TO: Lisa Skumatz and Ralph Prahl, CT Energy Efficiency Board
CT Utilities, Eversource and United Illuminating

FROM: Brett Close, EMI Consulting
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DATE: July 21, 2020

RE: CT Retail Non-Lighting (R1973) ESRPP and E-Commerce Recommended PSD Updates and Short-Term Program Planning Recommendations

1 INTRODUCTION

This memo summarizes the results of the Engineering Review conducted as part of the Connecticut Retail Non-Lighting Evaluation (R1973) for the Connecticut Energy Efficiency Board and Connecticut Utilities, Eversource and United Illuminating (CT Utilities). Our review covered the impact parameters for measures included in the EnergizeCT ENERGY STAR® Retail Products Platform (ESRPP) and CT Utilities online E-commerce platforms. EMI Consulting reviewed the CT 2020 Program Savings Document (PSD), and supporting documentation, in comparison to Technical Reference Manuals (TRMs) across five other states (MA, RI, VT, NY, and CA).

The remainder of this memo provides a detailed explanation of the Engineering Review methods (Section 2), findings (Section 3), and detailed measure-level recommendations (Section 4).

Section **Error! Reference source not found.** provides a summary of immediate, short term recommendations for the CT Utilities ESRPP and E-commerce programs. These recommendations were developed under the CT R1973 Retail Non-Lighting Evaluation as outcomes of various evaluation tasks including the PSD measure-level engineering review, literature review, peer utility interviews, retailer interview analysis, and the EM&V best practices comparison. Specific details on the individual evaluation tasks, including methodology, results, and more detailed long-term recommendations can be found in the CT R1973 Final Report.

1.1 PSD RECOMMENDATIONS

Table 1 and Table 2 below summarize our recommendations for each of the measures, including the original and updated savings values, the source(s) of the recommended update, and the section of this memo that contains a more detailed description of the measure-level recommendation.

TABLE 1. SUMMARY OF PSD RECOMMENDATIONS – ELECTRIC SAVINGS

Measure	Updated Value (kWh)	Existing Value (kWh)	Source for Updated Value (with Year[1,2])	Memo Section
ESRPP Measures				
Refrigerator Tier I	64	64	PSD, 2017	4.2.1
Refrigerator Tier II	96	96	PSD, 2017	4.2.1
Freezer, Upright	50	45	Supplemental PSD documentation, 2017	4.2.3
Freezer, Chest	32		Supplemental PSD documentation, 2017	4.2.3
Clothes dryer, Gas	36	93	VT TRM, 2015	4.2.2
Clothes dryer, Electric	194		VT TRM, 2015	4.2.2
Clothes Washer, Tier I	88.1	66	VT TRM, 2018	4.2.4
Clothes Washer, Tier II	120.3	117	VT TRM, 2018	4.2.4
Room AC	10.7	77.5	VT TRM, 2015	4.2.2
Dehumidifier	214	214	PSD, 2017	4.2.1
Air Cleaner/Purifier	214	227	VT TRM, 2004	4.2.4
Sound Bars[3]	24	45	VT TRM, 2013	4.2.4
E-Commerce Measures				
Wi-Fi Thermostats	104	25[4]	MA, 2018	4.3.1
Smart Thermostats	Calculated Deemed		VT TRM, 2018	4.3.1
Advanced Power Strips, Tier I	48	48	PSD, 2016	4.3.2
Advanced Power Strips, Tier II	179		MA TRM, 2018	4.3.2

[1]Year 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 Year[1])	Memo Section
ESRPP Measures				
Clothes dryer – gas[2,3]	1.215 therms	NA	New York, 2017	4.2.2
E-Commerce Measures				
Wi-Fi Thermostats	6.6 MMBtu	NA	MA, 2018	4.3.1

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

1.2 PROGRAM PLANNING RECOMMENDATIONS

Our conclusions from the measure-level engineering review result in the following recommendations for short-term program planning. Specifically, EMI Consulting recommends:

- The CT Utilities track upright and chest freezer purchases separately through the ESRPP program (if not already done) to allow the freezer type-specific savings estimates to be applied.
- The CT Utilities track Wi-Fi and Smart (learning) thermostat purchases separately through the e-Commerce platform (if not already done) to allow the thermostat type-specific savings estimates to be applied.
- The CT Utilities track Tier I and Tier II advanced power strip purchases separately (if not already done) to allow the type-specific savings estimates to be applied.

A comprehensive review of our high-level findings from the evaluation tasks and related program planning recommendations are outlined in Section **Error! Reference source not found.**.

2 ENGINEERING REVIEW METHODS

EMI Consulting reviewed Connecticut's 2020 PSD (Connecticut PSD) and supporting documentation (excel workbooks) that included savings calculations and source references for the measures included in ESRPP and E-commerce platforms.

In addition to the Connecticut PSD, we reviewed TRMs for three other states with ESRPP programs, including New York[1], Vermont[2], and California's Database for Energy Efficiency Resources (DEER)[3], for information on measures included in the CT ESRPP.[4] The evaluation team also reviewed TRMs for two states without ESRPP programs, Massachusetts[5] and Rhode Island[6], due to their proximity to and similarities with Connecticut.

