economic or achievable savings, GTP savings from the R&A market are substantial.

The study estimated that 7% of single family homes undergo renovations and/or additions each year; this is 27 times the number of new homes built annually. R&A projects are split relatively evenly between minor projects (500 ft2 or less) and major projects (greater than 500 ft2 ). The average modeled GTP savings per project (26.2 MMBtu) are comparable to claimed savings for the RNC program (28.9 MMBtu) and higher than that of HES Core Services (6.2 MMBtu). This compares GTP savings for the R&A program with claimed savings for the RNC and HES programs; achievable savings for the R&A program would be lower than these GTP values. These GTP values also include fuel-switching savings (homes shifting from oil heat to electric heat pumps), which the Companies may not be able to claim under the current PSD. Per early participants, key participation barriers are costs associated with energy-efficiency measures, adding HERS raters to the project team, and low program awareness, a result of the program being in pilot phase.

**Recommendations & Considerations**

* Expand the program out of the pilot phase. Apply lessons from the MA R&A program launch, mimic RNC program successes, and target small and large projects.
* Adopt hybrid baseline for renovations that uses ISP for the portion of the home initially included in the project scope and pre-existing conditions for measures added due to program.
* Adopt RNC program’s new homes baseline for addition projects, rather than a code-based baseline.
* Streamline program eligibility criteria, in particular the distinction between major and minor project paths.

To the extent allowed in Connecticut, claim savings generated from fuel-switching projects.

## **R1973 Retail Products, Non-Lighting**

The *R1973 Connecticut Retail Non-Lighting Evaluation* covered two program groups run by Eversource and United Illuminating (Connecticut Utilities): the ENERGY STAR® Retail Products Platform (ESRPP) and E-commerce platform. The study had two main objectives; (1) develop improved impact parameters for ESRPP and the E-commerce platform programs, and (2) recommend improvements to the design and implementation of each program.

The ESRPP and E-commerce programs are part of the Connecticut program administrator’s (PA’s) efforts to provide additional energy efficiency opportunities to residential customers in the face of recent declining savings opportunities from lighting. This research supports the Connecticut PA’s expansion of energy efficiency opportunities to residential customers.

**Key Findings and Recommendations**

Table 1 and Table 2 below summarize the study’s recommendations out of the engineering review for each of the ESRPP and E-commerce measures, including the original and updated savings values, the source(s) of the recommended update.

**Table 1. Summary of 2021 PSD Recommendations – Electric Savings1**

| Measure | Updated Gross Value (kWh) | Existing Gross Value (kWh)2 | Source for Updated Value (with Year3,4) |
| --- | --- | --- | --- |
| *ESRPP Measures* | | | |
| Refrigerator Tier I | 64 | 64 | PSD, 2017 |
| Refrigerator Tier II | 96 | 96 | PSD, 2017 |
| Freezer, Upright | 50 | 45 | Supplemental PSD documentation, 2017 |
| Freezer, Chest | 32 | Supplemental PSD documentation, 2017 |
| Clothes dryer, Gas | 36 | 93 | VT TRM, 2015 |
| Clothes dryer, Electric | 194 | VT TRM, 2015 |
| Clothes Washer, Tier I | 88.1 | 66 | VT TRM, 2018 |
| Clothes Washer, Tier II | 120.3 | 117 | VT TRM, 2018 |
| Room Air Conditioner | 10.7 | 77.5 | VT TRM, 2015 |
| Dehumidifier | 214 | 214 | PSD, 2017 |
| Air Cleaner/Purifier | 214 | 227 | VT TRM, 2004 |
| Sound Bars4 | 24 | 45 | VT TRM, 2013 |
| *E-Commerce Measures* | | | |
| Wi-Fi Thermostats | 104 | 256 | MA, 2018 |
| Smart Thermostats | Calculated Deemed | VT TRM, 2018 |
| Adv. Power Strips, Tier I | 48 | 48 | PSD, 2016 |
| Adv. Power Strips, Tier II | 179 | MA TRM, 2018 |

1The table represents gross values, a discussion of NTG values can be found in Section 2.2.3 Net Impacts.

2Existing values are pulled from the 2020 Connecticut PSD.

3Year represents the date of the source information, not the date the respective TRM was updated.

4The evaluation consultant has no reason to believe that a clothes dryer would operate differently in VT than in CT.

5A follow-up email was sent on 6/25/20 to confirm there is no additional documentation not shared with the evaluation consultant. To date no additional documentation has been received for sound bars.

6 The Connecticut PSD deemed savings for Wi-Fi/smart thermostats distributed through ESRPP or E-commerce is for cooling savings only.

**Table 2. Summary of 2021 PSD Recommendations – Gas Savings1**

| Measure | Updated Gross Value | Existing Gross Value2 | Source for Updated Value (with Year3) |
| --- | --- | --- | --- |
| *ESRPP Measures* | | | |
| Clothes dryer – gas4,5 | 1.2 therms | NA | New York, 2017 |
| *E-Commerce Measures* | | | |
| Wi-Fi Thermostats, gas | 62.4 therms | NA | MA, 2018 |
| Wi-Fi Thermostats, oil6 | 5.7 MMBtu | NA | MA, 2018 |

1The table represents gross values, a discussion of NTG values can be found in Section 2.2.3 Net Impacts.

2Existing values are pulled from the 2020 Connecticut PSD.

3Year represents the date of the source information, not the date the respective TRM was updated.

4The evaluation consultant has no reason to believe that a clothes dryer would operate differently in NY than in CT.

5The evaluation consultant is aware that gas clothes dryers are not currently offered through the ESRPP program in Connecticut.

6MA (and other state’s TRMs) do not have a value for propane savings. Connecticut could either conduct primary research to determine the propane savings or assume the 5.7 MMBtu for the instance where a residence has propane heat.

**ESRPP Findings and Planning Recommendations**

The study’s high-level evaluation findings and conclusions from the engineering review of the ESRPP measures result in the following recommendations.

A number of changes in how the Connecticut Utilities interact with the national program and participating retailers would likely improve the program’s success. Retailers make purchasing and marketing decisions one year, or more, in advance of stocking products. The Connecticut Utilities should institute two-year or three-year incentive levels and budgets to better align with retailer purchasing timelines. Retailers also need help understanding why customers would be interested in different energy efficient (rebated) products. The Connecticut Utilities should provide specific directions to national retailers on purchasing and promoting specific products (e.g., marketing strategies and content) and establish relationships with local retailers to ensure national guidance is implemented. Lastly, the Connecticut Utilities should work with the national ESRPP collaborative to recruit regional peer utilities into the program. Recruiting additional, regional Program Sponsors will enhance the impact of the program on retailer stocking and support greater savings.

The Connecticut Utilities can take a number of actions to better track the program’s impact on the market and increase short-term savings. Tracking upright and chest freezer purchases separately (if not doing so already) will allow freezer type-specific savings estimates to be applied. The amount of potential energy savings is different for these specific products and better tracking may result in higher overall savings depending on the distribution of sales. The Connecticut Utilities should also monitor key performance indicators (KPIs) to help identify where the program is having success in the shorter-term and where it is lagging. Table 3 below outlines suggested KPIs that can be developed using data that is already being collected by the Connecticut Utilities or other ESRPP stakeholders.

**Table 3. Key Performance Indicators for ESRPP**

| Metric Description | Metric Calculation | Data Collection Activity |
| --- | --- | --- |
| Total Deemed Savings | Monthly deemed savings overall, and by product category | ICF sales data portal |
| Net Benefit | Total program spend ($) per kWh or kW saved | Program data |
| Number of Participating Store Locations | Number of unique store locations participating in utility territory, by retailer | Program data |
| Number of Product Categories | Count of product categories incented overall | Program data |
| Efforts to recruit retailers | Documentation of efforts to recruit new national or regional retailers | Program documents |
| Total incentive dollars paid | Total incentive amount, by retailer and product category | Program data |

**E-Commerce Findings and Planning Recommendations**

The study’s high-level evaluation findings and conclusions from the engineering review of the E-commerce measures result in the following recommendations.

The literature review indicates that consumers “broader online digital experiences are continually refining and resetting” their expectations, and platform design should enable an “effortless customer experience.”[[3]](#footnote-3) The Connecticut Utilities have made recent updates to their E-commerce platforms including additional products and product information that enhances the customer experience. They should continue to review the design and user experience of E-commerce platforms by using non-utility E-commerce platforms as a benchmark for platform design. The Connecticut Utilities should also continue to increase the number of product categories available on E-commerce platforms. Any products that have existing prescriptive rebates, as well as non-rebated efficient products, that can be sold through the E-commerce platform such as dishwashers and clothes washer and dryers, should be included. Eversource has recently updated their platform to include these products. Lastly, the Connecticut Utilities should add educational information to help customers understand the benefits of buying efficient products. Eversource recently updated their site to include educational information, but the UI platform focuses on products and information about other energy efficiency programs. The more robust utility E-commerce sites provide specific information on the efficiency of both rebated and non-rebated products, buyers guide information, and customer ratings and reviews to give products more credibility.

To improve the delivery of savings, the Connecticut Utilities should track Wi-Fi and Smart (learning) thermostat purchases separately, as well as Tier I and Tier II APS purchases separately (if not doing so already). The amount of potential energy saved is different for these specific products. Tracking them separately will allow for more specific savings claims which may result in higher overall savings depending on the distribution of sales. The Connecticut Utilities should also leverage direct email for effective marketing outreach. Peer utilities noted this was their primary and most successful marketing channel to drive traffic to their sites. The Connecticut Utilities should put in place a direct marketing campaign (if they are not doing so already) and could consider either separate engagement or partnering with other program outreach such as Home Energy Reports.

## **R2023 RASS Database Enhancement**

This study introduced a number of enhancements to the residential database constructed as part of the RASS Study (R1706/R1616). That database was designed as a user-friendly resource to identify measures with low saturation, baseline-related information, housing / occupant characteristics, and other information useful for program planning and targeting. The database contains data from more than 2,400 web surveys and 227 follow-up on-site verification visits. The delivered database included raw case-level data and factors suitable for appropriate weighting of the data for uses. The database produces cross tabulations with 35 rows per measure, and provides penetration, saturation, and efficiency level information for a variety of key subgroups.

This project enhanced the database capabilities to incoproate: ENERGY STAR saturation, and cross tabulated efficacy averages. Training, a slide deck, and an updated internally-documented database were provided. These types of update are planned periodically to assure the database is current and as useful as possible.

