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Retail Product Portfolio: Televisions Key Assumptions Review

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Executive Summary

On behalf of the Northwest Energy Efficiency Alliance (NEEA), TRC conducted the *Retail Product Portfolio (RPP): Televisions Key Assumptions Review*. Through this work, TRC reviewed inputs and calculations used to track energy savings from uptake of energy efficient televisions for comprehensiveness and accuracy. This included conducting a focused review of current literature to determine if alternate inputs or calculations are appropriate, and, if applicable, recommending updates to savings calculations.

TRC's review of NEEA's calculations and sources resulted in the following recommendations, organized here by research objective.

1. *Research Objective 1:* Assess NEEA's current assumption that all televisions meeting the Televisions Manufacturers' Voluntary Agreement (TVA; Consumer Technology Association 2023a) also meet ENERGY STAR® Version 9.1 specifications for standby mode (ENERGY STAR 2022b) and make recommendations for how to alter NEEA's estimate of the market share of ENERGY STAR Version 9.1 televisions reflected in the data, if needed.[1]

   Recommendation 1-1: NEEA should revise its assumption that all televisions complying with the TVA also meet ENERGY STAR Version 9.1 standby mode requirements (≤ 1 Watt), given evidence that some TVA-qualifying televisions have standby power consumption between 1 and 2 Watts.

   Recommendation 1-2: NEEA should estimate the potential growth in market share for televisions that use between 1 and 2 Watts of energy in standby mode, to explore how this will influence the energy savings forecast for this measure.

2. *Research Objective 2:* Review NEEA documentation of its television model number suppression approach[2] for categorizing energy efficient televisions represented in sales data and make recommendations, if indicated, for how to refine this approach.

   Recommendation 2-1: Refine the model-matching process to more carefully address cases in which a single sales model matches multiple California Energy Commission (CEC) models with similar wildcard representations.[3] NEEA could address this issue by:

[1] The ENERGY STAR televisions specification (v9.1) stipulates that televisions in standby mode can use up to 1 Watt of power, whereas the Televisions Voluntary Agreement (TVA; CTA 2023a) allows televisions in standby mode to use up to 2 Watts of power. Early reviews of the California Energy Commission television test data showed no televisions using between 1 and 2 Watts of energy in standby mode, which is what led to the assumption that TVA-qualifying televisions would align with ENERGY STAR specifications.

[2] Some television sales data obtained by NEEA has had the television model numbers suppressed (ie, model numbers are sometimes not included in the information, though other television features are described). NEEA has developed a model suppression methodology to merge sales data information with television model information, which then provides descriptions of a television's energy efficiency, needed for reporting co-created energy savings.

[3] Televisions are a complex product category, in which several model numbers may be associated with the same product over time and across different retailers. Sometimes available sales data have incomplete model numbers, represented by "wildcard" symbols like an asterisk, that takes the place of

1. Incorporating additional quality checks, such as comparing operating systems, screen resolution, or other available product specifications of matched models, or
2. Refining formatting rules to minimize the occurrence of multiple-valid matches. NEEA previously noted this issue in the model improvement opportunities section of the documentation, and TRC reiterates its importance here.

3. *Research Objective 3:* Assess if the current margin of power usage added to raw lab test data for on mode power calculations is overly conservative and, if so, make recommendations for adjustments. NEEA currently uses raw lab test data in its calculations and applies a 15% margin of energy usage in its energy savings forecasting. Applying a 15% energy usage margin to calculated values may be creating an unwarranted, overly-conservative estimate of how much energy savings are generated by televisions in NEEA's energy savings forecast.

   Recommendation 3-1: Consider relying on manufacturers' reported (not calculated) on mode power values without adding a 15% margin to maintain consistency with ENERGY STAR V9.1 on mode compliance requirements. NEEA could raise concerns about inconsistencies with how manufacturers share calculated and reported energy usage values to ENERGY STAR staff to ensure that reporting methodologies and resulting values are applied consistently and remain appropriate.

4. *Research Objective 4:* Review NEEA's average wattage estimates and Unit Energy Consumption (UEC) calculations for televisions and make recommendations for revisions.

   Recommendation 4-1: NEEA should continue to use the UEC calculations and current inputs in the short term.

   Recommendation 4-2: Longer term, NEEA could assess the representativeness of the Circana sales data, by assessing manufacturer market share. NEEA should review whether the set of non-qualifying televisions tested adequately reflects the full market. If the analysis relies primarily on California sales data, the results may not be fully representative, given California's more stringent appliance regulations. As a result, non-qualifying televisions may be underrepresented, potentially leading to overly conservative estimates of non-qualifying standby power. NEEA could assess the representativeness of the sample by comparing it to sales data from NEEA's Northwest region (Idaho, Montana, Oregon, and Washington), including sales by manufacturer market share.