Information was gathered on eight measure categories for ESRPP:

- Refrigerators
- Freezers
- Clothes washers
- Clothes dryers
- Room air conditioners (Room AC)

[1] Version 6 of the New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs was issued on April 16, 2018, and effective as of January 1, 2019.
[2] The Efficiency Vermont Technical Reference User Manual (TRM) was published December 31, 2018.
[3] The DEER2021 Database was adopted on September 12, 2019.
[4] Although information was collected about California measures, due to differences in climate and geography compared to the other states reviewed (all of which are in close proximity to Connecticut), California was ultimately excluded from the analysis.
[5] The Massachusetts Technical Reference Manual (TRM) is regularly updated, the most recent measure update was published in January 2020.
[6] The National Grid Rhode Island Technical Reference Manual (TRM) was published in November 2018.

- Air cleaners/purifiers
- Dehumidifiers
- Sound bars

For E-commerce measures, the evaluation team reviewed the Connecticut PSD and TRMs from five other states including Massachusetts, Rhode Island, Vermont, New York, and California.

Information was gathered on two measures categories for E-commerce:
- Wi-Fi/smart thermostats
- Advanced Power Strips

EMI Consulting collected information on the overall approach to calculating savings for each measure, assumptions for a measure's baseline and efficient cases, deemed savings values, equations used to determine savings, and all relevant sources for these measures.

3 ENGINEERING REVIEW FINDINGS

This section outlines the evaluation team's findings relative to the overall PSD and TRM comparisons, ESRPP program measures, and E-Commerce measures. Recommendations are summarized in Section 4.

3.1 TRM COMPARISON FINDINGS

The savings estimation methodologies of the TRMs reviewed fell into three broad approach categories:

1. **Deemed UES only** – where only a savings value was included.
2. **Deemed UES with supporting documentation** – where both a savings value and the equation(s) and assumptions used to calculate the deemed value were documented.
3. **Calculated deemed** – where a savings value was not included. Instead a deemed equation was provided, and baseline and efficient usage were documented for input into the savings equation.

Table 3 below summarizes these savings methodologies by state. Connecticut is the only state that included deemed values without supporting calculations or detailed references.

TABLE 3. ESRPP MEASURE SAVINGS METHODOLOGY BY STATE

Savings Methodology				
CT	MA	RI	VT	NY
Deemed UES	Deemed UES with Supporting Equations	Deemed UES with Supporting Equations	Deemed UES with Supporting Equations	Calculated Deemed

The most common approach, employed by Massachusetts, Rhode Island, and Vermont, was to include a single deemed savings value for each measure category in addition to documenting equations, assumptions, and detailed references. For example, Vermont's TRM included a simple equation ($\Delta kWh = kWh_{Base} - kWh_{EE}$) as well as assumptions for each measure's baseline and efficient energy usage as outlined in Figure 1 below. In addition, the Vermont TRM included documentation of these assumptions (e.g., ENERGY STAR® 5.0 specification, effective September 15, 2014).

FIGURE 1. EXAMPLE OF VERMONT TRM'S INPUTS FOR DEEMED SAVINGS CALCULATION

Product	kWh_{BASE}	kWh_{EE}	ΔkWh	ΔkW
ENERGY STAR +50% Sound Bars	48.7	24.7	24.0	0.00274
ENERGY STAR Freezers (Upright)	438.6	394.8	43.8	0.00516
ENERGY STAR Freezers (Chest)	239.3	215.3	24.0	0.00283
ENERGY STAR Freezers (Unknown Type)[10]	312.5	281.3	31.2	0.00368
ENERGY STAR +5% Freezers (Upright)	438.6	375.1	63.5	0.00749
ENERGY STAR +5% Freezers (Chest)	239.3	204.6	34.7	0.00409
ENERGY STAR Freezers +5% (Unknown Type)[10]	312.5	267.2	45.3	0.00534
ENERGY STAR/CEE Tier 1 Refrigerators	592	533	59	0.0070
CEE Tier 2 Refrigerators	592	503	89	0.0105
CEE Tier 3 Refrigerators	592	474	118	0.0140

New York is the only state, of the five we reviewed, that followed a calculated deemed approach. While the New York equations are similar to those in the other TRMs reviewed, their equations also included heating, cooling, and ventilation (HVAC) interactive effects for each measure. For example, Equation 1 was used to calculate annual electric energy savings from refrigerator and freezer replacement.

EQUATION 1. ANNUAL ELECTRIC ENERGY SAVINGS (REFRIGERATORS)

$$\Delta kWh = units \times (kWh_{baseline} - kWh_{ee}) \times (1 + HVAC_c) \times F_{occ}$$

Where:

- $HVAC_c$ = HVAC interaction factor for annual electric energy consumption
- F_{occ} = Adjustment factor to account for the number of occupants.

Additionally, the TRMs for Massachusetts, Rhode Island, Vermont, and New York clearly documented the assumed measure type, relevant assumptions (e.g., hours of use), baseline and efficient case energy usage, and all supporting equations in their TRMs. An example of Vermont's TRM documentation of their baseline and efficient case assumptions are illustrated in Figure 2 below.

FIGURE 2. VERMONT TRM'S DOCUMENTATION OF BASELINE AND EFFICIENT CASE ASSUMPTIONS

Product	Baseline Efficiency	High Efficiency
ENERGY STAR Sound Bars	Weighted average of electric energy consumption[1] for both non-ENERGY STAR and ENERGY STAR models	50% more efficient[2] than ENERGY STAR Version 3.0 specification, effective May 1, 2013
ENERGY STAR Freezers	Federal standard, effective September 15, 2014	ENERGY STAR Version 5.0 specification, effective September 15, 2014 and 5% more efficient than ENERGY STAR
ENERGY STAR and CEE-Qualified Refrigerators	Federal standard, effective September 15, 2014	ENERGY STAR Version 5.0 specification, effective September 15, 2014/CEE Tier 1, CEE Tier 2, and CEE Tier 3

3.2 CONNECTICUT PSD FINDINGS

This section summarizes the overall findings related to the content and documentation outlined in the Connecticut 2020 PSD (Connecticut PSD). Measure specific findings are outlined in the next section.