## **R2120 – Appliance Recycling Impacts Study**

The *R2120 Appliance Recycling Study* had the following objectives:

* To estimate gross and net energy savings resulting from the recycling of refrigerators and freezers through the Energize Connecticut Appliance Recycling Program in 2020
* What participants think they would have done with the appliances at various incentives levels (including having to pay to have the unit removed)
* The importance of incentives relative to other benefits, including the reclamation of refrigerants and other materials, energy savings, and ease of removal
* To estimate the amount of materials reclaimed from appliances recycled in 2020 that could be attributed to program activity

The *R2120 Appliance Recycling Study* makes the following recommendations:

* The study recommends that the utilities adopt the PSD updates listed below:
  + **Refrigerators**:Gross Savings = 932 kWh, Realization Rate = 0.90, NTG Ratio = 0.37
  + **Freezers:** Gross Savings = 760 kWh, Realization Rates = 0.83, NTG Ratio = 0.38
* The program should keep the incentive at $30 but also periodically offer limited time special promotions at higher incentive levels.
* Should the program decide to permanently raise incentives, the NTG ratio should be raised to match those in Massachusetts and Rhode Island: 46% for refrigerators and 50% for freezers.
* If and when Connecticut policy rules allow non-energy impacts in cost-effectiveness testing for this program, the study suggests that 40% of the materials reclaimed or recycled should be directly attributed to program efforts.

To arrive at these recommendations, the *R2120 Appliance Recycling Study* found the following:

* **Program Savings:** Gross saving are comparable between Connecticut and Massachusetts, but the NTG ratio is lower in Connecticut than in Massachusetts. This may reflect the lower incentive paid in Connecticut ($30 to $60) compared to Massachusetts ($75). The gross savings and realization rate estimates reflected the application of recent study results from Massachusetts to the characteristics of appliances recycled in Connecticut in 2020. The study calculated net savings based on survey responses of Connecticut participants.
* **Incentives:** The study results did not provide clear guidance on the optimal incentive level. Many participants seemed willing to take part without an incentive. However, the program convinced more people to get rid of a unit they would have otherwise kept when they temporarily offered a $60 incentive over the typical $30 one.
* **Attribution of Recycled Materials:** The program reclaims ozone-depleting refrigerants and other hazardous materials, and recycles the glass, plastic, and metals contained in recycled appliances. The study results suggest that 60% of these materials would have been reclaimed outside of the program. This means that the program should be attributed 40% of the recycled and reclaimed materials if and when policy rules allow.

## **X1931-1 Industry Standard Practice for Boilers and Furnaces**

This project provided a summary of the research team's findings about industry standard practices (ISP) for commercial boiler and furnace installations in Connecticut as part of a x1931-1 study. For this research, ISP is defined as the typical installation practices for lost opportunity measures, encompassing both replace-on-failure (ROF) and new construction or gut renovation projects. Retrofit or early replacement (ER) of working equipment is not included in ISP baseline recommendations, as the pre-existing conditions at the site are always the first-year baseline for ER projects. Furnace research was restricted to stand-alone systems and excludes ducted heaters and rooftop unitary (RTU) systems.

There were three phases to this study: secondary research of building codes and other literature, interviews with program administrators (PAs) and with industry subject matter experts, and triangulation of findings from these research tasks to inform final recommendations. The interviews with experts defined standard practice as typical installation characteristics outside of the incentive programs currently offered by utilities.

The study found that condensing heating equipment was the most installed type for boilers. For furnaces, both condensing and non-condensing equipment was commonly specified, with site-specific circumstances providing clearer baseline equipment types.

**Results / Recommendations**

The contractor interviewed 10 industry professionals, including designers, installers, manufacturers, and distributors about commercial boiler ISPs. Key findings include the following:

* For buildings with hot water distribution systems, condensing hot water boilers are standard equipment. For buildings with steam distribution systems, slightly above-code steam boilers are standard practice. This finding applies equally to new construction and ROF applications.
* There is an important exception for buildings with hot water distribution systems for which the installation of a condensing boiler is not physically or financially possible due to space or venting constraints. In these cases, a non-condensing cast iron sectional boiler is the most appropriate equipment.
* Boiler efficiency ISP varies by different categories such as size and type, as does the metric used for efficiency, such as annual fuel utilization efficiency (AFUE), or thermal or combustion efficiency. When there were significant ranges within a category, researchers estimated a value based on expert interview responses and using DNV engineering judgement. Overall, efficient equipment has a high market share and, in many categories, would be standard practice in the absence of energy efficiency incentive programs.

Recommended boiler baseline efficiencies are shown in Table 1-1 below.

Table 1-1: Boiler Efficiency ISP Recommendations

| Boiler Type | Current International Energy Conservation Code (IECC) 2021 | Recommended |
| --- | --- | --- |
| Small (<300,000 Btu/hr) | 82% AFUE | 92% AFUE |
| Medium (300,000 to 2.5 million Btu/hr) | 80% Et | 90% Ec |
| Large (>2.5 million Btu/hr) | 82% Ec | 90% Ec |
| Steam | 80% AFUE (<300,000 Btu/hr)  79% Et (>300,000 Btu/hr) | 82% Ec (all sizes) |
| Cast Iron Sectional Hot Water | 82% AFUE (<300,000 Btu/hr)  80% Et (300,000-2.5 million Btu/hr)  82% Ec (>2.5 million Btu/hr) | 82% Ec (all sizes) |

**ISP Recommendations: Furnaces**

Five industry professionals, including both designers and installers, answered the research questionnaire about commercial furnaces. Their expert opinions provided the following important insights:

* Condensing equipment and code-minimum efficient equipment were both specified, depending on the client’s needs and particular applications. Both condensing and non-condensing furnaces are the ISP.
* Furnace efficiency values varied widely. Some experts specify condensing equipment in nearly all cases, but others specify standard efficiency equipment. For ROF events, the experts agreed that the presence of an existing condensing exhaust stack was an indicator that condensing equipment was standard practice for that site. Secondary research about similar market studies in Massachusetts found that, for sites with no existing condensing stack, a code efficiency furnace was typical practice. A site with unknown venting conditions or a new construction baseline should have a blended baseline, acknowledging that both condensing and noncondensing equipment are commonly specified.
* In most commercial applications, central forced air furnaces are rare, whereas boilers, direct-vent heaters, or RTU systems are common. For smaller commercial buildings with ducted furnace systems (smaller than 120,000 Btu/hr capacity), residential furnace equipment baselines should be used instead. At the time of writing, the residential baseline efficiency in CT for furnaces is 85% AFUE. Recommended furnace baseline efficiencies as shown in Table 1-2.

Table 1-2: Boiler Efficiency ISP Recommendations

| Furnace Type | Current (IECC 2021) | Recommended |
| --- | --- | --- |
| 120,000 Btu/hr or greater | 80% Et | Unknown existing venting or new construction: 85% Et  Existing condensing stack: 90% Et  Existing non-condensing stack: 80% Et or code |
| Less than 120,000 Btu/hr | 80% Et | Use CT Program Savings Document (PSD) ISP for residential systems, currently 85% AFUE. |

In addition to the major ISP findings detailed above, the expert interview process also yielded some ancillary findings that may be useful for program designers, administrators, and implementers:

* Few (11%) of furnace projects received incentives. The experts noted that the perceived prescriptive incentive payout relative to the difficulty of filling in the project application was a major barrier.
* The majority (77%) of boiler projects received incentives. The experts noted that the program has been very effective at changing the way that they design equipment.
* For boiler projects, incentives on efficient equipment were still cited as an important decision-making factor for customers. However, several experts noted that, even if the program no longer existed, they would still specify condensing boilers and their clients would still want them.
* Venting requirements were cited by almost all experts as the biggest barrier to installing efficient equipment at a site. The second largest barrier cited was physical space for the boiler to fit into the building. One expert described a project in which a section of sidewalk needed to be excavated and an exterior subgrade wall needed to be breached to fit new, condensing boilers into the boiler room.
* Supply and return water-temperature design setpoints are tied to the distribution system in a given building, limiting a designer’s ability to reduce supply water setpoints to maximize condensing operation. This suggests that there may be derating of combustion efficiency in ROF applications, relative to new construction applications; however, a value for any derating factor would be more appropriately determined in a program evaluation or separate study.

## **X1931-2 Coincidence Factor and Load Shape Study**

The X1931 PSD Review project examined the PSD measures across all sectors. Phase 3 of this study provided detailed measure or parameter research on items that the X1931 team identified in earlier project stages. One of those research efforts, X1931-2, focused on the coincidence factors and loadshapes contained within the measure characterizations and appendices of the PSD. This study had three main objectives:

1. revise the loadshapes in Appendix 2 of the PSD,
2. confirm or update the coincidence factors for residential and commercial measures using the recent ISO-NE seasonal peak hours,
3. compile the updated coincidence factors from all measures into the tables in Appendix 1 of the PSD.

The study team leveraged data from two recent commercial Connecticut evaluations (C1634 and C1635), along with commercial savings loadshape data from additional regional studies. Similarly, the team leveraged extensive metered data from the Massachusetts baseline study to update loadshapes and coincidence factors. The team modified the existing Massachusetts C&I loadshape tool to facilitate the updates to produce loadshapes and coincidence factors. Similarly, the team created a calculator which determines the residential measure loadshapes and coincidence factors. Both calculators are available for updating and future use by Connecticut stakeholders.

The study provided updated loadshapes for four residential and four commercial measures and created four new loadshapes. The study also recommended updates to 48 measure coincidence factors.

**Results and Recommendations**

The study recommends updates to four C&I loadshapes and four residential loadshapes, four new residential loadshapes, and updates of coincidence factors for 48 different types of equipment. The recommended values are provided in the report. Overall, the recalculated commercial coincidence factors were slightly lower, while the residential factors were marginally higher than the values in the 2021 PSD. The evaluation team believes the commercial differences are caused by the shift of seasonal peak hours later when many commercial buildings begin to ramp down energy usage. Review of the prototypical load profiles (e.g. office building in July) shows that at 5:00 p.m. (hour 17), the energy consumption in the office building declines quickly, leading to a slight decrease in the seasonal peak coincidence factor.

Conversely, the early evening is when a significant number of loads in residential homes are beginning to increase. Review of the end use profile for residential home in July shows that the cooling usage during the 5:00 p.m. hour is very near the peak in residential dwellings. Other end uses such as laundry and hot water also increase usage as residents return home from work or school. The higher coincidence factors for many residential measures reflect higher usage during the evening hours.

**Energy Savings Loadshapes**

The evaluation team used the C&I and residential loadshape calculators to determine updated energy savings loadshapes for four commercial and four residential end-uses. Additionally, information was available to create four additional loadshapes for different types of equipment. The recommended update to PSD is provided in the report.

The Evaluation team also recommends updating the tables in Appendix 1 of the PSD, providing an array of specific recommendations for a comprehensive list of the coincidence factors for each measure in the PSD.

