Northwest Energy Efficiency Alliance (NEEA) Retail Products Portfolio (RPP) Methodology Documentation for Room Air Conditioners

Table 1: Report Summary

Product	Room Air Conditioners
Last Updated:	February 12, 2019
Last Revised By:	Ari Mytelka, Energy Solutions
Report Generated:	February 12, 2019

1. Introduction

This automatically-generated document reports the methodologies and assumptions used to calculate the sales-weighted unit energy consumption (UEC) of **room air conditioners** (by product class) for the Northwest Energy Efficiency Alliance (NEEA) Retail Products Portfolio (RPP, also used interchangeably with 'Retail Products Platform') Program[4]. Since NEEA uses these calculated values to track and estimate long-term energy savings, it is important that the methodologies and assumptions are well-documented, transparent, and reproducible. This document is generated using `R Markdown`. The values reported in this document are retrieved from the same R source code used to calculate energy savings and thus reflect the actual values used as of the report generation date. Manual revisions to this document shall be tracked in Appendix Section A.1.

2. Methodology

To calculate the sales-weighted UEC of each product category and efficiency tier, NEEA performs the following steps:

1. Acquire RPP sales data from RPP data provider (web portal)
2. Identify model attributes (product features and energy efficiency metric)
3. Modify/adjust the efficiency metric for NEEA-specific regional characteristics
4. Calculate UEC for each model
5. Weight model UECs by sales

The following sub-sections will discuss steps 1 through 4.

2.1 Sales Data

Sales data for the RPP program is managed on http://www.retailproductsplatform.com.[4] NEEA and other program sponsors have access to only the masked and aggregated data. For the purposes of energy savings calculations, NEEA uses the `sales by model` dataset, which contains the brand and model number of each product sold through participating retailers, and the quantity of units sold for that model in a given month (aggregated by month).

2.2 Model Attributes

In order to determine the energy usage characteristics for each **room AC** model, each model number (for a given brand) was mapped to models in the ENERGY STAR Qualified Products List,[3] U.S. Department of Energy Compliance Certification Management System,[6] and California Energy Commission Modernized Appliance Efficiency Database.[1] If there was conflict between the values reported by the three sources for a given model, the values listed in the ENERGY STAR Qualified Products list were used. If a model was not qualified for ENERGY STAR, the values listed by the California Energy Commission were used. The table below shows the attributes used for determining Unit Energy Consumption (UEC):

Table 2: Table of Attributes

Attribute	Equation Variable	Source(s)
On-Mode Power (W)	OP	[1][3][6]
Standby-Mode Power (W)	SP	[1][3]

Attribute	Equation Variable	Source(s)
DOE Product Class	-	[3][6]

2.3 Calculations

Operation of room ACs is climate-dependent, so the UEC calculation incorporates information on the distribution of room AC shipments and the average number of cooling degree days (CDD) across three cooling zones in the NEEA region. The ICF data portal details annual sales by cooling zone,[5] and the average CDD by cooling zone are determined by weighting the average CDD for each zone by ICF's reported sales for that zone. The hourly average CDD for each zone is taken from the Regional Technical Forum's calculated values.[7]

For determining the on-mode operating hours in each cooling zone, a standard civil engineering equation relates the cooling effective full-load hours (assumed to be equivalent to the room AC operating hours) to the CDD:

$$EFLH_{zone} = CDD \times \frac{24}{T_d - 65}$$

$EFLH_{zone}$, Equivalent full-load hours, the annual on-mode operating hours of a typical room AC unit

CDD, The shipment-weighted average cooling degree days for the cooling zone

T_d, The outdoor design temperature - the maximum hourly temperature after eliminating the hottest 1% of hours in a year, assumed to be 90 degrees Fahrenheit for all three cooling zones after on considering typical temperatures in Idaho, Montana, Oregon, and Washington

The constant 24 refers to the number of hours per day, and the constant 65 is the standard assumed setpoint temperature in Fahrenheit.

After determining the average operating hours for each cooling zone, the following equation was used to calculate the average UEC by cooling zone:

$$UEC_{zone} = OP \times EFLH_{zone} + SP \times (8766 - EFLH_{zone})$$

UEC_{zone}, The average UEC for a room AC unit in the given cooling zone

OP, The sales-weighted average on-mode power for the product class

$EFLH_{zone}$, Equivalent full-load hours, the annual on-mode operating hours of a typical room AC unit

SP, The sales-weighted average standby-mode power for the product class

The constant 8766 refers to the number of hours per year, accounting for leap years.