PSD DOCUMENTATION

The Connecticut PSD **did not include sufficient documentation** of the equations used, the individual inputs into savings equations, or assumptions. Instead the Connecticut PSD included only deemed savings values. In some cases, the specific type of equipment was not referenced. For example, the PSD did not indicate whether freezer savings are for upright or chest freezers, or an average of both. While supporting documentation to most of the saving calculations was provided, it was not outlined the Connecticut PSD document.

PSD REFERENCES

The ENERGY STAR® links included in the PSD are inactive or outdated. ENERGY STAR® has recently (within the last two years) moved calculations from the previously downloadable excel workbook to an interactive online calculator.

SUPPORTING DOCUMENTATION

Due to the shift in ENERGY STAR® methodology and the lack of documentation directly in the PSD, comparison of savings calculations to other states' deemed savings measures was very difficult using only the Connecticut PSD. Upon request, the CT Utilities provided the evaluation team with additional supporting documentation, including multiple calculation workbooks and an off-line copy of the (outdated) ENERGY STAR® Appliance Calculator. The additional documentation allowed for a more detailed comparison of Connecticut's savings values and methodology to those of other states.

Overall, the supporting documentation demonstrated that **CT utilizes different methodologies for across measures to calculate savings**, rather than a consistent methodology. These inconsistencies are greater than those to be expected given differences in the nature of ESRPP measures. For example:

- For refrigerators a regression model of federal baseline standards was used to determine the baseline energy usage. While a list of 1,042 efficient refrigerators from the CEE qualified products and their associated energy usage was provided, the deemed savings value did not use this list and was instead a weighted average of a 15% and 20% reduction from the baseline energy usage calculated by the regression model.
- Clothes dryers did not use a regression to calculate baseline energy use, but instead adopted a number in a table titled "Tier 2 and above Clothes Dryers – LAB TESTED WITH SUPPLEMENTAL (real clothing) TEST Protocol" without further calculations or documentation of the source for the Table.
- Dehumidifiers simply used the ENERGY STAR Appliance Calculator.

In contrast, other TRMs use the same calculation methodology ($\Delta kWh = kWh_{Base} - kWh_{EE}$) for every ESRPP measure, despite inherent differences between the measures, with the documentation of the kWh_{Base} and kWh_{EE} clearly documented in a table such as Figure 2. Usually the assumed kWh_{Base} and kWh_{EE} values are the federal standard or improvement upon the federal standard, as shown in Figure 2, as opposed to a calculation of an average or a regression based on qualified product lists. Utilizing this consistent methodology has the advantage of its easy to update when federal standards change and don't require the maintenance of qualified product lists for savings calculation.

3.3 ESRPP PROGRAM MEASURE FINDINGS

This section describes EMI Consulting's findings relative to the measures included in the PY2018-PY2019 ESRPP program. Recommendations are presented in Section 4.2.

Our detailed measure-level comparison of the additional documentation found:

- **Measures with a well-documented, verifiable approach.** For six of the nine measures, Connecticut's approach to determining savings was well

documented and verifiable, though references and data sources were out of date.

- **Measures with insufficient documentation.** For two measures, the documentation did not have enough detail for the research team to re-construct or confirm the calculations.
- No supporting documentation was provided for sound bars.

3.3.1 Measures with A Well Documented and Verifiable Approach

The evaluation team was provided adequate documentation to compare the methodology and savings calculations to measures in other states for six of the nine Connecticut PSD measures analyzed. These measure categories were:

- Refrigerators
- Freezers
- Clothes dryers - electric
- Clothes dryers - gas
- Room ACs
- Dehumidifiers

However, in many cases references such as evaluation reports and data sources (e.g., ENERGY STAR® workbooks) were out of date. Table 4 provides an overview of the savings values included in Connecticut's PSD alongside those savings values included in the Massachusetts, Rhode Island, Vermont, and New York[7] TRMs. This comparison shows that CT's refrigerator, freezers, and dehumidifier values were in line with measure savings values in other states, while the values for clothes dryers (electric and gas) and room AC were very different from the other states. Importantly, these other states included sufficient documentation for the research team to determine that measure savings values were based on reasonable methodologies and sources. For example:

- The data for **clothes dryers** in the supporting documentation for the PSD is from "Q4 2014 Ecova," and is only a single number in a table titled "Tier 2 and above Clothes Dryers – LAB TESTED WITH SUPPLEMENTAL (real clothing) TEST PROTOCOL without any further documentation of sources or calculations. The Massachusetts numbers are based on 2018 baseline load shape modeling conducted by Navigant.
- The data for **room AC** in the supporting documentation for the PSD is from a version of ENERGY STAR earlier than 2013. In Massachusetts numbers are based on the 2018 ENERGY STAR calculator and the 2018 baseline load shape modeling conducted by Navigant.

[7] New York follows a calculated deemed approach where detailed equations are included in the TRM in lieu of a single deemed value. For the deemed values included in Table 3 for New York, the research team calculated these values using assumptions included in the New York TRM as well as inputs from the Vermont TRM where needed.

The data sources for the other states are based on studies conducted in close proximity to Connecticut and were considerably more up-to date sources than those currently used in the CT PSD.