## **X1931-3 New Measure Study – Air Compressor**

The objective of this study was to create entries for industrial Compressed Air Systems (CAS) measures to be incorporated into the 2022 CT PSD. The new measures were developed through secondary literature review and through discussions with program administrators (PA) and program implementers. The primary source of information for the development of the new measures was the literature review. The team reviewed over 15 sources published between 2000 – 2021, including the following TRMs: IL, MA, Mid-Atlantic, MN, NH, NY, VT, WI.

The 2021 CT PSD did not include any compressed air systems measures. The team developed the electric energy and demand savings methodologies and inputs for each measure based on secondary research which included the evaluation and assessment of several TRMs’ methodologies. The team selected and developed the most appropriate savings calculation methodology for each measure by critically examining and evaluating the referenced sources, target system and baseline descriptions, and applicability of the measure in the reviewed TRMs. The sections below describe the savings calculation methodology for each measure. See Appendix A for complete write-up of each measure for entry into the PSD.

The following measures were developed as part of this study:

1. Variable Speed Drive-Controlled Air Compressors – Main Inputs for Measure

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Savings Factor | 0.189 kW/HP | DNV GL, 2015 |
| Summer Coincidence Factor | 94.7% | Coincidence Factor & Load Shape Study for 2022 CT PSD |
| Winter Coincidence Factor | 74.3% | Coincidence Factor & Load Shape Study for 2022 CT PSD |

2. High Efficiency Refrigerated Air Dryers – Main Inputs for Measure

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Savings Factor | 0.00554 kW/CFM | DNV GL, 2015 |
| Summer Coincidence Factor | 83.8% | Coincidence Factor & Load Shape Study for 2022 CT PSD |
| Winter Coincidence Factor | 77.7% | Coincidence Factor & Load Shape Study for 2022 CT PSD |

3. Efficient Compressed Air Nozzles – Main Inputs for Measure

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Specific Air Flow Reduction Percentage | 50% | Based on review of several manufacturers’ technical specifications sheets |
| Nozzle Usage Percentage of Total System Operation | 94.7% | Site specific. If unknown, use 0.03, based on 15 minutes per 8 hour shift |

\* The values of the marginal efficiency factor, efficiency of air compressor, and standard specific flow rates for various orifice diameter are to be determined from separate tables that are included in measure write-ups.

4. Compressed Air Leak Detection – Main Inputs for Measure

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| Summer Coincidence Factor | 94.7% | Coincidence Factor & Load Shape Study for 2022 CT PSD |
| Winter Coincidence Factor | 74.3% | Coincidence Factor & Load Shape Study for 2022 CT PSD |

\* The values of the marginal efficiency factor, efficiency of air compressor, and standard specific flow rates for various orifice diameter are to be determined from separate tables that are included in measure write-ups.

## **1931-4 New Measure for PSD – Advanced Lighting Controls (ALC), Phase 1**

The objective of this study is to create entries for new residential and commercial Advanced Lighting Controls (ALC) measures to be incorporated into the 2022 Connecticut Program Savings Document (CT PSD). In Phase 1 of this study, these new measures were developed through a literature review, discussions with experts, and program administrator (PA) interviews.

The primary source of information for the development of the new measures was the literature review. The team reviewed over 25 sources published between 2000 – 2021, including the following Technical Reference Manuals (TRMs): IL, MA, Mid-Atlantic, NH, NY, PA, RI, WI.

The three new measures developed as part of this study were:

1. Commercial Interior Lighting Controls (including networked lighting controls (NLC), luminaire-level lighting controls (LLLC), the combination of high-end trim with daylight dimming or occupancy sensors, dual occupancy and daylight controls, high-end trim, daylight dimming, and occupancy sensors),
2. Residential Connected LED Lighting, and
3. Residential Occupancy Sensors.

The new measure write-ups follow the format for direct insertion in the PSD and include description of the measures, savings methodologies with descriptions of the inputs and nomenclature, definitions for all the control technologies, and corresponding measure references and notes. NLCs and LLLCs are defined according to the DesignLights Consortium (DLC) NLC definition. DLC certification is not a requirement for this control type, but it is recommended that the programs consider eligibility requirements that ensure quality product is installed.

The commercial measures developed for Phase 1 of this study are applicable to all CT programs, including Energy Opportunities (EO), Midstream, and SBDI. The developed commercial measure is specifically for interior lighting controls and does not apply to exterior lighting, such as parking lot or street lighting. The team developed savings methodologies for each of the measures and selected control technologies based on the review of other TRMs.

The key factors to determine the measure energy and demand savings are the controls savings factors, which were selected through the literature review. The team identified three sources, which they felt had the best available information based on primary data for the corresponding controls technologies. Table 1 summarizes the savings factors for each measure/control type and the corresponding source.

**Table 1. New measure write-ups selected commercial and residential savings factors**

|  |  |  |  |
| --- | --- | --- | --- |
| Measure | Controls Technology | Savings Factor | Source |
| Commercial Interior Lighting Controls | Networked Lighting Controls (NLC) | 49% | DLC and NEEA, 2020 |
| Luminaire-Level Lighting Controls (LLLC) | 49% | DLC and NEEA, 2020 |
| Dual Occupancy and Daylight Sensors | 38% | Williams, et. al., 2012 |
| Combination of High-end Trim and Daylight Dimming | 35% | Calculated based on High-End Trim and Daylight savings factors from Williams, et. al., 2012 |
| Combination of High-end Trim and Occupancy Sensors | 33% | Calculated based on High-End Trim and Daylight savings factors from Williams, et. al., 2012 |
| High-End Trim | 27% | DLC and NEEA, 2020 |
| Daylight Dimming | 28% | Williams, et. al., 2012 |
| Occupancy Sensors | 24% | Williams, et. al., 2012 |
| Residential Connected LED Lighting | Connected LED Lighting | 29% | Navigant, 2019 |
| Residential Occupancy Sensors | Occupancy Sensos | 17% | Navigant, 2019 |

The study team believes the results of the Phase 1 research are sufficient to immediately add these new measures to CT’s PSD. In Phase 2 researchers will refine the measures’ factors based on primary research.

## **X1931-6 Hours of Use Documentation for PSD**

This report presents the results of the primary research to update and document the source of the hours of use (HOU)/full load hours (FLH) values presented in Appendix Five of the Connecticut Program Savings Document (PSD). This research study was commissioned by the Connecticut Energy Efficiency Board (EEB) Evaluation Administrators (EA) as part of the ongoing project X1931 PSD Review and Update project.

The CT PSD reports default HOU/FLH values for 60 commercial and industrial (C&I) facilities; however, the source and recency of those HOU/FLH values are unknown. The objective of this research study was to identify and document the source of PSD’s default C&I HOU/FLH values and to update the HOU/FLH values as available.

Key Findings:

This study involved documenting the source and updating, as applicable, the CT PSD’s C&I default HOU/FLH values for the following end uses: lighting, HVAC fan, heating, cooling, heating pump, and chilled water pump (CHWP) and cooling towers. The PSD primarily uses the default HOU/FLH values in savings calculation algorithms of C&I measures when site-specific HOU/FLH values are not available.

For the lighting end-use category, the study updated HOU values based on the most recent CT1 and MA HOU2 update studies. We developed HOU/FLH values for the remaining end-uses based on eQuest simulation of commercial building prototypes. Overall, the updated HOU/FLH values presented in this study are 7% higher compared to the C&I default HOU/FLH values reported in the most recent (2021) version of the PSD. Notably, the study team found significant differences in HVAC fan motor and heating pump HOU values. The report includes updated HOU/FLH values for all 60 PSD C&I facilities.

## **X1931-7 Degree Days Update for PSD**

This report presents the results of primary research to update the heating degree day (HDD) and cooling degree day (CDD) values recommended in the Connecticut Program Savings Document (PSD). This research study was commissioned by the Connecticut Energy Efficiency Board (EEB) Evaluation Administrators (EA) as part of the ongoing project X1931 PSD Review and Update project. The 2021 PSD recommends a single set of statewide HDD and CDD values, which were developed using historical (1978-2008) weather data of the Hartford weather station. The objective of this research study is to update the PSD’s recommended HDD and CDD values to reflect more recent climatological trends among all weather stations in CT.

**Key Findings:** This study involved recalculation of HDD and CDD values based on 2005-2020 weather data of ten Connecticut weather stations listed on the National Oceanic and Atmospheric Administration’s (NOAA) website. The PSD primarily uses HDD and CDD values in the savings estimation for residential weatherization measures such as insulation. The study developed statewide, utility-specific, and regional (inland/coastal) HDD and CDD values representative of the state’s ten weather stations based on residential population weighting. As shown in Table 1-1 and Table 1-2, the updated statewide HDD and CDD values are 7% lower and 28% higher than the HDD and CDD values recommended in the 2021 version of the PSD, respectively. Notably, the study team found key differences in HDD and CDD values between inland and coastal regions, reflecting the climatological differences in those regions.

**Table 1. 2021 CT PSD HDD values and updated HDD values**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **CT PSD HDD Values** | **Updated HDD Values** | **% Difference** | **ASHRAE Adjustment Factor (Fadj)** |
| Statewide | 5,885 | 5,362 | -8.9% | 0.61 |
| Eversource | 5,885 | 5,473 | -7.0% | 0.61 |
| UI | 5,885 | 5,165 | -12.2% | 0.60 |
| Inland | 5,885 | 5,578 | -5.2% | 0.61 |
| Coastal | 5,885 | 5,019 | -14.7% | 0.60 |

**Table 2. 2021 CT PSD CDD values and updated CDD values**

| **Description** | **CT PSD CDD Values** | **Updated CDD Values** | **% Difference** |
| --- | --- | --- | --- |
| Statewide | 603 | 772 | 28.0% |
| Eversource | 603 | 757 | 25.5% |
| UI | 603 | 864 | 43.3% |
| Inland | 603 | 740 | 22.7% |
| Coastal | 603 | 823 | 36.5% |

**Recommendations:** To best characterize the weather-dependent impacts of measures such as residential weatherization, the study team recommends that future versions of the PSD adopt the inland/coastal HDD and CDD values and the corresponding ASHRAE adjustment factor values presented in this study. The study team acknowledges that adoption of two different HDD and CDD values may introduce complexity within the utilities’ tracking systems. As an alternative, the study team recommends that the PSD adopts utility-specific HDD and CDD (and the corresponding ASHRAE adjustment factor) values as presented in Table 1-1 and Table 1-2 in the report. The HDD and CDD values should be updated in the specific sections of the PSD listed in the report.