5. *Research Objective 5:* Assess the reasonableness of the sources NEEA uses for measure life and average hours of use for modeling energy savings in televisions. Current estimates of televisions' average hours of use are adopted from NEEA's 2022 Residential Building Stock Assessment (NEEA 2024) and the estimate for measure life is based on a prior televisions assumption review (Cadeo 2021).

   Recommendation 5-1: NEEA should continue to use the $Hours_{On}$ estimate of 5.2 hours

potential information. These are placeholders that indicate the rest of the model number is not provided. NEEA's model number suppression approach assigns a model number to data like this, where the model number is incomplete, based on a series of rules.

per day from the 2022 RBSA data. While this value is based on interviews (which are not as reliable as metering), it is relatively recent and specific to the NEEA region. In addition, Nielsen data collected in 2024-2025 across the U.S., which did include metering, found that $Hours_{On}$ is between 4.5 and 5 hours per day (Nielsen 2025). This is the most recent data that TRC found and is close to the NEEA estimate of 5.2 hours.

Recommendation 5-2: TRC recommends that NEEA investigate $Hours_{On}$ in the near future, potentially through upcoming national or regional studies as they become available, since television viewing patterns may be changing as some consumers rely more on tablets and phones than television sets.

Recommendation 5-3: TRC does not recommend changing the measure life estimate of seven years at this time. TRC could not find a study with a recent estimate, and the value of 7 years aligns with a recent trade association report (CTA 2023b). The Consumer Technology Association (2023b) data shows a similar measure life of 6.5 years which is close to the 7-year value used by NEEA.

Introduction

On behalf of the Northwest Energy Efficiency Alliance (NEEA), TRC conducted the *Retail Product Portfolio: Televisions Key Assumptions Review*, which reviewed key assumptions and calculation inputs supporting savings estimation for uptake of energy efficient televisions in NEEA's Retail Product Portfolio (RPP) Program.

Through its participation in ENERGY STAR® Retail Products Platform (ESRPP) program[4], NEEA provides midstream incentives to influence retailer purchasing, stocking, and promotional practices for higher-efficiency products. These retailer-driven actions contribute to increased consumer awareness and adoption of energy-efficient products. NEEA's RPP program analyzes national and Northwest regional sales data to identify high-potential efficiency opportunities and to support increased stringency in ENERGY STAR specifications and federal standards. Through its participation in ESRPP, NEEA procures access to full-category sales data that supports internal analysis and strategic decision-making.

Prior evaluation findings demonstrate NEEA's sustained, multifaceted role in advancing on mode and standby mode energy use testing methodologies to reflect real-world usage and the nuances of product specifications more accurately, and now the national ESRPP program is considering adding energy efficient televisions to its portfolio of incented products (TRC 2022).

The goal of TRC's work was to review NEEA's existing inputs and calculations for energy savings resulting from market uptake of more efficient televisions. This includes conducting a focused review of current literature to assess whether inputs and calculations are comprehensive and accurate, determine whether alternate inputs and calculations are appropriate, and, if applicable, recommend updates to inputs and savings calculations.

[4] For more information on ESRPP, review the landing page for the program here: https://www.energystar.gov/partner-resources/energy-star-retail-products-platform

Methodology

This section provides an overview of the research objectives and methodology for this evaluation.

Research Objectives

This review evaluates several key assumptions used to inform NEEA's modeling of energy savings. The specific approach designed for each research objective is detailed under the Findings section. TRC conducted the evaluation to meet five research objectives:

1. Assess NEEA's current assumption that all televisions meeting the Televisions Manufacturers' Voluntary Agreement (TVA; CTA 2023a) also meet ENERGY STAR® Version 9.1 specifications for standby mode (ENERGY STAR 2022b) and make recommendations for how to alter NEEA's estimate of the market share of ENERGY STAR Version 9.1 televisions reflected in the data, if needed[5].
2. Review NEEA documentation of its television model number suppression approach for categorizing energy efficient televisions represented in sales data and make recommendations, if indicated, for how to refine this approach.
3. Assess if the current margin of power usage added to raw lab test data for on mode power calculations is overly conservative and, if so, make recommendations for adjustments.
4. Review NEEA's average wattage estimates and Unit Energy Consumption (UEC) calculations for televisions and make recommendations for revisions.
5. Assess the reasonableness of the sources for measure life and average hours of use for modeling energy savings in televisions. Current estimates on televisions' average hours of use are adopted from NEEA's 2022 Residential Building Stock Assessment (NEEA, 2024) and the estimate for measure life is based on a prior televisions assumption review (Cadeo, 2021).

Data Collection and Analysis Methodology

TRC identified key documents and studies based on a literature review and input from NEEA. Detailed information is available for each of these in the references section at the end of the report.