TABLE 4. SAVINGS (KWH) FOR MEASURES WITH WELL-DOCUMENTED PSD APPROACH

Measure	Measure Savings (kWh)				
	CT	MA	RI	VT	NY
Refrigerator Tier I	64	N/A	N/A	59	52
Refrigerator Tier II	96	N/A	N/A	89	78
Freezer	45	N/A	N/A	31.2	27.4
Clothes dryer – gas	93	N/A	N/A	36	18.4
Clothes dryer – electric	93	160	160	194	N/A
Room AC	77.5	36	N/A	10.7	N/A
Dehumidifier	214	167.6	N/A	229	N/A

Vermont and New York TRMs also include gas savings values for gas clothes dryers. These measure savings values are outlined in Table 5 below. For gas dryers, New York uses a calculated deemed approach (similar to other measures) with an equation and assumed inputs, whereas Vermont includes a single deemed value. This difference in methodology, combined with a slight variation in inputs (NY TRM uses ENERGY STAR® 2017 while VT TRM uses the 2014 specification), account for the substantial difference in savings values between the two states.

TABLE 5. SAVINGS (THERMS) FOR GAS CLOTHES DRYERS

Measure	Measure Savings (therms)				
	CT	MA	RI	VT	NY
Clothes dryer – gas	Not Included	N/A	N/A	5.2	1.215

3.3.2 MEASURES WITH INSUFFICIENT DOCUMENTATION

The additional supporting documentation did not provide enough detail for the research team to reconstruct or confirm calculations for two of the nine measure categories reviewed. These measures were clothes washer Tier I, clothes washer Tier II, and air cleaner/purifier. No supporting documentation was provided for sound bars.

Therefore, it was challenging to make a direct comparison of the methodology and deemed values for these measure to those included in other states. While Table 6 below provides an overview of the savings values included in CT's PSD alongside those savings values included in the Massachusetts, Rhode Island, Vermont, and New York TRMs, not enough information was available for the research team to fully understand if the savings values are for the same equipment, similar treatment, or if the calculations used similar or different assumptions. Conversely, the approach in other reviewed states, especially Vermont, provided a clear, well documented

methodology in enough detail for the evaluation team to understand the type of equipment, measure treatment, input assumptions, equations used, and up-to-date data sources, to confirm the reasonableness and relevance of included measure savings values.

TABLE 6. SAVINGS (KWH) FOR PSD MEASURES WITH UNCLEAR APPROACH OR INSUFFICIENT DETAIL

Measure	Measure Savings (kWh)				
	CT	MA	RI	VT	NY
Clothes Washer, Tier I	66	N/A	N/A	88.1	109.9
Clothes Washer, Tier II	117	N/A	N/A	210.3	116.35
Air cleaner/purifier	227	391	N/A	213.9	214
Sound bars	45	N/A	N/A	24	N/A

3.4 E-COMMERCE MEASURE FINDINGS

For the E-commerce platform the evaluation team reviewed communicating thermostats and advanced power strips. The findings for each are discussed below. Recommendations are presented in Section 0.

3.4.1 TYPES OF COMMUNICATING THERMOSTATS

For the purposes of our review we used the following definitions of communicating thermostats:

- **Wi-Fi thermostat** – a programmable thermostat which allows remote set point adjustments and control.
- **Smart thermostat** – a programmable thermostat which allows remote set point adjustment and control and also includes behavioral learning capabilities to perform automatic adjustment and control.

All of the TRMs we reviewed included one or two types of communicating thermostats on their E-commerce platforms.[8] However, not all states included both Wi-Fi thermostats and smart thermostats in their TRMs. All states, with the exception of Vermont, included Wi-Fi thermostats in their TRM. However, only Vermont and New York included smart thermostats.

Table 7 below outlines which measures were included in each state's TRM, as well as which savings estimation methodology was used in each case. States varied in which savings estimation methodology was used for each measure. As with the ESRPP measures, the savings estimation methodologies we reviewed fell into three broad categories: deemed UES, deemed UES with supporting equations, and calculated deemed. Only one state, New York, included both Wi-Fi thermostats and

[8] At least one utility within each state included Wi-Fi thermostats and/or smart thermostats on their E-commerce platforms. However, this does not mean that every utility in every state included products in both categories on their E-commerce platform.

smart thermostats in their TRM; different savings methodologies were employed for each.

TABLE 7. THERMOSTAT SAVINGS METHODOLOGY

Measure	Savings Methodology				
	CT	MA	RI	VT	NY
Wi-Fi Thermostat	Deemed	Deemed	Deemed with Supporting Equations	Not Included	Deemed with Supporting Equations
"Smart" Thermostat	Not Included	Not Included	Not Included	Calculated Deemed	Calculated Deemed

SMART THERMOSTATS

The Connecticut PSD does not include smart thermostats. Therefore, we did not include findings specific to smart thermostats. However, recommendations related to smart thermostats are provided in Section 4.3.1.

WI-FI THERMOSTATS

Connecticut's PSD includes savings values for Wi-Fi thermostats when:

- The heating fuel or cooling system is known (Direct Install program)
- The heating fuel is unknown (midstream and E-commerce programs)

The savings for each case is provided in Table 8.

TABLE 8. CONNECTICUT WI-FI THERMOSTAT DEEMED SAVINGS VALUES

	Wi-Fi E-Commerce	Wi-Fi Direct Install			
	Cooling only, heating fuel or cooling system unknown	Cooling	Heating (electric resistance)	Heating (heat pump)	Heating (ground source heat pump)
Electric Savings (kWh)	25	64	637.5	318.7	212.5

Unlike the Connecticut PSD, there are not separate savings values by heating system type in other states' TRMs. The other states (MA, RI, and NY) also predominantly assume the Wi-Fi thermostat is used to control both heating and cooling, as opposed to Connecticut's assumption of cooling only. The exception is Massachusetts which does provide a deemed savings value for a Wi-Fi thermostat that controls cooling only (**Error! Reference source not found.**).