## **X1931-8 New Measure – Updated Thermostats**

The objective of this study was to create the entry for a new commercial advanced thermostat measure to be incorporated into the 2022 Connecticut Program Savings Document (CT PSD). In Phase 1 of this study, this new measure was developed through literature review and discussion with experts. The primary source of information for the development of this new measures was the literature review. The team reviewed over 25 sources published between 2012– 2021, including the following Technical Reference Manuals (TRMs): IL, MA, Mid-Atlantic, NY, and WI.

The commercial advanced thermostat measure is for replacing an existing manual or programmable thermostat with an ENERGY STAR® certified smart thermostat. A smart thermostat is a thermostat that can be controlled remotely with a phone, tablet, or other internet-connected devices. Using features like learning, scheduling, geofencing, by diagnosing problems with the HVAC system, and by reminding users of when it’s time to perform HVAC system maintenance, a smart thermostat ensures that the HVAC system runs efficiently and that the controlled space is heated or cooled only as much as needed, reducing heating and cooling energy consumption.

As explained in the measure definition above, the measure is for installing ENERGY STAR certified smart thermostats – it is recommended that the programs consider ENERGY STAR certification of the installed thermostats as a measure eligibility requirement. The commercial advanced thermostats measure developed for Phase 1 of this study are applicable to all CT programs, including Energy Opportunities (EO), Upstream, Midstream, and SBDI. The full report describes the measure savings methodology, the selection of the measure savings factors, and the topics that will be investigated in Phase 2. Appendix A of the report includes complete measure write-ups for entry into the PSD.

* Recommendations for New Measure Savings Methodology: The energy and demand savings methodologies and inputs based on the TRMs reviewed as part of the literature review are provided in the report.
* Savings Factor: The Commercial Savings Factors developed from the literature are 4.5% for the heating savings factor, and 2% for the cooling savings factor.
* Effective Useful Life: The effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. For smart thermostats, the team recommends using an EUL of 9.1 years
* Retrofit Gross Seasonal Peak Demand Savings, Electric (winter and summer) Assumed to be zero until additional information is available.

**Phase 2 Areas of Interest**

Based on the literature review and the discussions during the presentation of the Phase 1 results, the team identified the following topics to be investigated further during Phase 2 of this study.

* Update CBECS heating and cooling energy intensities with CT specific energy intensities from the x1931- 6 Hours of Use/ Full Load Hour Update study.
* Potential data collection and metered/billing analysis in small businesses to develop CT specific savings factors for smart thermostats.
* Update measure savings algorithms based on phase 2 findings. To investigate these topics, the team will request any available, applicable data from the utilities and will develop questions to include in the expert interview and market actor interview guides that address these topics.

## **X1939 Early Retirement Programs, Phase 1**

The X1939 Early Retirement Evaluation project involves the evaluation of Early Retirement programs as well as providing feedback on the adoption of dual baseline methodologies for other programs where existing equipment may be used as the baseline. The Early Retirement programs are specific initiatives launched in CT to achieve energy savings by driving the removal of working equipment. This study consists of five objectives addressed through two phases: best practices research and the impact evaluation of the programs.

The report addressed the first phase of the X1939 study, focusing on best practices recommendations for data and lifetime savings calculations, evaluation considerations and early retirement program design. The recommendations that are within the data and lifetime savings calculations and evaluation considerations categories apply to all programs that include a retrofit component, while the early retirement program design recommendations focus on early retirement programs specifically. The study reviewed practices in three key jurisdictions across the country, MA, NY, and CA. The authors performed secondary research, six in-depth interviews with program staff in other states, and six in-depth interviews with trade allies in CT, some of which had bid into the competitive bid programs released to date in CT.

The team identified eleven practices and recommendations that will aid the adoption of dual baseline calculation methodologies as well as the performance and the evaluation of Early Retirement programs. These recommendations and the categories within which they fall are summarized in the table below.

| Category | Recommendation Summary |
| --- | --- |
| Data and Lifetime Savings Calculations | 1. Adopt clearly defined protocols with respect to assigning an event type (retrofit, replace on failure, early retirement).  2. Use the values in the CT PSD where they are listed for remaining useful life (RUL), and elsewhere where dual baseline calculations should be adopted, use 1/3 of the EUL.  3. Collect additional information on RUL to inform that 1/3 EUL assumption.  4. Expanded use of dual baseline calculation approaches should be adopted when calculating lifetime gross savings for retrofit measures.  5. Use of a calculation tool can help dual baseline adoption in the state. Evaluation Considerations |
| Evaluation Considerations | 6. Clear, defensible documentation is the most important aspect in ensuring that savings are upheld through evaluation. |
| Early Retirement Program Design | 7. Timing is critical for the customer decision process.  8. Plan programs further in advance and hold vendor trainings well in advance of program release.  9. Use energy studies to bolster customer relationships and to identify target equipment for early replacement.  10. Test the BCR models at varying incentive levels and if it passes the BCR tests, incent up to 40% of the cost to maximize market impact.  11. Use of market studies can be beneficial to identify opportunities and target replacement in bulk such as with residential or commercial programs. |

## **X1941 MultiFamily Impact Evaluation and Baseline**

The **Multifamily (MF) Impact Evaluation (X1941)** project conducted by TRC (the research team) contains two main elements related to updating the PSD with improved results from primary and secondary sources:

* A review of the array of CT PSD values related to multifamily measures, involving extensive research of the evaluation literature nationwide and regionally, and a review of leading TRMs / PSDs in other states. Previously, CT’s MF PSD values were based on single-family or commercial values. This work included specific recommendations for updated MF PSD values, and was included in a separate report[[4]](#footnote-4) and is briefly summarized in Chapter 3.
* An impact evaluation of Eversource and United Illuminating’s (UI) Multifamily Initiative for program years 2017-2019. Impact evaluations are the key source for CT-specific PSD updates, and an impact evaluation of multifamily retrofit programs had not been conducted for Eversource and UI for at least ten years. This provides multifamily-specific values for measure level savings, and this work is the subject of this report.

The research team proposed updates to the **2020 CT PSD** focused on providing multifamily-specific values for measure-level savings. Based on the findings from the data-driven engineering review, the research team proposed revisions to the 2020 PSD to reflect the accepted engineering assumptions for multifamily building characteristics and operations. The following is an overview of recommendations:

* Updates to hours of use specific to multifamily buildings.
* Clarifications for how certain measures should be applied in multifamily projects.
* Update to coincidence factors for some measures so they are specific to multifamily common areas.
* Different assumptions for multifamily buildings for some measures, such as base case gas usage for heating savings and capacity assumptions for Wi-Fi thermostats due to the smaller size of multifamily dwelling units (compared with single-family), and default efficiency values for multifamily equipment,
* Multifamily-specific equations for a few measures, including for central furnaces and air conditioners (due to different usage patterns compared to commercial buildings) and low-flow fixtures (due to typically lower numbers of bathrooms per unit than in single-family homes)

Note that almost none of these recommendations are incorporated into this impact evaluation, because these recommendations would be incorporated into future versions of the PSD. The two exceptions were the recommendation to adjust the low-flow fixture equation, because the research team believed the equation in the 2020 PSD was not mathematically correct, and to adjust the residential lighting baseline so it aligns with a federal regulation (Energy and Security Independence Act – EISA) that has been effective since 2014.

The Multifamily Initiative includes multiple energy efficiency retrofit programs that support multifamily buildings or complexes with five or more units. This impact evaluation is focused on projects tracked through the Home Energy Solutions (HES) and HES-Income Eligible (HES-IE) programs,[[5]](#footnote-5) which this study found to provide the vast majority (if not all) savings for the Multifamily Initiative[[6]](#footnote-6).

The **main objectives** of this study were to:

* Calculate program-level realization rates,
* Calculate measure level realization rates (only possible for Eversource, since the UI program database does not track savings at the measure-level), and
* Identify opportunities to improve realization rates in the future, and for additional savings opportunities.

The research team calculated prospective (based on the 2020 PSD) and retrospective (based on the PSD for each program year that the measures were installed: 2017 through 2019 PSD) realization rates. This report only shows prospective results since retrospective results were very similar to prospective for almost all measures.

In addition, the research team conducted a “deep dive” investigation of the air sealing measure, a commonly installed in-unit measure within the HES and HES-IE programs, to develop recommendations to improve the robustness of savings claims from air sealing, and the persistence of savings from this measure.

The research team verified savings as well as calculated retrospective and prospective realization rates using data from a sample of facility managers[[7]](#footnote-7) on measures installed at a sample of project sites. The research team verified the savings at the measure and site level, and extrapolated site-level savings to program-level results for annual energy (kWh, ccf, and BTU), demand, and lifetime savings; and project-level savings for delivered fuels. For Eversource, which tracks savings in its database at the measure-level, the research team also calculated measure-level realization rates for commonly installed measures.

**Results:**

**Program level realization rates**: At the program level, the realization rates (RRs) were moderately high or high, and similar for HES and HES-IE for both utilities for most metrics (annual kWh, lifetime kWh and annual CCF), with the exception of summer kW for both utilities. These results are shown in Table 1 and Table 2, where \* indicates the value met or exceeded 90% confidence, 10% precision. Specifics follow:

* Installation count issues and calculation errors: Most of the adjustments made to the realization rates were the result of either a misapplication of the correct values in the ex ante calculations, or adjustments made to the installation counts. This latter problem occurs often with instances of double-counting misspecification, or omission of measures in the records.
* Coincidence factor issue: For demand savings, HES had a much higher realization rate for summer demand (summer kW), while HES-IE had a much higher realization rate for winter demand (winter kW). The study found the HES-IE program had more savings from common area and exterior lighting compared to HES. The research team decreased summer demand and increased winter demand savings to correct the fact that the *ex ante* claims had used incorrect coincidence factors for the measure.
* Gas Saving vs. kW savings issue: Eversource had a moderately lower realization rate for winter kW and had a much higher realization rate for annual CCF. Eversource had a lower winter demand savings realization rate because there were 27 projects in which Eversource claimed winter demand but realized demand savings were zero (0), in part because Eversource had misapplied peak *natural gas* savings to peak *demand (kW)* savings in several cases. UI had a lower annual gas (CCF) savings realization rate because UI awarded gas savings to one lighting project and claimed two gas savings measures that could not be documented as installed.