Table 1 below shows which data source TRC reviewed for each research objective (RO):

[5] NEEA assumes this is the case, even though the TVA specifies that standby modes can use 2 watts or under, while the ENERGY STAR specification designates energy usage of 1 watt or under. This is because a thorough review of test data on every television sold in California (which generally reflects the availability of products across the US) revealed that no models exist which use between 1 and 2 watts of power in standby mode. Therefore, televisions that meet TVA requirements should also meet ENERGY STAR requirements.

Table 1. Data Sources Used for each Research Objective

Data Source or Study	RO1	RO2	RO3	RO4	RO5
California Energy Commission (CEC) Television test data	x	x	x	x	x
ENERGY STAR Version 9.1 Television specifications	x		x	x	
NEEA Data Processing Pipeline Documentation for Televisions		x			
Circana television sales data (with model numbers[6])		x			
Circana television sales data (without model numbers[7])		x			
ENERGY STAR Program List of Certified Televisions		x	x		x
US Department of Energy (DOE) test procedure for televisions			x	x	
California Energy Commission: 2019 California Residential Appliance Saturation Study (RASS)					x
Cadeo Group: Televisions Assumptions Planning Review, 2021					x
Nielsen Study: Your Guide to the 2024-2025 Upfronts/NewFronts Planning Season					x
NEEA Residential Building Stock Assessment (RBSA), 2022					x
CTA article, Product Lifecycles Shrinking published 2023 (using 2022 data)					x

[6] This data contains television sales data by month and year and includes television features such as display size, resolution, Display Type, Backlight Type, Quantum Dot Technology, Local Dimming, HDR, Brand, Model Number, Television Series, Manufacture Year, Operating System etc.
[7] This data is equivalent to the Circana sales data that includes model numbers, but without model-level specificity.

Findings

Research Objective 1

Objective: Assess NEEA's current assumption that all televisions meeting the Televisions Manufacturers' Voluntary Agreement (CTA 2023a) also meet ENERGY STAR Version 9.1 specifications for standby mode (ENERGY STAR 2022b), and make recommendations for how to alter NEEA's estimate of the market share of ENERGY STAR Version 9.1 televisions reflected in the data, if needed.

Approach: TRC reviewed the CEC test data, which consists of all television models being sold in California and their technical details, including on-mode and stand-by power usage and pass rate information, along with calculations relevant to other research objectives (CEC 2026). TRC also used secondary research, including specifications from the ENERGY STAR website (ENERGY STAR 2022b), to assess the prevalence of models using between 1 and 2 Watts of power in standby mode.

Findings: TRC found that 1% of the television models listed in the CEC test data had a standby energy consumption between 1 and 2 Watts (66 4K LED televisions of 6,544 total units), which does not pass the ENERGY STAR standby limit of one Watt energy usage. TRC conducted a further review of the television models that fell between 1 and 2 Watts energy usage in standby mode to assess current market share of the units that failed to meet ENERGY STAR requirements and their future growth potential in overall market share over the near term. All identified televisions with a standby power consumption between 1 and 2 Watts were 4K LED televisions. Table 2 shares the sales weighting[8] of all 4K LED televisions in the market, categorized by screen size (medium, large, and extra-large). According to NEEA-provided sales data, large and extra-large 4K LED televisions account for 83% of total 4K LED television sales (46% and 37%, respectively). This indicates that televisions with a standby power consumption between 1 and 2 Watts account for the majority of current sales. As a result, although the identified models represent a very small fraction of the total product catalogue, they fall within the size segments that dominate sales volume.

Table 2. Sales weighting of 4K LED televisions

Display Technology	Size	Screen Size (Diagonal Inches)	Sales Weighting (%)	Number of TV models between 1 and 2 Watts
4K LED	Medium	39" < x ≤ 49"	17%	0
4K LED	Large	49" < x ≤ 59"	46%	17
4K LED	Extra Large	59" < x ≤ 120"	37%	49

[8] The sales weighting is based on anonymized 2020 sales data, provided by NEEA under confidentiality agreements.

TRC notes that only sales distribution percentages by size category are available, rather than sales data at the individual model level. As a result, we cannot assess the actual market share or potential of these units. However, these models are likely to be more prevalent in sales data moving forward and therefore, NEEA's assumption that all televisions meeting the 2023 TVA also meet ENERGY STAR Version 9.1 specifications for standby mode is not accurate.

Recommendation 1-1: TRC recommends that NEEA should review its assumption that all televisions complying with the TVA also meet ENERGY STAR Version 9.1 standby mode requirements (≤ 1 Watt), given evidence that some TVA-qualifying televisions have standby power consumption between 1 and 2 Watts.