TABLE 9. WI-FI THERMOSTAT DEEMED SAVINGS VALUES COMPARED TO CT

Savings Type	Wi-Fi Thermostat Savings (kWh)

	CT	MA	RI	NY
Cooling only savings	25	46	n/a	n/a
Heating and cooling savings	n/a	104[1]	104	104

[1]Savings value based on Navigant (2018) Home Energy Services Impact Evaluation. The savings values are based on a literature review of over a dozen thermostat studies, not primary research.

The electric savings values for Wi-Fi thermostats in other states are identical as shown in Table 10 below; deemed gas savings values are identical for Massachusetts and New York as well, however differ for Rhode Island (Table 11). Rhode Island uses a different methodology that breaks out MMBtu savings by fuel type, whereas the other states (MA and NY) include a single value.

TABLE 10. WI-FI THERMOSTAT DEEMED SAVINGS VALUES

Savings Type	Thermostat Controlling Cooling Only	Thermostat Controlling Heating and Cooling, all heating system types		
	MA	MA	RI	NY
Annual Gross Electric Energy Savings (kWh)	46	104	104	104

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TABLE 11. WI-FI THERMOSTAT DEEMED GAS SAVINGS VALUES

Savings Type	Wi-Fi Thermostat Savings (MMBtu)		
	MA	RI	NY
Heating and cooling savings	6.6	3.11	6.6

3.4.2 ADVANCED POWER STRIPS

All of the TRMs we reviewed included advanced power strips on their E-commerce platforms. Additionally, most states included both Tier I and Tier II advanced power strips on their E-commerce platforms, except Rhode Island which only included Tier I advanced power strips. The Connecticut PSD does not document whether the deemed savings values are for Tier I or Tier II advanced power strips. Additionally, the research team was not able to obtain the referenced citation for advanced power strip savings.

The states we reviewed followed different methodologies for determining savings. Only Connecticut included deemed values without supporting equations; Massachusetts, Rhode Island and New York all include deemed values but provide

supporting equations and assumptions. Vermont follows a calculated deemed approach for determining savings for both Tier I and Tier II power strips (Table 12).

TABLE 12. ADVANCED POWER STRIP SAVINGS METHODOLOGY

Measure	Savings Methodology				
	CT	MA	RI	VT	NY
Tier I	Deemed UES (unspecified tier)	Deemed UES with Supporting Equations	Deemed UES with Supporting Equations	Calculated Deemed	Deemed UES with Supporting Equations
Tier II		Deemed UES with Supporting Equations	Deemed UES with Supporting Equations	Calculated Deemed	Deemed UES with Supporting Equations

Table 13 below outlines the deemed savings value in each states' TRM. While Tier I savings values varied, Connecticut's value falls within the range of Tier I savings from the Rhode Island and New York TRMs. The Tier II savings for Massachusetts and New York were fairly similar.

TABLE 13. ADVANCED POWER STRIP DEEMED SAVINGS VALUES

Measure	Measure Savings (kWh)				
	CT	MA	RI	VT	NY
Tier I	48 (unspecified tier)	117	21.6	N/A	57.5
Tier II		179	Not Included	N/A	158.9

4 ENGINEERING REVIEW RECOMMENDATIONS

4.1 OVERALL PSD RECOMMENDATIONS

This section summarizes the overall recommendations related to content and documentation outlined in the Connecticut 2020 PSD (Connecticut PSD). Measure specific recommendations are outlined in the next section.

At a minimum, the PSD should be amended to include the following:

- The measure type (such as upright or chest freezers)
- All equations used in calculating savings values
- All assumptions used in calculating savings values such as operating hours,
- Baseline equipment or energy use (such as the associated federal standard and date it became effective)

- Efficient equipment or energy use (such as the associated federal standard and date it became effective)

Overall, the Connecticut PSD document lacks the information required for understanding how measures savings were calculated and limits any comparison to other states' deemed savings measures when only referencing the PSD document. This documentation is provided, for some measures, in the supporting documentation provided by the CT Utilities. However, we recommend this information be moved to the PSD.

Connecticut should adopt a clear calculation approach that is consistent across measure types. This would include a framework for calculations that is consistent across measures. Some examples would be the online interactive ENERGY STAR® calculators, or a consistent calculation methodology in excel.

Connecticut should consider moving to a calculated deemed approach. The CT Utilities have already gathered most of the information needed to take this approach; however, it is currently located in the supporting documentation and not directly in the PSD. This approach would allow for:

- A fluid baseline, as inputs to the calculations (and not the calculations themselves) would be updated as the baseline information changes.
- Ease in updating the PSD as newer information becomes available, this would help reduce the amount of effort to maintain qualified product lists.
- Ease of review and comparison to other states savings values.

4.2 ESRPP PROGRAM MEASURE RECOMMENDATIONS

This section outlines the measure specific recommendations related to the ESRPP measures rebated over PY2018 and PY2019, including refrigerators, freezers, clothes washers, clothes dryers (electric and gas), room AC, dehumidifiers, air cleaner/purifiers, and sound bars.

This section is organized based on the following recommendation categories:

- Methodology and values are well-documented, but references need to be updated
- Methodology is well-documented, but input values need to be updated
- Methodology should be modified
- PSD documentation was insufficient to support current value

4.2.1 MEASURES WITH A WELL-DOCUMENTED METHOD AND VALUES

EMI Consulting determined both the approach and values were well-documented for the three measures outline in Table 14. Therefore, we have not recommended changes to deemed savings values but instead recommend that references to the inputs be updated and that documentation be included in the PSD document instead of the supporting documentation outside the actual PSD.