**Table 1. Program level realization rates**

|  |  |  |
| --- | --- | --- |
| By Program | | Mean Realization Rate (90% Confidence Interval) |
| Annual kWh | HES-IE | 87%\* (81 - 94%) |
| HES | 84%\* (79-89%) |
| Lifetime kWh | HES-IE | 82% (72-92%) |
| HES | 86%\* (80-92%) |
| Summer kW | HES-IE | 56% (39-73%) |
| HES | 75% (68-81%) |
| Winter kW | HES-IE | 89%\* (81-97%) |
| HES | 61% (47-76%) |
| Annual CCF[[8]](#footnote-8) | HES-IE | 93% (79-108%) |
| HES | 91% (71-111%) |

**Table 2. Program level realization rates by utility**

| Program level realization rate by Utility | | Mean Realization Rate (90% Confidence Interval) |
| --- | --- | --- |
| Annual kWh | UI | 85% (75-95%) |
| Eversource | 86%\* (81-90%) |
| Lifetime kWh | UI | 83% (70-96%) |
| Eversource | 86%\* (81-91%) |
| Summer kW | UI | 58% (40-77%) |
| Eversource | 58% (49-66%) |
| Winter kW | UI | 87% (77-97%) |
| Eversource | 75% (64-86%) |
| Annual CCF | UI | 80% (61-100%) |
| Eversource | 102% (89-116%) |

**Measure-level ex post realization rates:** The research team developed measure-level ex post RRs for Eversource only because UI does not currently collect savings data at the measure level. Results are showing in Table 3. Realization rates for the top savings measures are summarized here:

* Common area and exterior lighting: The research team found a high realization rate for annual electricity savings (97%) and winter demand (118%), and a low realization rate for summer demand (47%).
* Dwelling unit lighting: This measure showed a moderately high rate for annual electricity (67%) and demand savings (70% summer, 81% winter).
* Air sealing: Air sealing shows a very high realization rate for annual kWh (98%), annual CCF (172%), and summer demand (100%); the realization rate was lower but still high for winter demand (86%).
* Refrigerators: This measure had a moderately high realization rate (80% for annual electricity, summer, and winter demand).
* Other measures: The insulation measure also had a high realization rate for annual electricity (100%), gas savings (100%), and demand (100%). Other measures, like ECM pumps, showed a low realization rate for annual electricity savings (59%) and winter demand (68%).

The study found more diversity of gas saving by measure type than for electricity. Specifically, the combination of common area/ exterior and dwelling unit lighting comprises 80% of the program’s ex ante electricity savings. The PSD review phase of this project found that realization rates and attributable savings (relative to baselines) for lighting are declining significantly, and savings opportunities will sunset because the market is naturally adopting LEDs. This threatens the future viability of the program at its current electricity and demand savings levels, since continued reliance on lighting will lead to lower savings if the market baseline is accounted for in the PSD. However, the Conservation and Load Management (C&LM) Plan does assume lower savings from this program after 2018, so this decline is anticipated[[9]](#footnote-9).

**Table 3. Measure Level Ex Post Savings Results (Eversource only)**

| Measure | Annual kWh | Annual CCF | Lifecycle kWh | Summer Demand | Winter Demand |
| --- | --- | --- | --- | --- | --- |
| Common Area and Exterior Lighting | 97%\* | - | 96% | 47% | 118%\* |
| Dwelling Unit Lighting | 67% | - | 45% | 70% | 81% |
| Refrigerators | 80% | - | 67% | 80% | 81% |
| Air Sealing | 98% | 172% | 104% | 100% | 86% |
| ECM Pumps | 59% | - | 67% | - | 68% |
| Windows | 83% | - | 83% | - | 79% |
| HVAC Heat Pumps | 100% | - | 100% | 100% | 60%[[10]](#footnote-10) |
| Boilers | - | 80% | - | - | - |
| Insulation | 100% | 100% | 80% | - | 100% |
| Low Flow Fixtures | 88% | 107% | 130% | - | 14% |

The research team developed recommendations to improve realization rates in the future and for additional savings opportunities. The recommendations are described in detail in the report.

**Recommendations for Eversource**:

* Develop a final review process for each project to verify the following:
  + All measure installations are documented,
  + The number of measure installations align with the correct PSD calculations,
  + The correct heating fuel is identified,
  + Winter demand is claimed only for electric measures, and
  + All measure installations are documented,
  + The number of measure installations align with the correct PSD calculations,
  + The correct heating fuel is identified,
  + Winter demand is claimed only for electric measures, and
  + The presence of air conditioning is captured correctly.
  + Correct measure-level program calculators as noted in Section 6, including:
  + Correct coincidence factors for demand calculations
  + Ensure that ECM Pump projects follow calculation for that measure
  + Update the low-flow fixture calculation to align with the 2021 PSD.
  + Consider “rolling up” the savings for measures listed twice for the same site. Several projects had the same measure listed twice in the databased, and the second entry often had a zero or low realization rate.

**Recommendations for UI**:

* Track savings at the measure level in the database.
* Add a comparison of measure-level roll-up savings to the project-level claimed savings for each project.
* Update the data management system to include the service address in all tracking records.
* Develop a process so the tracking systems maintain a consistent link between electric and gas work on the same projects.
* Provide some sort of clarification in files to distinguish outdated files from files with updated (correct) information, such as archiving old files, adding dates to file names, or adding “final” to file name of final documentation.
* Similar to the first recommendation for Eversource, develop a final review process for each project to verify the accuracy of information compared to the final documented information.

**Recommendations for Both Utilities:**

* Phase out savings from lighting. Consider removing the dwelling unit lighting incentive immediately, since LEDs are standard practice and incumbent technologies (incandescent) have short measure lives. Consider phasing out common area and exterior lighting in the next few years; these incumbent technologies (fluorescent and high intensity discharge fixtures) have longer measure lives, so are likely still serving as installed fixtures. However, these should also be sunset in a few years, given the market’s natural adoption of LEDs.
* Continue to offer the comprehensive bonus and potentially increase it, or provide an additional kicker for non-lighting measures, like HVAC or domestic hot water (DHW) replacements, duct insulation, or for ≥ 15% savings. In addition, the utilities could consider that a maximum portion of a project’s savings (e.g., < 50% savings max) come from lighting.
* Highlight case studies of HVAC or DHW measures at annual meeting and/ or provide annual awards for projects with diverse scopes of work or that installed a less commonly installed measure.
* Investigate measures with future savings opportunities. This should include an investigation of electrification measures (e.g., estimates of energy and carbon impacts from moving from fossil-fueled based HVAC and DHW measures to electric sources such as heat pumps) to inform policy discussions that could consider allowing fuel switching in the program.

# 3. STUDIES IN PROGRESS IN 2021

The following studies had kick-offs in 2020 or 2021 and were still in progress at the end of 2021. Note that study numbers beginning with C are commercial, R means residential, and X studies cross both residential and commercial sectors.

## **C1902 – Energy Consious Blueprint (ECB) Net to Gross (NTG) and Baseline Study**

The Energy Conscious Blueprint (ECB) program serves commercial, industrial, or municipal customers of any size from Eversource, United Illuminating (UI), Connecticut Natural Gas (CNG), and Southern Connecticut Gas Company (SCG). The program offers incentives for new construction, major renovation, and tenant fit-out projects, as well as new (or end-of-useful-life replacement) equipment projects. Utility energy experts work with customers and design teams (architects, engineers, contractors) to identify potential energy conservation measures (ECMs). Savings estimates are calculated in advance of implementation, and upon completion and verification of measures, customers receive incentive payments. Projects may include energy-efficient lighting, HVAC, whole-building performance, energy- efficient envelopes, refrigeration, water heating equipment, or process equipment.

This study focuses on key issues related to proper baselines. This study will update baselines and net-to-gross ratios for true new construction and end of life replacements. It will incorporate baseline assessment to ensure that savings and program attribution calculations are aligned. This study updates specific PSD values that are widely used across the ECB program in savings analysis and reporting. The study will improve the accuracy of gross and net savings estimates by integrating research into market baselines, free ridership and spillover under a single study. The study will improve alignment between baseline and free ridership data to minimize the potential for double-counting impacts, particularly where market practices are better than common baselines.

## 

## **C1906 – Strategic Energy Management (SEM) Program Evaluation.**

The C1906 SEM Best Practices and Evaluation project focuses on evaluating the Strategic Energy Management (SEM program), a specific initiative of the Business and Energy Sustainability (BES) program designed to achieve energy and non-energy benefits. The study consists of three phases: the evaluation method development, the SEM process evaluation, and the SEM impact evaluation.

This report addressed the first of three components of the C1906 study, focusing on best practices recommendations and data requirements for SEM program evaluation in Connecticut. ERS and IEc (“the team”) reviewed eight SEM evaluation reports that covered program activity in 12 states, along with 16 other papers and technical documents, to develop the findings presented in this report. The authors also conducted in-depth interviews with program managers, implementers, and industry experts from across the country, many of whom contributed to the evaluation reports that were reviewed. Overall, the team completed 10 interviews, including 4 with evaluators, 3 with technical leads, and 3 with SEM implementers.

For this component of the study, the team identified the following program practices and observations that will aid the evaluation of SEM programs in Connecticut: The implementer should collect and store robust data on energy consumption, facility characteristics, weather, and other influential independent variables as this data are essential for SEM evaluation. Developing and testing the baseline model before starting the program will give indication of whether a whole facility analysis will work based on an estimate of fractional savings impacts of the program and the expected fractional savings uncertainty.

1. The implementer bears significant responsibility for data collection. The nature of the SEM relationship with implementers allows for good access to data during the engagement period.
2. The default savings approach should include a robust top-down analysis model that has been tested for validity and has accounted for non-routine adjustments and other factors. The model should meet established standards for mean bias error (MBE) and coefficient of variation of root-mean squared error (CV(RMSE)) as set out by ASHRAE Guideline 14 and expected savings should exceed the fractional savings uncertainty; otherwise, a bottom-up analysis approach should be taken.
3. Stakeholders should agree upfront on the data and methodological requirements for the SEM savings model and have a contingency plan in place. The requirements should specify the data collection protocol and accepted method(s) to calculate SEM impacts.
4. Non-routine events must be diligently identified, documented, and accounted for during reported savings estimation. The identification and explanation of non-routine adjustments (NRAs) is easiest during implementation.
5. Measure lives/persistence assumptions vary widely by program and region and must be investigated for Connecticut’s SEM program design. The measure life for SEM in the 2020 Connecticut program savings document (PSD) is 4 years. From literature review and expert interviews, SEM measure lives in other jurisdictions ranged from 1 to 7 years, with most programs centering on a 3- to 5-year period for SEM interventions.

## **C2014 – C&I Lighting Saturation and Remaining Potential**

The *C2014 C&I Lighting Saturation and Remaining Potential* study addresses the question, “How much potential remains for lighting measures in the Connecticut C&I market today and over the next ten years?” The study objectives are:

1. understand the current C&I lighting market saturation by technology, application, and building type for both participant and non-participant customers;
2. forecast Connecticut lighting potential over the next ten years; and
3. characterize current lighting purchasing behavior.