Recommendation 1-2: NEEA should estimate the potential growth in market share for televisions that use between 1 and 2 Watts of energy in standby mode, to explore how this will influence the energy savings forecast for this measure. The shift from no models to a few models in the 1 to 2 Watt range may indicate that this segment is growing, underscoring the importance of accounting for it in both current and future estimates.

Research Objective 2

Objective: Review NEEA documentation of its television model number suppression approach for categorizing energy efficient televisions represented in sales data and make recommendations, if indicated, for how to refine this approach.

NEEA's television model number suppression approach: NEEA currently utilizes three different data sources to match television sales data with appropriate model numbers and other information about individual products being sold (including technical details that relate to each model's energy efficiency). These sources include CEC test data, the ENERGY STAR list of qualified products, and confidential sales data obtained through Circana. Sometimes, the sales data lacks model numbers and/or other feature information that is relevant to categorizing a product's energy efficiency. NEEA's model suppression approach is meant to generate a usable dataset from the sales data that merges relevant details about each product sold in the Northwest. For sales data without corresponding model matching information in the CEC test data, NEEA's approach estimates energy savings features based on other product information available.

Approach: TRC reviewed NEEA's model matching and model number suppression approach for estimating market penetration of energy-efficient televisions and the energy savings associated with uptake of these models. This review included an assessment of CEC test data, Circana sales data with model numbers, Circana sales data without model numbers, the ENERGY STAR qualified product list, as well as the methodology documentation.

Findings: Overall, TRC finds that NEEA's general approach to estimating market penetration of energy-efficient televisions is reasonable but could be improved. As documented by NEEA, when a sales model matches multiple CEC television models, the current model matching technique selects the most recent record as its match. While this approach is theoretically sound, practical challenges arise when wildcard representations[9] do not consistently align, making the matching

[9] Wildcard representations refer to a sequence of characters or symbols used within regular expression matching to define a word pattern in a pattern matching operation. For example, an asterisk (*) can refer to zero or multiple characters, whereas a question mark (?) refers to a single character being present.

logic difficult to apply. For example, the Hisense 50A6GV model matches two wildcard representations in the CEC dataset with different add dates, resulting in the selection of one model over the other without a clear technical justification. A similar concern arises with the Hisense 32H4030F3 model, which matches two wildcard representations in the CEC data: one matching the first eight characters of the model number and another matching only the first four. In this case, the methodology selects the less specific match, despite the availability of a more precise alternative. This reduces transparency in the decision-making process and limits TRC's ability to fully support the methodology without a more detailed review of the underlying regular expression matching logic.

Recommendation 2-1: TRC recommends refining the model-matching process to more carefully address cases in which a single sales model matches multiple CEC models with similar wildcard representations. TRC recommends addressing this issue by incorporating additional quality checks, such as comparing operating systems, screen resolution, or other available product specifications of matched models or by refining formatting rules to minimize the occurrence of multiple-valid matches. NEEA previously noted this issue in the model improvement opportunities section of the documentation, and TRC reiterates its importance here.

Research Objective 3

Objective: Assess if the current margin of power usage added to raw lab test data for on mode power calculations is overly conservative and, if so, make recommendations for adjustments.

On mode power usage and the 15% margin: When the new television test methodology was first being used to assess energy efficiency for televisions in the CEC database, Pacific Crest Labs (PCL), a NEEA consultant, recommended applying a 15% margin to the on mode "calculated" power usage category to categorize the energy efficiency of televisions. It was unclear if and when manufacturers were adding a buffer of potential additional energy usage to their CEC test data for on-mode power calculations to be conservative in their own reporting to the CEC. Following the PCL recommendation therefore, might sometimes result in NEEA's adding a conservative power usage estimate on top of another estimate that already has an energy usage buffer built in when merging power usage data from the CEC test data with available sales data, resulting in potentially not recognizing a more realistic amount of energy savings resulting from the sales of energy efficient televisions in the Northwest.

Approach: TRC reviewed NEEA's documentation sharing details about the CEC data set and communication records with PCL and conducted a targeted literature review for additional product on-mode usage data to assess reasonableness of this assumption. The literature review included resources from the U.S. EPA (ENERGY STAR 2022a) and the CEC test data.

Findings: Results of TRC's analysis of the CEC test data and the ENERGY STAR qualified product list data are below. Because NEEA draws the 15% margin applied to the on-mode power from variation around television model performance during the initial phase of the recently developed on-mode tests, there was limited scope to assess or comment on the underlying calculation methodology. TRC reviewed three different data sets:

- On Mode Power Usage in CEC Data Compared to ENERGY STAR Data: To evaluate on-mode power consumption, TRC compared the CEC test data with the ENERGY STAR certified list of televisions' reported energy usage by model. This comparison revealed that some manufacturers report different on mode power values to CEC than they do to ENERGY

STAR for the same models, indicating potential inconsistencies in reported or applied margins. Of the 140 ENERGY STAR certified televisions that matched the CEC list of television models, 119 reported higher on-mode power usage to the CEC than the corresponding ENERGY STAR federal test procedure values. The CEC values for measured on-mode power averaged 9% higher across all 140 records. This suggests that NEEA may be adding a 15% margin to values that in some cases are already elevated in the CEC data set's "reported" value category. Determining which data source (ENERGY STAR or CEC) provides the more accurate information is beyond the scope of this project. However, TRC recommends that NEEA engage with both organizations to address and resolve the identified inconsistencies.