TABLE 14. DEEMED SAVINGS VALUE RECOMMENDATIONS

Measure	Recommended Value (kWh)	Existing Value (kWh)	Reason for Recommendation	Source for Recommended Values
Refrigerator, Tier I	64	64	Approach and values well-documented, update references	PSD, 2017
Refrigerator, Tier II	96	96	Approach and values well-documented, update references	PSD, 2017
Dehumidifier	214	214	Approach and values well-documented, update references	PSD, 2017

Specific recommendations by measure type are included below.

- ***Refrigerator -*** Update the qualified product list used in the savings calculations; the product list included in these calculations is from 2017.
- ***Dehumidifier -*** Update references included for this measure.

4.2.2 MEASURES WITH A WELL-DOCUMENTED METHOD BUT OUT OF DATE INPUT VALUES

For the three measures outline in Table 15, EMI Consulting determined the approach was well-documented but the sources of the inputs to savings calculations were out of date. Therefore, we recommend updating in the input values to more recent sources found in the VT TRM. Updating the input values results in changes to deemed savings values. We also recommend the documentation be included in the PSD document instead of the supporting documentation outside the actual PSD.

TABLE 15. DEEMED SAVINGS VALUE RECOMMENDATIONS

Measure	Recommended Value	Existing Value	Reason for Recommendation	Source for Recommended Values[1]
Clothes dryer – gas[2] (kWh)	36 kWh	93 kWh	Input sources out of date	VT TRM (2018), High Efficiency: ENERGY STAR Version 5.0 specification, effective January 1, 2015
Clothes dryer – gas[2] (therms)	1.215 therms	NA	Currently not included in the PSD	New York (2018), ENERGY STAR Program Requirements Product Specification for Clothes Dryers, Eligibility Criteria

				Version 1.1, May 2017
Clothes dryer – electric	194 kWh	93 kWh	Input sources out of date	VT TRM (2018)[3], High Efficiency: ENERGY STAR Version 5.0 specification, effective January 1, 2015
Room AC	10.7 kWh	77.5 kWh	Input sources out of date (2002, 2008) and calculator no longer available	VT TRM (2018)[3], High Efficiency: ENERGY STAR Version 4.0 specification, effective October 26, 2015

[1]For all measures, the source for the baseline efficiency was the post recent federal standard.
[2]The research team is aware that gas clothes dryers are not currently offered through the ESRPP program in Connecticut.
[3]The research team has no reason to believe that a clothes dryer or room AC would operate differently in Vermont than in Connecticut.

Specific recommendations by measure type are included below.

- ***Clothes Dryer -*** Update the references included for these measures; the current approach uses references from 2014. For gas clothes dryer, we recommend including the calculated deemed gas savings value included in the New York TRM, as the New York TRM uses more up to date inputs than the Vermont TRM (2017 vs. 2014). The equation and assumptions included in the New York case are outlined below (Equation 2).
- ***Room Air Conditioner -*** Update the references and input sources for this measure; input sources are from 2002 and 2008, and the ENERGY STAR® calculator used for this measure is no longer available.

EQUATION 2. NEW YORK TRM CLOTHES DRYER – GAS EQUATION

$$\Delta therms = units \times Cycles_{annual} \times Load \times \left[\frac{F_{gas,baseline}}{CEF_{baseline}} - \frac{F_{gas,ee}}{CEF_{ee}}\right] \times \frac{3{,}412}{100{,}000}$$

Where:

- Units = Number of measures installed under the program;
- $Cycles_{annual}$ = Number of dryer cycles per year (assumed to be 283 for a vented gas dryer);
- Load = Average total weight (lbs) of clothes per drying cycle (assumed to be 8.45 for a vented gas dryer);
- F_{gas} = Percentage of energy consumed that is derived from gas (assumed to be 0.95 for both the baseline and efficient case);

- CEF = Combined energy factor (lb/kWh) (assumed to be 3.3 for the baseline case and 3.48 for the efficient case for a vented gas dryer);
- 3,412 = Conversion factor, one kWh equals 3,412 BTU, and;
- 100,000 = Conversion factor (BTU/therm), one therm equals 100,00 BTU.

4.2.3 Recommend Modifying Method

EMI Consulting recommends splitting freezers into upright and chest categories, as the savings values are significantly different (Table 16). Existing calculation methodology provided in the supporting documentation already includes the input data required to split freezers into the two categories. In doing so, the values for upright and chest categories will then align with other TRMs. Disaggregating freezers will also allow for greater transparency into future changes in the installation mix and better represent actual savings.

Table 16. Deemed Savings Value Recommendations

Measure	Recommended Value (kWh)[1]	Existing Value (kWh)	Reason for Recommendation	Source for Recommended Values
Freezer, Upright	50	45	Split upright and chest to more accurately represent savings	Supplemental PSD documentation, 2017
Freezer, Chest	32	45	Split upright and chest to more accurately represent savings	Supplemental PSD documentation, 2017

[1]The recommended values were calculated using the inputs provided to the evaluation team in the supporting documentation.

Specific Freezer Recommendations

- Update the qualified product list used in the savings calculations; the product list included in these calculations is from 2017.
- Calculate deemed savings values for upright and chest freezers separately, as separating chest and upright freezers brings deemed savings values in line with those included in other TRMs.