The study leverages a similar but larger effort in Massachusetts by using the same adoption curves and measure costs, savings and lives, modified for the Connecticut market. Data collection methods include customer surveys, on-site surveys, and market actor interviews. In addition to reporting current and forecast C&I lighting saturation of lighting technologies including LED penetration the study will deliver a proprietary Connecticut lighting market model in Excel to forecast 2020-2029 lighting fixture counts including control status. The output is like the Massachusetts model providing a record for each unique combination of year, lighting system application (six types), technology (ten types), facility (seven types), and control type.

## **C2117 Persistence Study for Retrocommissioning Measures**

This study is focused on understanding the persistence of RCx measures, to provided updated values for the PSD. The last CT study was published in 2013 covering PY 2008-2010 and only covered persistence of treated air compressor leaks. This study will conduct a literature search, staff interviews, and program tracking analyses to:

1. summarize findings by measure from other regional and national studies and
2. prioritize Energize CT RCx measures for an in-depth persistence evaluation and
3. develop defensible, recommended values for the CT PSD.

## **R1965 - HP/HPWH Baseline and Potential Assessment.**

With the Connecticut Utilities considering a shift in the residential market toward efficient heat pump systems, it is critical to gain a full understanding of these markets in terms of their size, the key market actors, and the drivers and barriers that affect adoption. There are a number of key questions. How many of these systems are sold, and into what supply chain channels? Do market actors see a value proposition for these products? Is the air source heat pump (ASHP) market trending toward ductless mini-splits, or is there increasing interest in less-visible distribution systems that use ducts or in-ceiling cassette blowers? Will the efficiency of heat pump water heaters (HPWHs) compensate for their complex installation requirements? Do mini-split ASHPs and ground source heat pumps (GSHPs) meet the needs of the retrofit market?

The study will incorporate multiple primary and secondary data sources to estimate the size of the market in Connecticut. Secondary sources include previous baseline studies, purchased sales data, as well as shipment data. Primary data collection work will solicit feedback from manufacturers, distributors, and installers through interviews and interactive surveys to better understand the future of the market for heat pumps, as well as system configurations that are dominating the market. The project will provide results from cost effectiveness testing at the measure level, focusing on particular system configurations of interest to identify the most cost-effective systems and system installation configurations for the Utilities to consider in order to meet the C&LM goals for heat pumps. This study will take an in-depth dive into the state of the Connecticut market for heat pumps and heat pump water heaters, investigating the size and state of the market, what market actors think about these technologies, real-world factors affecting heat pump installations in homes, and how the Utilities can best promote cost-effective heat pump programs, given the rapid change in heat pump technologies.

## **R2027 – Heat Pump and Heat Pump Water Heater Reliability Study**

This study is assessing the reliability, repair costs, satisfaction, and perceptions associated with heat pumps (HPs) and heat pump water heaters (HPWHs). HPs include the three types supported by CT programs: ductless split air-source heat pumps (DSHPs), central ducted air-source heat pumps (central ASHPs), geothermal (ground-source) heat pumps (GSHPs). The study is collecting information on contractor callbacks, customer satisfaction, perception, and cost of repairs, and the goal is to provide recommendations for program planning. The project is being coordinated with two other studies (X1942 and R1965) for efficiencies. The project’s efforts include:

* Detailed literature review to compile data and literature providing baseline information on topics that address HP/HPWH reliability and customer satisfaction and perceptions, as well as costs associated with HP/HPWHs. The literature review is also being used to benchmark and enrich the study’s results.
* Installer Surveys and In-depth interviews . These surveys will gather data on service frequency and type of service and repair calls, operational issues, repair costs, skepticism among customers, and customer complaints.
* Surveys of participants installing HP and HPWH. These web-based surveys are gathering information on satisfaction with measure, frequency and type of issues, repair costs, experience in cold weather. It will also gather baseline details of replaced equipment and other mechanical configurations as well as non-energy impacts.
* The report is focused on concise results, and actionable recommendations for HP/HPWH program planning.

## **R1968 - RNC Baseline and Code Compliance (Phase 1)**

Residential new construction (RNC) baseline studies are typically conducted one year after a code change. This allows the study to capture some homes built at the end of the old code and some at the beginning of the new code. This type of study is becoming harder and more expensive to accomplish for a number of reasons: difficulty in unbiased recruitment of non-participant homes, difficulty in measuring energy efficiency differences after construction is completed, and difficulty in parsing out program and code effects. The study will gather data on code compliance, baseline, and may provide information related to industry standard practice (ISP) in new construction.

## **R1982 - HVAC / DHW Performance & Potential Evaluation**

This project is focused on obtaining up-to-date performance measurements for two emerging technologies: mini-split heat pumps and heat pump water heaters. This project will install metering equipment in 150 homes in Connecticut to provide detailed energy use and load shapes for prevalent HVAC and DHW equipment types. This data will update the PSD values for efficiency, annual use, seasonal peak and off-peak loads.

The project will install end-use metering equipment on major energy-consuming equipment in 150 single-family homes across Connecticut. Emphasis will be on selecting homes with heat pumps or heat pump water heaters, though the sampling plan includes homes that have furnaces, boilers, or other types of water heaters. Meters will remain in place for at least one year so that data from summer and winter periods will be collected. When possible, other large electric equipment will be metered. Together this project will update baseline and efficiency assumptions in the PSD. It will also provide better load shape data for use in demand-response studies and as inputs to the New England ISO.

## **R1983 HES & IE Process and NTG Evaluation And Impact Evaluation (R1984)**

This project is conducting a comprehensive process evaluation and impact evaluation of the single-family portions of the Home Energy Solutions (HES) programs and HES-IE (income-eligible) program. The HES and HES/IE Programs are the biggest programs in Connecticut’s residential portfolio. The process evaluation focuses on program process and efficiency, document and performance review and a substantial customer profiling / data mining effort. The impact evaluation quantifies gross and net savings, NTG, and realization rates at the end use and measure level – with a drill-down on drivers for unexpected results.

The process component uses document review, interviews, and hundreds of surveys to examine: workforce needs, marketing and customer /engagement, recruitment, program delivery, quality assurance and vendor performance, vendor business models and viability, costs assessment, data collection and management, the role of financing including coordination with the Green Bank, and customer satisfaction. The program tracking database review is examining: performance, performance by contractor and utility (and possibly region or other factors), backlogs, percent with deeper measures, and other statistics.

The data-centric residential market assessment / customer profiling effort is examining what areas and customer types have been served by the residential efforts and where opportunities lie to improve participation, assess equity issues, and inform program refinement, with results stratified by renters, low and moderate- income households, households that have limited English proficiency, distressed areas, and other subgroups.

The impact evaluation is very important to Connecticut’s update of the PSD values for this program and uses surveys and statistical analysis to provide measure- and end-use related consumption, savings and realization rates, and include a detailed drill-down of drivers for the results. A comparison to recently-completed work using Recurve will also be conducted.

The major parts of the project are expected to be completed by Summer 2021, with additional research results delivered in late 2021 and early 2022.

## **R2015 – Low Load Residential New Construction**

This study uses information gathered from literature reviews and in-depth interviews to conduct a technical and cost effectiveness study of strategies to produce low energy consumption residential new construction. The study will include the Passive House low energy construction standard, zero net energy standards and other programs that promote highly efficient low load buildings. Energy savings, incremental construction costs, and customer acceptance will be examined for single family and multifamily new construction. Beneficial electrification and integration with battery storage systems will be examined. Barriers to adoption, such as contractor readiness, training needs, customer acceptance will be identified. Study will include literature review of evaluations similar program offerings in other states, and interviews with IOU staff, contractors, design/build professionals and homeowners. For the budget attached to this project, we do not expect it will be able to conduct more detailed tasks (e.g., engineering analysis including building simulation modeling to evaluate the technical potential of various low energy design approaches in CT buildings) but we are interested in information from the literature that will provide information / analysis of construction cost estimates of designs resulting from the strategies to assess cost effectiveness.

## **R2029 – Single Family Weatherization Metric and Update**

This study’s goal is to develop and estimate a quantitative indicator of progress toward the Legislature’s Weatherization Goal that can be estimated and reviewed on a regular periodic basis, be reasonably inexpensive to measure, and reflect the progress over time. The goal is to leverage available secondary data, potentially from the HES / HES-IE program and from CT participants in the national Weatherization Assistance Program (WAP) to create this metric.

In 2011, the CT legislature established a goal of having 80% of homes weatherized by 2030; however, the legislature was mute on the definition of weatherization. The 2014 R5 Study developed housing “types” and inspected 180 homes to assess the performance of homes relative to EEB's draft weatherization standard. The weatherization definition used was based on presence of various measures on-site, some of which could be validated on-site, and some of which ultimately could not be inspected in a practical / reliable way. The study found a significant shortfall in meeting the goal, but also cost a great deal to conduct, so it is not a feasible source for frequent updates monitoring progress. This analysis relies on a “desk study” approach rather than a primary data study with on-site data collection.

These findings are out of date at this point, but a progress metric toward the Legislative goal of 80% Residential Weatherization is a priority to DEEP. This study is tasked with:

* Identifying one or more feasible, workable, replicable weatherization definitions, with recommendations for best metric
* Quantification of the metric based on readily-available data to be reviewed by EM&V, DEEP and potentially a public process,
* Revisions as needed, and instructions (and data sources) for implementation of the metric into the future, and
* Coordinating with / supporting DEEP on aspects of the public process.

**Researchable Questions**:

* What progress is being made toward the 80% weatherization goal? How much progress is still needed?
* Is this a workable definition for “weatherization”? What other definitions may be appropriate and/or feasible and measurable? Can this (or another reasonably-feasible) method be used to track progress going forward in-between larger field inspection-based studies of weatherization progress?

## **1931-4 New Measure for PSD – Advanced Lighting Controls (ALC), Phase 2**

Phase 1 of this study is described above. The objective of this study is to create entries for new residential and commercial Advanced Lighting Controls (ALC) measures to be incorporated into the 2022 Connecticut Program Savings Document (CT PSD). In Phase 1 of this study, these new measures were developed through a literature review, discussions with experts, and program administrator (PA) interviews. The three new measures developed as part of this study were:

1. Commercial Interior Lighting Controls (including networked lighting controls (NLC), luminaire-level lighting controls (LLLC), the combination of high-end trim with daylight dimming or occupancy sensors, dual occupancy and daylight controls, high-end trim, daylight dimming, and occupancy sensors),
2. Residential Connected LED Lighting, and
3. Residential Occupancy Sensors.