Different On Mode Power Usage Reported within ENERGY STAR Data: TRC reviewed the ENERGY STAR certified data, which includes metrics such as "average on mode power consumption for certification," "maximum average on mode power for certification," and "reported on mode power" (per the DOE federal fest procedure). Analysis of these metrics confirms inconsistencies both within the ENERGY STAR data and between ENERGY STAR and CEC datasets.

- Table 3 shows the difference between the “average on mode power consumption for certification” and “reported on mode power” (per the federal test procedure) from the ENERGY STAR data. While most televisions (90%) report average on-mode power equal to ENERGY STAR certification values, 13 out of 146 televisions (9%) report federal test procedure values exceeding the certification maximum, with an average increase of 30%. Again, PCL’s recommendation is that NEEA apply an additional 15% margin to values that, in some cases, already exceed those reported under the test procedure. Although the ENERGY STAR dataset represents fewer than 150 televisions compared to nearly 7,000 in the CEC test data, these inconsistencies in a small sample indicate that similar discrepancies may exist more broadly.
- Different On Mode Power Usage Reported within CEC Data: The CEC data includes different values for on-mode power, including “calculated” and “reported” value categories. According to NEEA, the “calculated” power values refer to the unedited power results produced directly by the ANSI/CTA 2037-D test process and TV EASY software, whereas the “reported” power values refer to on-mode energy use reported by manufacturers to be used for determining ENERGY STAR V9.1 on-mode compliance. The reported on-mode power is based on calculated values but will often include a buffer factor (for example, +10%) decided by the manufacturer to account for variances in individual television units ensuring that spot checked television units will measure at or below this value. TRC reviewed the “calculated” and “reported” on-mode power results in the CEC data. Across all products, TRC found that the average “reported” on-mode power was 124 Watts, compared to 116 Watts for “calculated” on-mode power. For ENERGY STAR qualified products, the average “reported” on-mode power was 75 Watts, compared to 71 Watts for “calculated” on-mode power. These results show that reported on-mode power is on average slightly higher than calculated on-mode power, both overall (for ENERGY STAR qualified and non-qualified models combined) and for ENERGY STAR qualified models alone. NEEA believes that ENERGY STAR intends to rely on “reported” power values. Consequently, if NEEA also used reported values, it would maintain methodological consistency with ENERGY STAR.

Table 3. Review of on-mode power consumption in ENERGY STAR data.

TRC Review Findings	Number of TVs in ENERGY STAR data set using this approach (out of 146 total TVs)
Average On Mode Power Consumption is the same as Reported On Mode Power (per the federal test procedure)	90% (130/146) TVs
Average On Mode Power Consumption is greater than Reported On Mode Power (per the federal test procedure)	0.7% (1/146) of TVs
Average On Mode Power Consumption is less than Reported On Mode Power (per the federal test procedure)	9% (13/146) TVs with an average of 30% increase from average to reported

Based on TRC's review of the televisions federal test procedure's on-mode power consumption methodology, the on-mode power measurement uses ANSI/CTA-2037-D and provides a reasonable representation of typical on-mode energy use. The procedure specifies standardized operating conditions, including controlled video content, defined picture settings, and consistent test configurations, which contribute to repeatability and comparability across television models and manufacturers. By measuring power consumption while the television is actively displaying content and performing its principal functions, the test captures the dominant contributors to on-mode power use, including the display panel, internal electronics, and integrated software platforms.

Recommendation3-1: TRC recommends that NEEA consider relying on the manufacturers' reported (not calculated) on mode power values without adding a 15% margin to maintain consistency with ENERGY STAR V9.1 on mode compliance requirements. NEEA could raise concerns about inconsistencies with how manufacturers share calculated and reported energy usage values to ENERGY STAR staff to ensure that reporting methodologies and resulting values are applied consistently and remain appropriate.

Research Objective 4

Objective: Review NEEA's average wattage estimates and Unit Energy Consumption (UEC) calculations for televisions and make recommendations for revisions.

Approach: TRC reviewed NEEA's documentation and calculations and conducted a targeted literature review for additional information regarding wattage assumptions and UEC calculations. The literature review included resources from the U.S. EPA, U.S. DOE federal appliance standard program, and the CEC test data. Note that TRC's review also included the calculation for Unit Energy Savings (UES), since NEEA reports co-created savings to its alliance members.