Finally, the weighted average UEC across NEEA regions is calculated using weights of the total AHAM-reported shipments for each cooling zone.

The efficiency tier is determined based on qualification for the **ENERGY STAR v4** measure level.[2] Qualification for this measure level is determined based on product class and the combined energy efficiency ratio (CEER), see Appendix Section A.3 for a table listing the minimum required CEER for each product class.

The product class is determined based on the listed product class if a match was found in the DOE Compliance Certification Management System or the ENERGY STAR Qualified Product List. If no match was found on those lists, the product class is determined based on the model attributes described in the California Energy Commission Modernized Appliance Efficiency Database (see Appendix Section A.2 for the code to classify models from listed attributes).

3. Sources

[1] California Energy Commission Modernized Appliance Efficiency Database. https://cacertappliances.energy.ca.gov

[2] ENERGY STAR Final Version 4.1 Residential Room Air Conditioners Specification. https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%204.1%20Room%20Air%20Conditioners%20Specification.pdf

[3] ENERGY STAR Qualified Products List. https://www.energystar.gov/productfinder/

[4] ICF. January 2019. Program Sponsor Portal-NEEA. Sales By Model. 2015-2018 Total Sales Airconditioners. http://www.retailproductsplatform.com

[5] ICF. January 2019. Program Sponsor Portal-NEEA. Sales By Cooling Zone. 2018 Total Sales Airconditioners. http://www.retailproductsplatform.com

[6] U.S. Department of Energy Compliance Certification Management System. https://www.regulations.doe.gov/certification-data

[7] Regional Technical Forum. 2019. RTF_ClimateZoneCalculations_v1_2.xlsx. NOAA Site Daily CDD weighted by Households. https://rtf.nwcouncil.org/work-products/supporting-documents/climate-zones

Appendix

A.1. List of Revisions

Date	Description	Author
December 31, 2018	Original Publication	A. Mytelka, Energy Solutions
January 2, 2019	Added RTF CDD Source	A. Mytelka, Energy Solutions
February 12, 2019	Edited CDD and Cooling Zone Sources	A. Mytelka, Energy Solutions

A.2. R Functions

DOE Product Class Determination Function

```
for (i in 1:nrow(MASTER_PRODUCT)) {

  if (isTRUE(MASTER_PRODUCT[i, "Room.AC.Type"] == "Casement-Slider Room Air Condi")) {
    MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "16"
  } else {

    if (isTRUE(MASTER_PRODUCT[i, "Heating.Capable"] == "Heat Pump Only")) {
      if (isTRUE(MASTER_PRODUCT[i, "Louvers."] %in% c("TRUE", "True", "true"))) {
        if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 20000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "11"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] > 20000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "13"
        }

      } else if (isTRUE(MASTER_PRODUCT[i, "Louvers."] == "False")) {
        if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 14000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "12"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] > 14000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "14"
        }
      }
    } else {
      if (MASTER_PRODUCT[i, "Louvers."] %in% c("TRUE", "True", "true")) {
        if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 6000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "1"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 7999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "2"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 10000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "3a"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 13999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "3b"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 19999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "4"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 27999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "5a"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] > 27999)) {
```

```
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "5b"
        }

      } else if (isTRUE(MASTER_PRODUCT[i, "Louvers."] == "False")) {
        if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 6000)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "6"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 7999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "7"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 10999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "8a"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 13999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "8b"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] < 19999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "9"
        } else if(isTRUE(MASTER_PRODUCT[i, "Cooling Capacity (BTU/h)"] > 19999)) {
          MASTER_PRODUCT[i,"Determined DOE Product Class (CEC)"] = "10"
        }
      }
    }
  }
}
```

A.3. Reference Tables

Table 4: ENERGY STAR CEER by Product Class

DOE Product Class	Minimum ENERGY STAR CEER
1	12.1
2	12.1
3	12
4	11.8
5a	10.3
5b	9.9
6	11
7	11
8a	10.6
8b	10.5
9	10.2
10	10.3
11	10.8
12	10.2
13	10.2
14	9.6
15	11.4
16	11.4