The primary source of information for the development of the new measures was a detailed literature review. The Phase 1 research was sufficient to immediately add these new measures to CT’s PSD. In Phase 2, the researchers will refine the measures’ factors based on primary research.

## **X1931- 5 Commecial Refrigeration Efficiency Update Study**

This study is part of the ongoing X1931 projects to update prioritized PSD values. This study will update the average coefficient of performance (ACOP) efficiency values of commercial refrigeration equipment for use in the PSD. This study will develop methods and results of research to quantify ACOP efficiency values that represent commercial cooler and freezer refrigeration systems in Connecticut. The PSD uses the ACOP efficiency value to estimate annual energy impacts of measures that include refrigerator LED lighting, evaporator fan controls, evaporator fan motor replacement, and door heater controls. The study will develop next versions of the PSD to replace the preexisting average coefficient of performance efficiency values for commercial freezers and coolers. The study will also recommend updates to associated savings calculators and tracking systems to incorporate new ACOP values based on the research from this study.

## **X1932 – Evaluation of Demand Reduction (DR) Programs (UI & Eversource, All Sectors)**

The CT utilities are increasing their attention to other types of programs as the reliance on lighting decreases. This includes demand reduction (DR) programs. There are a number of DR Projects / Pilots being developed by the utilities within the energy efficiency portfolio. Because the Utilities are offering a number of the DR programs across state lines, some of the DR projects / pilots are being assessed by independent evaluators in another state. However, this project is conducting evaluations of DR programs specific to CT, including HVAC and thermostat equipment, an Air conditioning project, and others.

The study is providing up-front work to ensure that the DR pilot projects are structured in a way that allows evaluation of results in consistent and valid manner, and collects data needed to conduct defensible estimates of kW savings for the program. After the fast-track review of the set of existing DR pilot evaluations, the work will involve monitoring / critiquing the pilots, assuring evaluations and pilots are well-designed for evaluation; and conducting evaluations of potential future pilot designs/performance. Depending on implementation schedule and number of participants in the program, the project will also estimate the kW savings associated with the program.

**Researchable Questions**

1. What kW reductions are realized by DR pilots?

2. How do DR pilots fit into existing EE efforts? Are there other efforts that would fit better with existing EE, or how does EE need to change to incorporate DR into the measure mix?

3. Are any changes to research questions or methods recommended for utility-administered studies?

4. How can the DR pilots be expanded/scaled up to a broader group of potential participants based on pilot eval results (e.g., will early adopters of pilots be more receptive & engaged or otherwise differ from the broader population)?

**Methods**

In the first period, the contractors have been in the role observers. In subsequent years, the contractors work with utilities, technical consultants, equipment manufacturers, and others with critical data to design evaluation plans, implement those plans, and analyze the results using data from the measures included in the program(s), including thermostats, wi-fi-connected heat pump water heaters (HPWH), AMI meters, billing records, and other customer data. On the C&I side, measures may include EMS, HVAC controls, lighting controls, process measures, battery storage or other measures. Surveys of customers may be a component of some of the individual studies.

## **X1942 – Cross-Cutting Non-Energy Impacts Evaluation**

Non-energy impacts (NEIs) are the effects, beyond energy savings, that energy efficiency program measures deliver to participants (comfort, productivity, etc.), utilities (T&D, bill payment improvements, etc.), and regional customers beyond participants (called “societal”, including emissions reductions, job creation, etc.). A traditional benefit-cost or cost-effectiveness test would include all benefits divided by all costs associated with the perspective of the “test”, but utility C/E tests have traditionally included only direct energy savings in the numerator, omitting indirect, harder-to-measure NEIs.

CT has been reviewing its cost effectiveness tests (C/E), and has been undertaking work consistent with the National Standard Practice Manual (NSPM) to review policy and options related to their C/E test, its perspective, and the potential role of various types of non-energy impact values in the revised test. Currently, only a limited set of NEIs are include in CT’s cost-effectiveness test.

This study will provide data and information to support review / revision work of CT cost-effectiveness test, and is designed to provide NEI results that can be included in updated C/E calculations as possible after CT’s C/E policy is updated.

The project is not a literature review; instead, it is data-focused, including substantial CT-based primary research. The study will provide quantitative estimates of high priority NEIs that can support revisions to cost-effectiveness tests, enhance the low income and other NEBs in PSD Appendix 6, and also identify next NEI research priorities.

The methods to be used are best practice, resulting in NEIs that are defensible, derived using transparent procedures, and not be perceived as a coming from a “black box”. The study will examine missing low income NEIs, and build off earlier CT projects in NEIs.

**Researchable Questions / Objectives**:

* Identify and implement cost-effective, efficient, state of the art estimates of NEIs to address priorities low income / residential and at least one commercial application for CT.
* Support policy and cost-effectiveness direction development, and answer issues addressed in the Order by expanding the coverage of NEIs in Appendix 6 of the PSD (from the current low-income NEBs, HES NEIs, and C&I BES NEIs).

The project involves detailed survey work, and calculation of NEIs associated with measures installed in the HES / HES-IE program, and two other programs. Additional efforts include an arrearage analysis, designed to allow quantification of the payment and financial benefits associated with CT’s low-income program.

The first round of NEI work was completed in 2021. Other estimation work for other programs will continue into 2022.

## **X2001 – Measure Life Study / EUL Update**

The measure lifetimes / EULs in the CT PSD are a key part of the cost-effectiveness calculations for measures and programs. However, the numbers in the PSD are very aged (>20 years), have been adopted / adapted from other locations (many without statistical underpinnings), and have not been updated to today's technologies or CT’s conditions. Defensible numbers are not available from literature; new surveys and statistical work are needed to support improved values.

**Research Objectives:** The research objectives for this project are to provide statistically-defensible, updated, CT-appropriate EULs for several major Residential and C/I measures. The selection of measures is prioritized based on savings, program importance, age, measure importance, and ability to conduct analytical / quantitative work that will meet budget (e.g., HVAC, DHW, but excluding lighting).

**Researchable Questions:**

* What are the highest priority EULs to address? Which can this study provide quantitative information for?
* How can the study be designed to use best (well-known) practices for EUL studies, but also leverage the fact that many years of participants can be surveyed in one sample to reduce cost and improve efficiency? For which measures can this work or not work? Can a template be developed and applied to future CT residential and commercial EUL studies?
* What are updated values for EULs for a set of priority residential and commercial EULs?

**Methods**:

The study is being conducted using the basic long-recognized statistical approaches for EULs – but can be conducted more efficiently than traditional studies that look at one program year, and later conduct follow-up surveys to identify later, longer-term failures. Instead, this study uses the fact that programs have been offering many of the same types of measures for many years, and if multiple cohorts / vintages of participants receiving measures are surveyed now (including those installed more than 10 years ago down through recent-year participants), no follow-up studies are needed to identify long-period failures. This approach should save time and money, and lead to reliable estimates of updated measure lifetimes.

## **X2022 – Evaluation of Customer Engagement, Education, and Workforce / Training Initiatives**

The C&LM Plan includes workforce development / training, education, and community and customer engagement initiatives that represent substantial expenditures of the public funds (about $14M over three years). To ensure a return on public investment, this study is conducting a formal evaluation of these activities to provide information to:

1. review best practices for the design and conduct of outreach / training programs;
2. provide information tailored to the three main initiatives on design, planning, and tracking;
3. identify which of the efforts currently underway have the ability to influence behaviors, and
4. where possible, quantify energy savings (either direct or indirect).

The key research questions being addressed by the project include:

What are the learning objectives of current training/education/engagement activities? How do they need to be altered to refocus activity to causing action by attendees that leads to energy savings?

How do current training/education/engagement activities conform to best practices in (adult and other) education and engagement?

What actions and behaviors are attendees taking as a result of the initiatives / programs? Which can be linked to energy savings? What limits the effectiveness in achieving energy saving actions being taken?

To what extent are training activities expanding the workforce? How many trainees get new jobs or expand services because of training?

How should the initiatives be refocused to improve goals, links to savings, and future evaluability?

What accounting/reporting/testing should be used during and after activities to improve effectiveness and document achievements?

Are any of the actions producing sufficient savings that warrants a quantitative assessment? If so, can were design and implement that assessment?

Which initiatives do not show promise for ultimate linking to energy savings?

To achieve these objectives, the evaluation is expected to conduct literature review, extensive interview and surveys, and examine the programs in detail. The following main activities include:

* Documentation of engagement efforts
* Secondary data analysis to identify best practices and develop tailored best practices for the various types of initiatives included in the program
* Conduct in-depth analysis of selected high-priority programs to conduct an evaluation assessment, quantify behavior changes, and where possible quantify savings and catalog savings opportunities.
* Synthesize the analyses and develop recommendations for specific initiatives for the various initiatives and programs.

## **R1973 - Retail Non-Lighting Evaluation**

The *R1973 Connecticut Retail Non-Lighting Evaluation* covered two program groups run by Eversource and United Illuminating (Connecticut Utilities): the ENERGY STAR® Retail Products Platform (ESRPP) and E-commerce platform. The study had two main objectives; (1) develop improved impact parameters for ESRPP and the E-commerce platform programs, and (2) recommend improvements to the design and implementation of each program.

The ESRPP and E-commerce programs are part of the Connecticut program administrator’s (PA’s) efforts to provide additional energy efficiency opportunities to residential customers in the face of recent declining savings opportunities from lighting. This research supports the Connecticut PA’s expansion of energy efficiency opportunities to residential customers.

**Key Findings and Recommendations**

Table 1 and Table 2 below summarize The study’s recommendations out of the engineering review for each of the ESRPP and E-commerce measures, including the original and updated savings values, the source(s) of the recommended update.

**Table 1. Summary of PSD Recommendations – Electric Savings**

| Measure | Updated Value (kWh) | Existing Value (kWh) | Source for Updated Value (with Year1,2) |
| --- | --- | --- | --- |
| *ESRPP Measures* | | | |
| Refrigerator Tier I | 64 | 64 | PSD, 2017 |
| Refrigerator Tier II | 96 | 96 | PSD, 2017 |
| Freezer, Upright | 50 | 45 | Supplemental PSD documentation, 2017 |
| Freezer, Chest | 32 | Supplemental PSD documentation, 2017 |
| Clothes dryer, Gas | 36 | 93 | VT TRM, 2015 |
| Clothes dryer, Electric | 194 | VT TRM, 2015 |
| Clothes Washer, Tier I | 88.1 | 66 | VT TRM, 2018 |
| Clothes Washer, Tier II | 120.3 | 117 | VT TRM, 2018 |
| Room AC | 10.7 | 77.5 | VT TRM, 2015 |
| Dehumidifier | 214 | 214 | PSD, 2017 |
| Air Cleaner/Purifier | 214 | 227 | VT TRM, 2004 |
| Sound Bars3 | 24 | 45 | VT TRM, 2013 |
| *E-Commerce Measures* | | | |
| Wi-Fi Thermostats | 104 | 254 | MA, 2018 |
| Smart Thermostats | Calculated Deemed | VT TRM, 2018 |
| Adv. Power Strips, Tier I | 48 | 48 | PSD, 2016 |
| Adv. Power Strips, Tier II | 179 | MA TRM, 2018 |

1Year represents the date of the source information, not the date the respective TRM was updated.

