

CHAPTER 7. ENERGY USE ANALYSIS

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CHAPTER 7. ENERGY USE ANALYSIS

7.1 INTRODUCTION

To carry out the life-cycle cost (LCC) and payback period (PBP) analyses described in chapter 8, DOE must determine the energy savings to consumers from more efficient products. This chapter describes how DOE determined the annual standby energy consumption of microwave ovens for use in the LCC and PBP analyses.

The engineering analysis described in chapter 5 reports energy use based on the DOE test procedure. This test provides standardized results that serve as the basis for comparing the performance of different appliances used under the same conditions. Actual usage in the field varies depending on the conditions in which the appliances are operated.

To establish a reasonable range of energy consumption of microwave ovens in the field, DOE primarily used data from the Energy Information Administration (EIA)'s 2005 Residential Energy Consumption Survey (RECS 2005).¹ RECS is a national sample survey of housing units that collects statistical information on the consumption of and expenditures for energy in housing units along with data on energy-related characteristics of the housing units and occupants. RECS 2005 collected data on 4,381 housing units and was constructed by EIA to be a national representation of the household population in the United States.

7.2 CONSUMER SAMPLE

The subset of RECS 2005 records used for the microwave oven sample met the following criteria:

- The household had a microwave

Because RECS 2005 provides no means of determining the type of microwave present in a given household, DOE used the same sample for both product classes. The RECS reported saturation of microwave ovens in 2005 was 88 percent.

Table 7.2.1 RECS 2005 Sample Statistics

Product Class	Selection Criterion	No. of Records	No. of U.S. Households Represented (million)
All	Has Microwave = Yes	3835	97.7

7.3 STANDBY POWER CONSUMPTION

To estimate the annual energy use associated with standby power (E_{SP}) for both product classes, DOE used the following expression where the standby power is multiplied by the number of hours in a year the microwave oven is in standby mode:

$$E_{SP} = P_{SP} \times Hours_{SP}$$

Where:

P_{SP} = standby power (watts), and
 $Hours_{SP}$ = hours in a year the microwave oven is in standby mode (kWh/yr).

The annual standby hours equal the total hours in a year less the number of hours the microwave oven is in active operation. DOE determined the hours of active operation ($Hours_{ACTIVE}$) with the following expression:

$$Hours_{ACTIVE} = Hours_{NOPR} \times Use_{RECS}$$

Where:

$Hours_{NOPR}$ = average microwave operating hours from the NOPR, and
 Use_{RECS} = relative usage factor.

In the previous NOPR for cooking products, DOE determined the average hours of operation for microwaves ($Hours_{NOPR}$) to be 71 hours per year.² DOE has no reason to believe that this number has changed.

For each household, RECS 2005 provides information on the frequency of microwave oven usage and the number of hot meals prepared per day. DOE calculated the RECS usage factor (Use_{RECS}) for each household in the sample using the following expression:

$$Use_{RECS} = (Meals_{RECS} \times Freq_{RECS}) / Use_{AVG}$$

Where:

$Meals_{RECS}$ = RECS reported household hot meals per day,
 $Freq_{RECS}$ = RECS reported microwave use frequency, and
 Use_{AVG} = Weighted average usage factor.

The weighted average usage factor was calculated using the following expression:

$$Use_{AVG} = \frac{\sum Meals_{AVG} \times Freq_{AVG} \times Weight_{RECS}}{\sum Weight_{RECS}}$$

Where:

$Meals_{AVG}$ = Average household hot meals per day,
 $Freq_{AVG}$ = Average microwave use frequency, and
 $Weight$ = RECS household weight.

The responses in RECS for $Meals_{RECS}$ and $Freq_{RECS}$ fall into one of the bins shown in Tables 7.3.1 and 7.3.2, respectively. For each question, DOE assumed a uniform or triangular distribution within the boundaries of each bin and randomly assigned a value from within the appropriate range to each sample household. For the calculation of the average usage factor (Use_{AVG}), DOE used the average values from the respective bins.

Table 7.3.1 Number of Meals Cooked per Day Based on RECS Sample

Bin	Description	Meals per day	
		Min	Max
0	Doesn't cook/Never cooks	0.0	0.0
1	Three or more times a day	3.0	4.0
2	two times a day	1.0	3.0
3	Once a day	0.5	1.5
4	A few times each week	0.2	0.8
5	About once a week	0.1	0.2
6	Less than once a week	0.0	0.1

Table 7.3.2 RECS Microwave Oven Use Percentage

Bin	Amount of food cooked in the microwave	Use Percentage	
		Min	Max
1	Most or all	90%	100%
2	About half	25%	75%
3	Some or very little	20%	30%
4	Used only for snacks, defrosting, or reheating food	5%	25%

7.3.1 Annual Energy Consumption by Efficiency Level

Tables 7.3.3 and 7.3.4 present the average annual energy consumption by efficiency level for both product classes.

Table 7.3.3 Microwave Ovens and Countertop Combination Ovens: Annual Energy Consumption by Standby Power Level

Efficiency Level	Standby (<i>W</i>)	Energy Use (<i>kWh/year</i>)
Baseline	4.00	34.75
1	2.00	17.38
2	1.50	13.03
3	1.00	8.69
4	0.02	0.17

Table 7.3.4 Over the Range Combination Ovens: Annual Energy Consumption by Standby Power Level

Efficiency Level	Standby (<i>W</i>)	Energy Use (<i>kWh/year</i>)
Baseline	4.50	39.10
1	3.70	32.15
2	2.70	23.46
3	2.20	19.11
4	0.04	0.35

7.3.2 Variability of Annual Energy Consumption

Figures 7.3.1 and 7.3.2 show the range of average annual energy consumption by efficiency level for both product classes. Because variation among households in active use of microwave ovens has a small effect on the number of standby hours, the range in standby energy use is very small.

