

CHAPTER 1. INTRODUCTION

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CHAPTER 1. INTRODUCTION

1.1 PURPOSE OF THE DOCUMENT

The U.S. Department of Energy (DOE) is evaluating new energy efficiency standards for residential microwave ovens, specifically as regards the electricity they consume in standby (non-operating) mode. This document, termed a technical support document (TSD), is a stand-alone report that describes the technical analyses performed and results obtained to examine the standby power consumed by microwave ovens. This TSD was prepared in support of DOE's supplementary notice of proposed rulemaking (SNOPR) for residential microwave ovens—standby power consumption.

1.2 SUMMARY OF NATIONAL BENEFITS

DOE's analyses indicate that the proposed standards for microwave oven standby power would save a significant amount of energy—an estimated 0.41 quads over 30 years (2014 through 2043). According to the Energy Information Administration's (EIA's) Annual Energy Outlook 2010 (AEO 2010), total residential energy consumption is projected to be 21.3 quads in 2015. The amount of energy saved over 30 years is equivalent to two percent of the projected household energy use.

The cumulative national net present value (NPV) of total consumer costs and savings of the proposed standards for products shipped in 2014–2043, in 2010\$, ranges from \$1.82 billion (at a 7-percent discount rate) to \$3.59 billion (at a 3-percent discount rate).^a The NPV is the estimated total value of future operating-cost savings during the analysis period, minus the estimated increased product costs, discounted to 2011. The industry net present value (INPV) is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2014 to 2043). Using a real discount rate of 7.2 percent, DOE estimates that INPV for manufacturers of all microwave ovens in the base case is \$1.1 billion in 2010\$. If DOE adopts the proposed standard, it expects manufacturers will lose 4.7 to 6.5 percent of their INPV, or approximately \$52.9 million to \$73.6 million. Using a 7-percent discount rate, the NPV of consumer costs and savings from today's proposed standards would amount to 25 to 34 times the total estimated industry losses. Using a 3-percent discount rate, the NPV would amount to 49 to 68 times the total estimated industry losses.

The projected economic impacts of the proposed standards on individual consumers are positive. For example, for Microwave-Only and Countertop Combination Microwave Ovens

^a DOE uses discount rates of 7 and 3 percent based on guidance from the Office of Management and Budget (OMB Circular A-4, section E, September 17, 2003).

(Product Class 1), the estimated average life-cycle cost (LCC) savings in 2010\$ are \$13, and all consumers of these products would have positive economic impacts. For Built-In and Over-the-Range Combination Microwave Ovens (Product Class 2), the estimated average LCC savings in 2010\$ are \$4, and most consumers of this product would have positive economic impacts.

In addition, the proposed standards would have significant environmental benefits. The energy savings projected from the proposed standards would result in cumulative greenhouse gas emission reductions of 31.48 million metric tons (Mt)^b of carbon dioxide (CO₂) in 2014–2043. During this period, the proposed standards would result in emissions reductions of 25.6 tons of nitrogen oxides (NO_x), and have a negligible impact on emissions of mercury (Hg).^c DOE estimates the present monetary value of the CO₂ emissions reduction is between \$139 million and \$2,118 million, expressed in 2010\$. DOE also estimates the present monetary value of the NO_x emissions reduction, expressed in 2010\$, is between \$3.82 million and \$39.3 million at a 7-percent discount rate, and between \$7.44 million and \$76.4 million at a 3-percent discount rate.^d

The benefits and costs of today's proposed standards can also be expressed in terms of annualized values over a 30-year period. The annualized monetary values are the sum of (1) the annualized national economic value of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in product purchase costs, which is another way of representing consumer NPV), and (2) the monetary value of the benefits of emission reductions, including CO₂ emission reductions.^e The value of the CO₂ reductions, otherwise known as the Social Cost of Carbon (SCC), is calculated using a range of values per metric ton of CO₂ developed by a recent interagency process. The monetary costs and benefits of cumulative emissions reductions are reported in 2010\$ to permit comparisons with the other costs and benefits in the same dollar units. The derivation of the SCC values is discussed in section IV.K.

^b Results for NO_x and Hg are presented in short tons. A metric ton is equivalent to 1.1 short tons.

^c DOE calculates emissions reductions relative to the most recent version of the Annual Energy Outlook (AEO) Reference case forecast. As noted in TSD chapter 16, this forecast accounts for regulatory emissions reductions through 2009, including the Clean Air Interstate Rule (CAIR, 70 FR 25162 (May 12, 2005)), but not the Clean Air Mercury Rule (CAMR, 70 FR 28606 (May 18, 2005)). Subsequent regulations, including the currently proposed CAIR replacement rule, the Clean Air Transport Rule (75 FR 45210 (August 2, 2010)), do not appear in the base case.

^d DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg in its rulemakings.