2 The research team has no reason to believe that a clothes dryer would operate differently in VT than in CT.

3 A follow-up email was sent on 6/25/20 to confirm there is no additional documentation not shared with the research team. To date no additional documentation has been received for sound bars.

4 The Connecticut PSD deemed savings for Wi-Fi/smart thermostats distributed through ESRPP or E-commerce is for cooling savings only.

**Table 2. Summary of PSD Recommendations – Gas Savings**

| Measure | Updated Value | Existing Value | Source for Updated Value (with Year1) |
| --- | --- | --- | --- |
| *ESRPP Measures* | | | |
| Clothes dryer – gas2,3 | 1.215 therms | NA | New York, 2017 |
| *E-Commerce Measures* | | | |
| Wi-Fi Thermostats | 6.6 MMBtu | NA | MA, 2018 |

1Year represents the date of the source information, not the date the respective TRM was updated.

2 The research team has no reason to believe that a clothes dryer would operate differently in NY than in CT.

3The research team is aware that gas clothes dryers are not currently offered through the ESRPP program in Connecticut.

**ESRPP Findings and Planning Recommendations**

ESRPP is designed as a national, long-term market transformation program but most Program Sponsors, including the Connecticut Utilities, lack the regulatory framework to operate it as designed. Therefore, ESRPP is typically implemented as a short-term resource acquisition program in terms of the selection of products and the focus on midstream incentives. This shift causes modifications to program implementation, as Program Sponsors adjust the program structure and incentives to suit their individual needs for claiming short-term, cost-effective savings. Another outcome of this shift is a lack of Program Sponsor engagement (including the Connecticut Utilities) in long-term market transformation activities such as advocacy for equipment standards, participation in national working groups, and overall advocacy for the program and recruitment of peer utilities into the program. This lack of engagement in long-term activities limits the prospects for all Program Sponsors to deliver significant savings.

These modifications to ESRPP implementation also weaken the program because national retailers cannot rely on consistent incentive levels. The study’s analysis of retailer interviews indicated they make stocking decisions at a national level. Differing incentive strategies for the various Program Sponsors make it challenging for retailers to see the benefit of pre-purchasing efficient equipment. Retailers also make product decisions about a year in advance of products hitting the shelves, so having annual incentive levels at the start of the program year do not align with retailer decision-making timelines. Retailers also requested more centralized and specific product guidance; however, when Program Sponsors are offering different incentives on different products, this does not provide a clear signal to retailers on which products to purchase.

The Connecticut ESRPP program is not yet impacting retailer stocking and shelf assortment of energy efficient products. The Connecticut’s ESRPP has only been in place since 2018, so this result is expected, as market transformation programs can take up to three years to impact the market. The study’s high-level findings from the evaluation tasks and conclusions from the engineering review of the ESRPP measures result in the following recommendations for program planning to support the future success of the Connecticut Utilities ESRPP.

* **Begin tracking upright and chest freezer purchases separately (if not doing so already) to allow freezer type-specific savings estimates to be applied for upright and chest types.** The amount of potential energy savings is different for these specific products. More granular product tracking will allow for more specific savings claims and may result in higher overall savings depending on the distribution of sales.
* **Institute two-year incentive levels and budgets instead of current annual process to better align with retailer purchasing timelines.** Retailers make purchasing and marketing decisions one year, or more, in advance of stocking products.
* **Monitor key performance indicators (KPIs) to help identify where the program is having success in the shorter-term and where it is lagging.** The table below outlines suggested KPIs that can be developed using data that is already being collected by the Connecticut Utilities or other ESRPP stakeholders.

**Table 3. Key Performance Indicators for ESRPP**

|  |  |  |
| --- | --- | --- |
| Metric Description | Metric Calculation | Data Collection Activity |
| Total Deemed Savings | Monthly deemed savings overall, and by product category | ICF sales data portal |
| Net Benefit | ICF sales data portal | Program data |
| Number of Participating Store Locations | Total program spend ($) per kWh or kW saved | Program data |
| Number of Product Categories | Number of Product Categories | Program data |
| Count of product categories incented overall | Count of product categories incented overall | Program data |
| Program data | Program data | Program documents |
| Total incentive dollars paid | Total incentive dollars paid | Program data review |

* **Work with the national ESRPP collaborative to recruit regional peer utilities into the program.** Recruiting additional, regional Program Sponsors will enhance the impact of the program on retailer stocking and support greater savings for the Connecticut Utilities ESRPP program.
* **Provide specific directions to national retailers on purchasing and promoting specific products (e.g., marketing strategies and content) and establish relationships with local retailers to ensure national guidance is implemented.** Retailers need help understanding why customers would be interested in different energy efficient (rebated) products. This will help staff better understand why it is important to stock high-efficiency products and how to actually market these products to customers. Some Program Sponsors have also had success expanding the scope of the program by signing up local retailers in addition to the national retailers.

**E-Commerce Findings and Planning Recommendations**

As more retail sales shift to online venues, utilities are establishing E-commerce (online) platforms as a way meet customers where they shop, educate customers on existing rebate products, and deliver energy savings. Program administrators (PAs) need to determine the specific goal of the platform – whether it will be a channel to deliver rebated products to customers or an educational platform to help customers discover energy efficient products and their features, or both. The design of the platform should match the selected objective. For example, if educating customers is the priority, the platform should be designed to share information about long-term cost and energy savings.

Utilities’ E-commerce platforms feature both rebated and non-rebated products, with some including non-energy related products as well. Literature review indicates that consumers “broader online digital experiences are continually refining and resetting” their expectations, and product design should enable an “effortless customer experience.”[[11]](#footnote-11) Therefore, including as many product categories as possible, as well as product information on both rebated and non-rebated efficient products offers a better, more integrated customer experience. The study’s high-level findings from the evaluation tasks and conclusions from the engineering review of the E-commerce measures result in the following recommendations.

* **Continue to review the design and user experience of E-commerce platforms.** The Connecticut Utilities have made recent updates to their E-commerce platforms including additional products and product information that enhances the customer experience. The Connecticut Utilities’ should continue to use non-utility E-commerce platforms that customers are familiar with as a benchmark for platform design.
* **Add educational information to help customers understand the benefits of buying efficient products.** Eversource recently updated their site to include educational information, but the UI platform focuses on products and information about other energy efficiency programs. The more robust utilityE-commerce sites clearly show users which products receive incentives, specific information on the efficiency of both rebated and non-rebated products, buyers guide information, and customer ratings and reviews to give products more credibility.
* **Track Wi-Fi and Smart (learning) thermostat purchases separately, as well as Tier I and Tier II purchases separately (if not doing so already).** Results from The study’s engineering review of E-commerce impact parameters indicate the amount of potential energy saved is different for these specific products. This level of product tracking will allow for more specific savings claims which may result in higher overall savings depending on the distribution of sales.
* **Leverage direct email for effective marketing outreach.** Peer utilities noted this was their primary and most successful marketing channel to drive traffic to their sites. The Connecticut Utilities should put in place a direct marketing campaign (if they are not doing so already).
* **Continue to increase the number of product categories available on E-commerce platforms.** Any products that have existing prescriptive rebates that can be sold through the E-commerce platform should be included. Further, non-rebated efficient products should also be featured*.* Eversource recently expanded their products to include appliances.

## 

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. [↑](#footnote-ref-1)
2. The current Evaluation Administration Consultant, initially contracted in 2013, and most recently contracted in 2019, is a team of experienced independent evaluators led by Skumatz Economic Research Associates (SERA) and includes Ralph Prahl and Associates, Wirtshafter Associates, BuildingMetrics, and Left Fork Energy. Each consultant on the team has between 20 and 40 years of experience in the field and has conducted work nationwide. The offices of these firms are located in Colorado, Florida, Massachusetts, and New York. [↑](#footnote-ref-2)
3. Accenture. The New Energy Consumer: Unleashing Business Value in a Digital World. 2015. <https://www.accenture.com/_acnmedia/accenture/next-gen/insight-unlocking-value-of-digital-consumer/pdf/accenture-new-energy-consumer-final.pdf> [↑](#footnote-ref-3)
4. ERS. [X1931] PSD Review. [↑](#footnote-ref-4)
5. HES and HES-IE provide incentives for energy efficiency measures for existing multifamily projects using a deemed savings approach. Multifamily customers can enroll in these programs, which provide tiered incentives for a variety of lighting; heating, ventilation, and air conditioning (HVAC); domestic hot water (DHW); and envelope measures. [↑](#footnote-ref-5)
6. While two other commercial programs, Energy Opportunities and Small Business Energy Advantage (SBEA), can serve multifamily common areas, this study found that those savings are tracked through the HES and HES-IE databases. [↑](#footnote-ref-6)
7. Since onsite data collection was not possible in many cases due to COVID-19, the research team used a combination of approaches to data collection, including facility manager photos, facility manager interviews, file reviews, and on-site data collection where possible. [↑](#footnote-ref-7)
8. The research team did not calculate Lifetime CCF, because UI does not track it (and the team calculated savings across programs at both utilities) and because the team’s understanding was that annual savings and demand savings are more critical than lifetime savings. The research team suggests it be incorporated into a future project if the EEB believes lifetime gas savings are valuable to calculate. [↑](#footnote-ref-8)
9. 2021 Plan Update to the 2019-2021 Conservation & Load Management Plan. D2 – Eversource CT Electric Historical and Projected Annual kWh (000s) (2012-2021) [↑](#footnote-ref-9)
10. As described in section 6.7, winter demand savings were removed for one project that was a common area heat pump, since the PSD does not award winter demand savings for common area heat pumps. In addition, the adjustments to the annual savings affected the winter demand savings for three other projects. Two other heat pump projects correctly did not claim winter demand savings. So only one of the five projects that claimed winter demand savings was verified to have winter demand savings. [↑](#footnote-ref-10)
11. Accenture. The New Energy Consumer: Unleashing Business Value in a Digital World. 2015. <https://www.accenture.com/_acnmedia/accenture/next-gen/insight-unlocking-value-of-digital-consumer/pdf/accenture-new-energy-consumer-final.pdf> [↑](#footnote-ref-11)