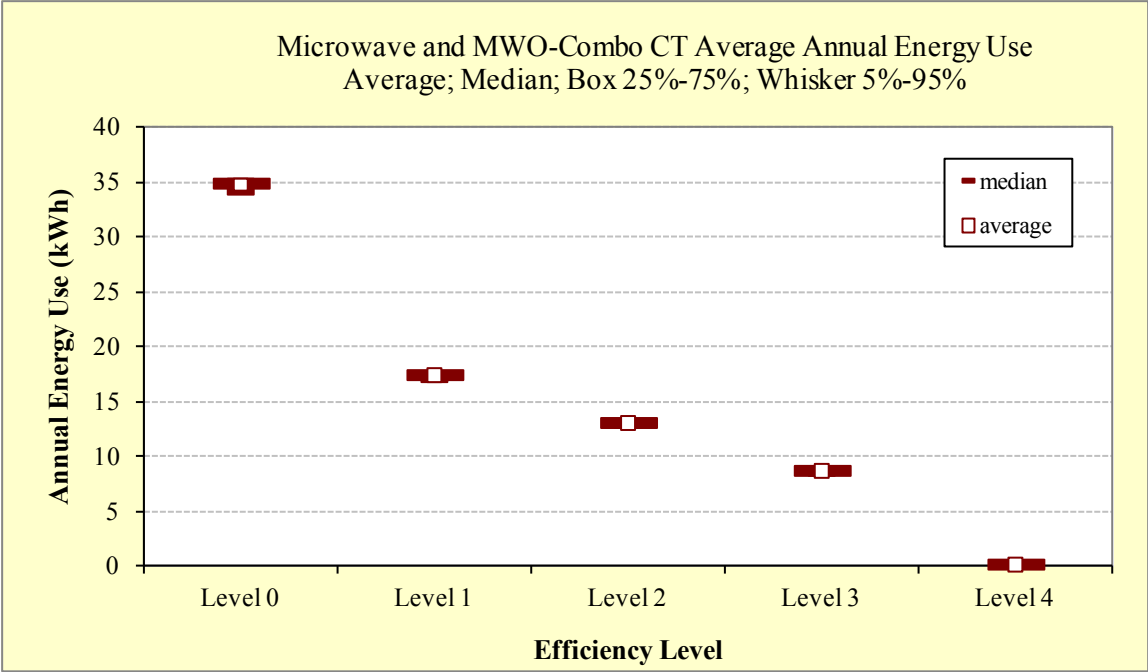


Figure 7.3.2 Range of Annual Energy Use for Microwave Ovens and Countertop Combination Ovens

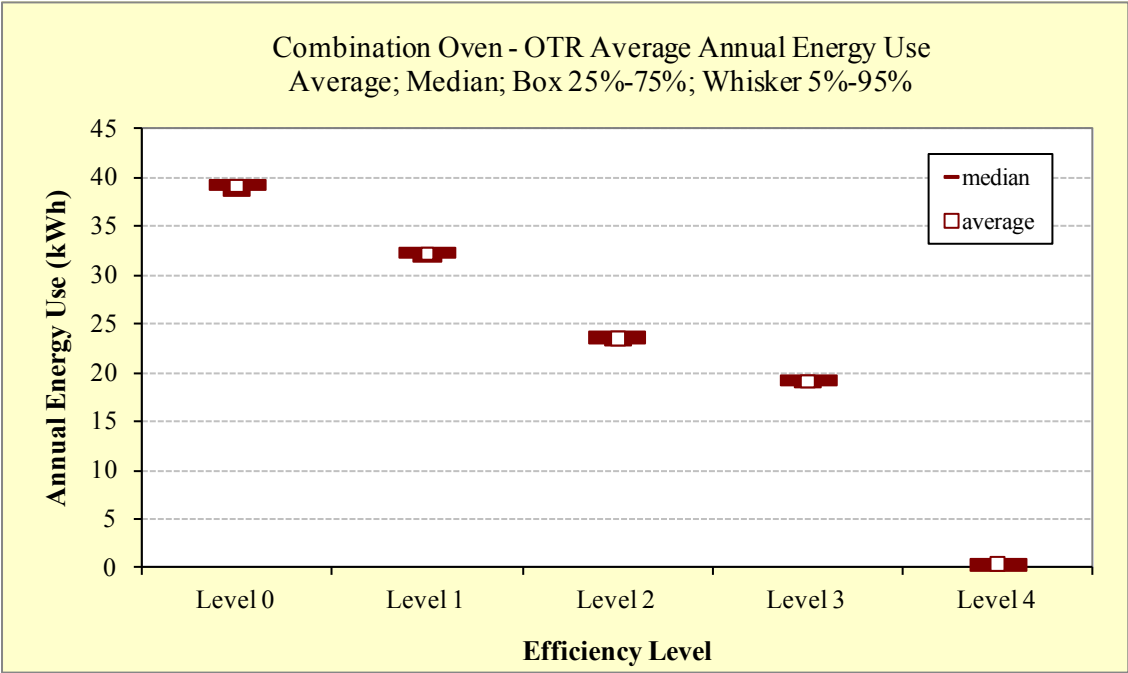


Figure 7.3.3 Range of Annual Energy Use for Over the Range Combination Ovens

REFERENCES

1. U.S. Department of Energy: Energy Information Administration, *Residential Energy Consumption Survey: 2005 Public Use Data Files*. 2008: Washington, DC.
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2. U.S. Department of Energy - Energy Efficiency & Renewable Energy, *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment, Residential Dishwashers, Dehumidifiers, and Cooking Products, and Commercial Clothes Washers*, 2008. Washington, DC.