^e DOE used a two-step calculation process to convert the time-series of costs and benefits into annualized values. First, DOE calculated a present value in the same year used for discounting the NPV of total consumer costs and savings. To calculate the present value, DOE used discount rates of 3 and 7 percent for all costs and benefits except for the value of CO₂ reductions. For the latter, DOE used a range of discount rates, as shown in Table 1.1. From the present value, DOE then calculated the corresponding time-series of fixed annual payments over a 30-year period starting in the same year used for discounting the NPV of total consumer costs and savings. The fixed annual payment is the annualized value. Although DOE calculated annualized values, this does not imply that the time-series of cost and benefits from which the annualized values were determined would be a steady stream of payments.

Although combining the values of operating savings and CO₂ reductions provides a useful perspective, two issues should be considered. First, the national operating savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, whereas the value of CO₂ reductions is based on a global value. Second, the assessments of operating cost savings and CO₂ savings are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of microwave ovens shipped in 2014–2043. The SCC values, on the other hand, reflect the present value of all future climate-related impacts resulting from the emission of one ton of CO₂ in each year. These impacts continue well beyond 2100.

Table 1.1 shows the annualized values for the proposed standards, expressed in 2010\$. The results under the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO₂ reductions, for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of \$22.3/ton in 2010, the cost of the standards proposed in today's rule is \$20.3 million per year in increased product costs, while the annualized benefits are \$167 million in reduced product operating costs, \$35.4 million in CO₂ reductions, and \$1.74 million in reduced NO_x emissions. In this case, the net benefit amounts to \$184 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of \$22.3/ton in 2010, the cost of the standards proposed in today's rule is \$21.6 million per year in increased product costs, while the annualized benefits are \$205 million in reduced operating costs, \$35.4 million in CO₂ reductions, and \$2.14 million in reduced NO_x emissions. In this case, the net benefit amounts to \$221 million per year.

Table 1.1 Annualized Benefits and Costs of Proposed Standards for Microwave Oven Standby Mode and Off Mode for Products Sold in 2014-2043

Standby Mode and On Mode for Products Sold in 2011-2015				
	Discount Rate	Primary Estimate *	Low Estimate *	High Estimate *
		Monetized (million 2010\$/year)		
Benefits				
Operating Cost Savings	7%	167	150	185
	3%	205	182	229
CO ₂ Reduction at \$4.9/t**	5%	9.02	8.49	9.55
CO ₂ Reduction at \$22.3/t**	3%	35.4	33.3	37.6
CO ₂ Reduction at \$36.5/t**	2.5%	55.9	52.5	59.3
CO ₂ Reduction at \$67.6/t**	3%	108.0	101.5	114.6
NO _x Reduction at \$2,537/t**	7%	1.74	1.65	1.82
	3%	2.14	2.02	2.26
Total [†]	7% plus CO ₂ range	178 to 277	160 to 253	196 to 301
	7%	204	185	224
	3%	243	217	269
	3% plus CO ₂ range	216 to 315	193 to 286	241 to 346
Costs				
Incremental Product Costs	7%	20.32	23.39	20.25
	3%	21.59	25.48	21.48
Total Net Benefits				
Total [†]	7% plus CO ₂ range	157 to 256	137 to 230	176 to 281
	7%	184	162	204
	3%	221	192	247
	3% plus CO ₂ range	195 to 294	167 to 260	219 to 324

* The Primary, Low, and High Estimates utilize forecasts of energy prices and housing starts from the [AEO2010](#) Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental product costs reflect a declining trend (default learning rate) for product prices in the Primary Estimate, constant prices (no learning rate) for product prices in the Low Estimate, and a declining trend (high learning rate) in the High Estimate. The derivation and application of learning rates for product prices is explained in section IV.D.1.

** The CO₂ values represent global values (in 2010\$) of the social cost of CO₂ emissions in 2010 under several scenarios. The values of \$4.9, \$22.3, and \$36.5 per ton are the averages of SCC distributions calculated using 5-percent, 3-percent, and 2.5-percent discount rates, respectively. The value of \$67.6 per ton represents the 95th percentile of the SCC distribution calculated using a 3-percent discount rate. The value for NO_x (in 2010\$) is the average of the low and high values used in DOE's analysis.

[†] Total Benefits for both the 3-percent and 7-percent cases are derived using the SCC value calculated at a 3-percent discount rate, which is \$22.3/ton in 2010 (in 2010\$). In the rows labeled as “7% plus CO₂ range” and “3% plus CO₂ range,” the operating cost and NO_x benefits are calculated using the labeled discount rate, and those values are added to the full range of CO₂ values.

1.3 OVERVIEW OF STANDARDS FOR MICROWAVE OVEN STANDBY POWER CONSUMPTION

The Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291–6309; EPCA) established an energy conservation program for major household appliances. Among the subsequent amendments made to EPCA was one giving DOE the authority to regulate the energy efficiency of several products, including residential microwave ovens, which are the focus of this document. The amendments to EPCA in the National Appliance Energy Conservation Act of 1987 (42 U.S.C. 6291–6309; NAECA) prescribed energy conservation standards for cooking products, as well as stipulating requirements for determining whether those standards should be amended. DOE is considering amending standards for microwave ovens, specifically standards that prescribe the maximum electricity consumed when the oven is in standby (non-operating) mode.