4.2.4 Measures with Insufficient Detail or Documentation

Table 17 below outlines recommended deemed savings values for measures where the evaluation team was unable to reconstruct the calculation methodology, or where insufficient detail was provided to sufficiently compare Connecticut's deemed savings values to those included in other states' TRMs. For these measures, EMI Consulting recommends adopting the energy savings methodology and estimates included in Vermont's TRM due to the clarity and simplicity of Vermont's methodology, and included references.

TABLE 17. DEEMED SAVINGS VALUE RECOMMENDATIONS

Measure	Recommended Value (kWh)	Existing Value (kWh)	Reason for Recommendation	Source for Recommended Values
Clothes Washer, Tier I	88.1	66	Insufficient documentation in PSD to support current value	VT TRM (2018), High Efficiency: ENERGY STAR Version 8.0 specification, effective February 5, 2018
Clothes Washer, Tier II	120.3	117	Insufficient documentation in PSD to support current value	VT TRM (2018), High Efficiency: ENERGY STAR Version 8.0 specification, effective February 5, 2018
Air Cleaner /Purifier	214	227	Insufficient documentation in PSD to support current value	VT TRM (2018), High Efficiency: ENERGY STAR Version 1.2 specification, effective July 1, 2004
Sound Bars[1]	24	45	Insufficient documentation in PSD to support current value	VT TRM (2018), 50% more efficient than ENERGY STAR Version 3.0 specification, effective May 1, 2013

[1]A follow-up email was sent on 6/25/20 to confirm that there was no additional documentation not shared with the research team.

4.3 ONLINE E-COMMERCE RECOMMENDATIONS

This section outlines the measure specific recommendations related to the E-commerce, including Wi-Fi/smart thermostats and advanced power strips.

4.3.1 THERMOSTATS

EMI Consulting recommends the Connecticut PSD include separate measure categories for Wi-Fi thermostats and smart thermostats as the savings methodology (i.e. deemed versus calculated deemed) and the resulting savings are different for Wi-Fi and smart thermostats.

Wi-Fi Thermostats

As the other states' TRMs utilize the same methodology and have updated sources of data for Wi-Fi thermostat savings (2019 for Rhode Island), we recommend adopting the savings approach utilized in other TRMs. This would mean adopting the 104 kWh deemed savings value for Wi-Fi thermostats, and 6.6 MMBtu deemed gas savings value, that control heating and cooling applications without a distinction for heating system or fuel type. This makes sense, as it is difficult to confirm the type of heating system when customers are purchasing a thermostat through an E-commerce platform.

Smart Thermostats

We recommend the PSD adopts the calculated deemed methodology in the Vermont TRM as this would align the methodology and sources with the ESRPP sources and would provide consistency and continuity between the CT ESRPP and E-commerce programs. Where Connecticut specific assumptions are unavailable, we recommend the PSD adopt Vermont assumptions as well. The equations and assumptions included in the Vermont TRM are:

Equation 3. Smart Thermostat Electric Energy Savings

$$\Delta kWh = \Delta kWh_{cooling} + \Delta kWh_{heating}$$

Where:

Equation 4. Smart Thermostat Cooling Savings

$$\Delta kWh_{cooling} = \%AC\ x \left(\frac{EFLH_{cool} \times Capacity \times \frac{1}{SEER}}{1000} \right) \times Cooling_{Reduction}$$

Equation 5. Smart Thermostat Heating Savings

$$\Delta kWh_{heating} = \%Electric\ Heat \times Elec_{Heating_{Consumption}} \times \%Controlled \times Heating_{Reduction} + \Delta MMBtu \times F_e \times 293$$

Equation 6. Smart Thermostat Fossil Fuel Savings

$$\Delta MMBtu = \sum \left(\%FossilHeat \times Heating_{Consumption} \times \%Controlled \right) \times Heating_{Reduction}$$

And:

- %AC = the fraction of customers with central air-conditioning;
- %Controlled = Assumed percentage of total heating load being controlled thermostat (69% for existing buildings and 53% for new construction);
- %ElectricHeat = Percentage of heating savings assumed to be electric (where unknown, 25% for existing buildings and 61% for new construction);

- %FossilHeat = Percentage of heating savings assumed to be fossil fuel (assumed to be 27% oil and 48% propane for existing buildings and 0% oil and 39% propane for new construction where heating system unknown);
- Capacity = Capacity of AC unit (assumed to be 41,400 Btu/hr);
- Cooling_Reduction = Assumed percentage reduction in total cooling energy consumption due to installation of advanced thermostat (assumed to be 8%);
- $EFLH_{cool}$ = Estimate of annual full load cooling hours for air conditioning equipment (assumed to be 755);
- Elec_Heating_Consumption = Estimate of annual heating consumption for heat pump heated buildings (assumed to be 8,273 for existing buildings and 6,416 for new construction);
- Heating_Consumption = Estimate of annual heating consumption (assumed to be 82 for existing buildings and 67 for new construction where heating system unknown);
- F_e = Furnance fan / boiler pump energy consumption as a percentage of annual fuel consumption (assumed to be 3.14%);
- Heating_Reduction = Assumed percentage reduction in total heating energy consumption due to advanced thermostat (assumed to be 8% for existing buildings and 5.6% for new construction), and;
- SEER = the cooling equipment's Seasonal Energy Efficiency Ratio rating (kBtu/kWh) (assumed to be 11.7 for existing buildings and 20.2 for new construction).