Findings: Following are the calculations that NEEA uses to determine annual energy savings for ENERGY STAR qualifying televisions compared to non-ENERGY STAR qualifying televisions.

NEEA calculates Unit Energy Savings (UES) separately by display technology (4K LED, 4K OLED, and 8K) and by screen size category (Medium, Large, and Extra Large). NEEA also estimates UES separately for on mode and standby mode and aggregates the results only when a model complies with both the on mode and standby mode specifications. These calculations include determining the on-mode Unit Energy Savings ("$UESo_n$"), standby mode Unit Energy Savings ("$UES_{standby}$"), aggregated Unit Energy Savings ("UES_{Total}") and Unit Energy Consumption ("UEC") as below:

1. $UES_{on} = ((Nonqual_{on} - NonqualLimit_{on}) + (QualLimit_{on} - Qual_{on})) * Hours_{on} * 365/1000[kWh]$; Where:

   $Nonqual_{on}$ = Measured On Mode Power of non-ENERGY STAR-qualifying televisions [W]

   $NonqualLimit_{on}$ = Maximum on Mode power allowed if these televisions were to qualify for ENERGY STAR, determined for non-ENERGY STAR-qualifying televisions. Note that the ENERGY STAR wattage limit varies depending on characteristics like screen size and display technology, so this value will depend on the group of non-qualifying televisions in the sample analyzed [W]

   $Qual_{on}$ = Measured On Mode power of ENERGY STAR-qualifying televisions [W]

   $QualLimit_{on}$ = Maximum on Mode power allowed to qualify for ENERGY STAR, determined specifically for ENERGY STAR-qualifying televisions [W]

   $Hours_{on}$ = Hours per day that television in On Mode [hours]

2. $UES_{Standby} = (Nonqual_{Standby} – Qual_{Standby}) * Hours_{Standby} * 365/1000\ [kWh]$

   Where:

   $Nonqual_{Standby}$= Measured Standby Mode power of non-ENERGY STAR-qualifying televisions [W]

   $Qual_{Standby}$ = Measured Standby Mode power of ENERGY STAR-qualifying televisions [W]

   $Hours_{Standby}$ = Hour per day that television is in Standby Mode [hours]

3. $UES_{Total}=UES_{On} + UES_{Standby}\ [kWh]$

4. *UEC = (On-Mode W × $Hours_{On}$ × 365.25) / 1000. See footnote on use of this equation*[10].

To determine UES for a certain class of television products (for example all televisions of a certain size that use LED technology), the most straightforward approach would be to take the average energy use for non-ENERGY STAR qualifying televisions in that product class and subtract the energy use of qualifying televisions in the same product class ($NonQual_{On}$ minus QualOn). Although television products can be grouped into broad product classes, key characteristics like screen size vary within that class rather than falling into discrete conditions. For instance, the 4K LED Medium category includes products with screen size diagonals of 39 to 49 inches. As a result, non-qualifying televisions on average may differ slightly in size from qualifying televisions to which they are compared, leading to different applicable ENERGY STAR power limits. To account for this, NEEA calculates UES by comparing the actual energy

[10] Unit Energy Consumption (UEC) is the difference between qualifying and non-qualifying televisions. This value is derived from the same logic as UES and is not a direct input into the UES calculations.

consumption of non-qualifying televisions ($Nonqual_{On}$) to their corresponding ENERGY STAR limits ($NonqualLimit_{On}$) and adding this difference to the comparison between the actual energy consumption of qualifying televisions ($Qual_{On}$) and their applicable ENERGY STAR limits.

The inputs for the above calculations are as shown in Table 4. TRC reviewed the calculation workbooks and determined that the values and methodologies applied were reasonable. NEEA derives power values for on mode calculations ($Nonqual_{on}$, $Qual_{on}$, $NonqualLimit_{on}$, $QualLimit_{on}$) from the CEC test data, in accordance with ENERGY STAR V9.1 specifications. ENERGY STAR V9.1 calculates the average on mode power at three different preset picture settings (Default Standard Dynamic Range, Brightest, and Default High Dynamic Range), which refers to pre-determined combinations of brightness, contrast, color and sharpness settings programmed in televisions. For standby mode calculations, the measured standby mode power for ENERGY STAR-qualifying televisions ($Qual_{Standby}$) is based on the ENERGY STAR V9.1 requirements, whereas the non-ENERGY STAR qualifying televisions ($Nonqual_{Standby}$) use an observed market average derived from testing a sample of non-qualifying televisions available to NEEA.

Table 4. 2024 Specific UES Calculations Inputs[11]

Input	Value	Source and Comments
$Nonqual_{on}$	106.9 W	CEC test data; based on a sample of non-qualifying TVs between 49"<x≤59"
$NonqualLimit_{on}$	88.52 W	CEC test data; based on a calculation (using ENERGY STAR formulas) for the sample of non-qualifying TVs in row above for TVs between <49" x ≤59"
$QualLimit_{on}$	102 W	CEC test data; based on qualifying TVs between <49" x ≤59"
$Qual_{on}$	87 W	CEC test data; for qualifying TVs between <49" x ≤59"
Hours (on mode)	5.2 hours	RBSA 2022 data (NEEA 2024)
$Nonqual_{Standby}$	15.72 W	Observed market average based on testing a sample of non-qualifying televisions; for all TV sizes
$Qual_{Standby}$	0.48 W	CEC test data of qualifying TVs; for all TV sizes

[11] Wattage calculations are performed every year.

Input	Value	Source and Comments
Hours$_{Standby}$	18.8 hours	RBSA 2022 data, based on interviews (NEEA, 2024)
UES$_{on}$	33 W	Calculation based on inputs above
UES$_{Standby}$	105 kWh	Calculation based on inputs above

**Note that the values for Nonqual$_{On}$, NonqualLimit$_{On}$, QualLimit$_{On}$, Qual$_{On}$, and UES$_{On}$ are broken out by size range of televisions where each variable had three different values (size ranges). Here, the most common television size range "Large" which is between <49" x ≤59" is used since NEEA determined that the sales weighting was 46% for this size range.*

In the CEC test data, the Nonqual$_{Standby}$ wattage assumption value comes from the observed market average based on testing a sample of non-qualifying televisions. While the calculation approach is sound and the inputs seem reasonable, TRC cannot confirm that the non-qualifying televisions in the CEC test data are representative of the total market. It is possible that the CEC test data is biased towards more energy efficient products if this database is developed from manufacturers checking that their products comply with Title 20. Title 20 is the California appliance standard, which has more stringent efficiency requirements than the U.S. DOE[12]. If the non-qualifying televisions in the CEC test data are more efficient than the total market average, this would mean that the baseline energy use for the non-qualifying televisions is lower than the total market, and NEEA's savings assumptions would be conservative. Similarly, the CEC test data includes a mix of non-qualifying televisions for calculating the Nonqual$_{on}$ wattage assumption. While the calculation approach is sound and the inputs seem reasonable, since it comes from a CEC workbook, it is possible that the non-qualifying televisions used for this calculation are biased towards more efficient televisions which would lead to overly conservative savings.

TRC conducted a literature search for more information regarding the Nonqual$_{Standby}$ assumption. An NRDC (2021) article highlights that "smart wake" features[13] can significantly increase television energy consumption in standby mode by keeping network connectivity and background functions active. Standby power values reported in the CEC test data follow the U.S. DOE federal test procedure (DOE 2023), which requires that connected and smart wake functionalities enabled by default be included during power measurements. The elevated standby power observed for non-qualifying televisions is therefore plausibly attributable, at least in part, to the energy required to support smart wake operation, consistent with the findings discussed in the NRDC article.

[12] DOE's published regulations indicate that no such standard is in effect, although test procedures and reporting requirements apply. In contrast, California's Title 20 Appliance Efficiency Regulations impose specific energy consumption limits (both on mode and standby/passive limits) for televisions sold in the state.

[13] According to the article, smart wake features provide the user with the convenience of waking their television through a voice command to a nearby smart speaker, or to seamlessly shift from watching content on a tablet or phone to the television, without using a remote control.

Recommendation 4-1: NEEA should continue to use its UEC calculations and current inputs in the short term.

Recommendation 4-2: Longer term, NEEA could assess the representativeness of the Circana sales data, by assessing manufacturer market share. In addition, NEEA should review whether the set of non-qualifying televisions tested adequately reflects the market of televisions sold in the Northwest region. If the analysis relies primarily on California test data, the results may not be fully representative given California's more stringent appliance regulations. As a result, non-qualifying televisions may be underrepresented, potentially leading to overly conservative estimates of non-qualifying standby power. NEEA could assess the representativeness of the sample by comparing it to sales data from NEEA's Northwest region (Idaho, Montana, Oregon, and Washington), including sales by manufacturer market share.

Research Objective 5

Objective: Assess the reasonableness of the sources NEEA uses for measure life and average hours of use for modeling energy savings in televisions. Current estimates on televisions' average hours of use are adopted from NEEA's 2022 Residential Building Stock Assessment (RBSA; NEEA 2024) and the estimate for measure life is based on a prior televisions assumption review (Cadeo 2021).