4.3.2 Advanced Power Strips

EMI Consulting recommends breaking advanced power strips into Tier 1 and Tier II savings to better align the approach and savings values to other states' TRMs. Connecticut's current savings value, 48 kWh, is appropriate for Tier I savings. We recommend adopting the Massachusetts TRM values, 179 kWh, for Tier II savings as this study is robust and occurred in close proximity to Connecticut (Table 18).

Table 18. Advanced Power Strip Deemed Savings Value Recommendations

Measure	Recommended Value (kWh)	Existing Value (kWh)	Reason for Recommendation	Source for Recommended Values
Advanced Power Strips, Tier I	48	48	Values reasonable, update sources and references	PSD, 2016
Advanced Power Strips, Tier II	179		Insufficient documentation in PSD to support current value	MA TRM (2019), NMR Group, Inc. (2018). Advanced Power Strip Metering Study

5 PROGRAM PLANNING RECOMMENDATIONS

This section summarizes EMI Consulting's immediate short-term program design recommendations that were developed through a combination of results from the measure-level engineering review, literature review, peer utility interviews, retailer interview analysis, and the EM&V best practices comparison.

5.1 ESRPP PROGRAM PLANNING RECOMMENDATIONS

This section summarizes our high-level findings and related short-term program planning recommendations for the ESRPP program.

HIGH-LEVEL FINDINGS

As part of the R1973 evaluation, the evaluation team reviewed the ESRPP incentive levels compared to average retailer markups (profit margin). This demonstrates the potential "attractiveness" and relative scale that incentives provide to retailers. Findings from this comparison include:

- Incentive levels were lower over the evaluation timeframe, PY 2018-2019.
- The utilities have already increased (and added) incentives for PY2020 similar to what the evaluation would have recommended.
- CT Utilities are increasing product incentives for air conditioners, washers, freezers and refrigerators to be more in-line with other program administrators.
- CT Utilities are adding basic tier incentives for dryers and freezers.

TABLE 19. ESRPP INCENTIVES FOR PY2019, AND PLANNED FOR PY2020

Measure	CT Incentive PY2019	CT Incentive PY2020	Retail Markup $[1]	2019 Incentive As % Of Markup	2020 Incentive As % Of Markup
Air Cleaner	$0	-	$70	-	-
Air Conditioner	$10	$20	$105	10%	19%
Washer	$15	$20	$367	4%	5%
Dryer[2]	$45	$45	$335	13%	13%
Sound bar	$0	-	$54	-	-
Freezer[2]	$10	$20	$119	8%	17%
Refrigerator	$10	$20	$507	2%	4%

[1]Estimated Retail Markup uses percentages derived by Department of Energy, published in technical support documents for product standards rulemakings.
[2]Utilities added basic tier incentives for PY2020; $25 for basic tier dryers, and $10 for basic tier freezers.

The evaluation team analyzed interview data with national level retailers (collected by Cadmus as the national evaluator). Our analysis indicated that while retailers generally view the ESRPP program favorably, they also would benefit from additional support. Specifically:

- Retailers make purchasing and marketing decisions at a national level.
- Retailer merchants and marketers take guidance from manufacturers, sustainability staff, sales data, and marketplace trends when making stocking decisions.
- Program Sponsors typically make product incentive decisions 3-5 months in advance of program-year launches, while retailers make their assortment decisions much farther in advance.

SHORT-TERM PROGRAM PLANNING RECOMMENDATIONS

Our high-level findings from the evaluation tasks and conclusions from the engineering review of the ESRPP measures result in the following recommendations for short-term program planning. Specifically:

- We recommend the CT Utilities consider 2-year incentive levels and budgets, as we found that retailers often make purchase decisions 1 year in advance of stocking products.
- We recommend the CT Utilities track upright and chest freezer purchases separately (if they are not doing so already) to allow the freezer type-specific savings estimates to be applied for upright and chest types.

5.2 E-COMMERCE PROGRAM PLANNING RECOMMENDATIONS

This section summarizes our high-level findings and related short-term program planning recommendations for the CT Utilities E-commerce platforms.

HIGH-LEVEL FINDINGS

The evaluation team interviewed four peer utility program managers and conducted a thorough literature review of existing e-Commerce platforms. Across these tasks, several common themes emerged around the concept of customer engagement. Specifically:

- Several utilities use the E-commerce platform as another channel to deliver prescriptive rebates also offered in stores.
- Most don't limit e-commerce offerings to only rebated products.
- Popular, rebated products can bring in visitors who then explore other categories.
- Several interviewees cited special promotions (e.g. Black Friday, Earth Day) and offering manufacturer discounts as best practices.

SHORT-TERM PROGRAM PLANNING RECOMMENDATIONS

Table 20 summarizes our short-term recommendations related to program planning and platform development of the CT Utilities E-commerce platforms. These recommendations are a result of our high-level findings from the evaluation tasks and conclusions from the engineering review of the E-commerce measures.

TABLE 20. SUMMARY OF SHORT-TERM E-COMMERCE RECOMMENDATIONS

E-Commerce Platform Component	Specific Recommendation	Rationale
Online Retailer Design	Design and promote platform **similar to on-line retailer** (Amazon) with rebate info, energy score info, special promotions	Seamless customer experience; Platforms appeal more with multiple products
Online Retailer Design	Include **info on measures** incentivized through other channels (ESRPP, midstream)	
Product Selection	Consider **adding product categories**, rebated or non-rebated (e.g. air cleaners / purifiers, dehumidifiers, VS pool pumps)	CT product variety limited compared to other states
Product Tracking	Recommend tracking Wi-Fi and Smart (learning) thermostat purchases separately, as well as Tier I and Tier II purchases separately (if not doing so already)	This will allow the measure type-specific savings values to be applied