Approach: TRC conducted a literature review for hours of use estimation, including estimated hours in each mode (on and standby). The literature review included resources such as the U.S. EPA, U.S. DOE federal appliance standard program, the California's Residential Appliance Saturation Study (RASS; CEC 2019), and a general search. TRC did not include the RASS estimates in the comparison table because the most recent version did not collect new hours of use for televisions; instead, it used data collected in 2009. To find more comparisons of the measure life and hours on estimates, TRC identified other available estimates, as shown in Table 5 below.

Table 5: Measure Life and Hours on Estimates

Input	Value	Source and Comments
$Hours_{On}$	5.2 hrs per day	NEEA's current assumption, based on RBSA 2022, which estimated HOU based on RBSA participant interviews (NEEA 2024).
	4.5 to 5 hrs	Based on Nielsen data collected in the US in 2024-2025 (Nielsen 2025).
	5.8 hrs	From 2020 data (Fraunhofer 2022). This is a US study and survey respondents noted 50% higher TV-on time during COVID.
$Hours_{StandBy}$	18.8 hrs	NEEA's estimate, from RBSA surveyed data from 2022, based on subtracting $Hours_{On}$ from 24 hrs/day (NEEA 2024)

Input	Value	Source and Comments
	19 hrs	Similar to NEEA, the DOE (2014) allocated all hours when the television is not in on mode (which DOE assumed as 5 hrs) to standby mode (24 hrs – 5 hrs = 19 hrs), because DOE expects such a television to remain in standby whenever it is not in on mode.
Measure Life	7 years	NEEA assumption, after feedback from key assumption review (Cadeo 2021). Cadeo estimated 5 to 7 years, and NEEA assumed 7 years.
	5 years	US DOE based on guidance last updated 2024 (DOE 2024). The website states that 5 years is in alignment with the ENERGY STAR savings calculations for efficient televisions. However, TRC was unable to locate the original source supporting the five-year estimate. Notably, an ENERGY STAR document from 2016 cites the same value, suggesting that this estimate may be derived from an earlier study.
	6.5 years	An online article from Consumer Technology Association (CTA 2023b), which is a trade organization, based on a study done in 2022. The article does not explicitly state which geographic region the data represents, but CTA reports it is a trade association of North America[14].

For $Hours_{On}$, the two sources that TRC views as the most reliable are:

- The 2022 RBSA, which reports a value of 5.2 hours per day. While the 2022 RBSA value is based on interviews rather than metering, it is specific to the Northwest region and relatively recent (NEEA 2024).
- The Nielsen data based on 2024-2025 analysis, which has an average value of 4.5 hours to 5 hours per day (Nielsen 2025). This is for the entire U.S. but is recent and based on metering[15].

[14] https://www.cta.tech/about/
[15] https://www.nielsen.com/data-center/the-gauge/#Methodology-FAQ

Additionally, TRC found a value of 5.8 hours per day from the Fraunhofer (2022) study. However, TRC views this value as less accurate because this value was collected in 2020 during COVID, and television watching may have increased during this time.

The two sources that are the most relevant – 5.2 from RBSA and 4.5 to 5 hours from Nielsen – are in a similar range, so TRC does not recommend changing NEEA's assumed value. However, this value may become inaccurate due to changing trends. For example, an online article notes that younger viewers may be shifting to watching screens on secondary devices (tablets, phones, etc.) more than television sets (MediaPost 2015).

NEEA assumes that hours in standby mode is equal to hours in a day (24 hrs) minus $Hours_{On}$. This is consistent with DOE methodology (DOE 2023).

For measure life, NEEA estimates seven years. This is based on the Cadeo (2021) study, which cited findings from a Fraunhofer (2017) study; Cadeo recommended an estimate of five to seven years. NEEA chose the higher range of these values (seven years). TRC found that this value is similar to the CTA (2023b) estimate of 6.5 years. NEEA should continue to assume a measure life of 7 years.

Recommendation 5-1: NEEA should continue to use the $Hours_{On}$ estimate of 5.2 hours per day from the 2022 RBSA data. While this value is based on interviews (which are not as reliable as metering), it is relatively recent and specific to the NEEA region. In addition, Nielsen data collected in 2024-2025 across the U.S., which did include metering, found that $Hours_{On}$ is between 4.5 and 5 hours per day (Nielsen 2025). This is the most recent data that TRC found and is close to the NEEA estimate of 5.2 hours.

Recommendation 5-2: TRC recommends that NEEA investigate $Hours_{On}$ in the near future, potentially through upcoming national or regional studies as they become available, since television viewing patterns may be changing as some consumers rely more on tablets and phones than television sets.

Recommendation 5-3: TRC does not recommend changing the measure life estimate of seven years at this time. TRC could not find a study with a recent estimate, and the value of 7 years aligns with a recent trade association report (CTA 2023b). The Consumer Technology Association (CTA 2023b) data shows a similar measure life of 6.5 years which is close to the 7-year value used by NEEA.

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