Following NAECA directives, DOE conducted two cycles of rulemaking to evaluate the need for more stringent standards for both gas and electric cooking products. (42 U.S.C. 6295 (h)(1)-(2)) DOE issued a notice of proposed rulemaking (NOPR) on March 4, 1994, proposing performance standards for eight gas and electric residential cooking products, including microwave ovens. 59 FR 10464. Based on the July 15, 1996, *Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products* (the so-called Process Rule), DOE refined its analysis of cooking products. 61 FR 36974. DOE issued a final rule on September 8, 1998, that covered only electric cooking products, including microwave ovens. 63 FR 48038.

1.4 PROCESS FOR ESTABLISHING ENERGY CONSERVATION STANDARDS

Under EPCA, when DOE evaluates a new or amended energy conservation standard, it must consider seven factors to the greatest extent practicable: (42 U.S.C. 6295 (o)(2)(B)(i))

1. the economic impact of the standard on the manufacturers and consumers of the affected product;
2. the savings in operating costs throughout the estimated average lifetime of the product compared to any increases in purchase price or maintenance costs;
3. the total projected amount of energy savings likely to result directly from the imposition of the standard;
4. any lessening of the utility or performance of the product likely to result from the imposition of the standard;

5. the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;
6. the need for national energy conservation; and
7. other factors the Secretary of Energy considers relevant.

Other statutory requirements are set forth in 42 U.S.C. 6295 (o)(1)–(2)(A), (2)(B)(ii)–(iii) and (3)–(4), and 42 U.S.C. 6316(e). Before DOE determines whether to adopt an energy conservation standard, it must solicit comments on the proposed standard. (42 U.S.C. 6313(a)(6)(B)(i)) Any new or amended standard must be designed to achieve significant additional conservation of energy and must be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)) To determine whether economic justification exists, DOE must review comments on the proposed standard and conclude that the benefits of the standard exceed its burdens to the greatest extent practicable, weighing the seven factors listed above. (42 U.S.C. 6295 (o)(2)(B)(i))

1.4.1 Process Rule

In conducting rulemakings for both appliance test procedures and energy conservation standards, DOE employs the procedures set forth in the 1996 Process Rule described in section 1.2. DOE applied those procedures to the extent they were appropriate for developing energy conservation standards for microwave oven standby power. The Process Rule greatly enhances opportunities for receiving public input and improving analytic approaches. The Process Rule sets forth policies and guidelines for providing early public review and consultation with interested parties regarding design options, proposed standards, and the final standard. Design options are identified and screened based on (1) technological feasibility; (2) practicability to manufacture, install, and service; (3) adverse impacts on product utility or availability; and (4) adverse impacts on health or safety (Process Rule at section 4(a)(4)). 61 FR 36982. The Process Rule also requires DOE to evaluate uncertainty and variability in analytical results through the use of scenario or probability analysis.

The Process Rule calls for experts and interested parties to review the analyses, including (1) the qualitative and quantitative analytical methods used; (2) the economic, engineering, and life-cycle cost analyses; and (3) impacts on manufacturers and consumers, national energy savings, the economy, and the environment. See appendix A to subpart C of Title 10 of the Code of Federal Regulations Part 430 (10 CFR Part 430).

1.4.2 Procedures, Analyses, and Stakeholder Involvement

DOE considers stakeholder participation vital to a balanced discussion of the information required for a standards rulemaking and to the adoption of energy conservation standards that are, to the extent practicable, consensus-based. DOE actively encourages the participation and interaction of all stakeholders by providing formal public notifications via the *Federal Register* and by designating comment periods at each major step in a standards rulemaking. DOE publishes a formal public notice of the initial framework document, then an advance notice of

proposed rulemaking (ANOPR), which is designed to publicly vet the models and tools used in the rulemaking and to facilitate public participation before the proposed standards are evaluated in detail. Next DOE publishes in the *Federal Register* a notice of proposed rulemaking (NOPR), which presents a discussion of comments received in response to the ANOPR; analyses of the impacts of standards on consumers, manufacturers, and the nation; DOE's weighting of those impacts; and the proposed standards. Lastly, DOE publishes in the *Federal Register* the final rule, which includes a discussion of comments received in response to the NOPR; the revised analysis of the impacts of standards; DOE's weighting of those impacts; the standard(s) DOE is adopting; and the effective date(s) of the standard(s).

Table 1.4.1 lists the analyses that are performed at each step of a standards rulemaking. Following the Process Rule, analyses are reported, examined, revised, and expanded throughout the process.

Table 1.4.1 Analyses Performed Under the Process Rule

ANOPR	NOPR	Final Rule
Market and technology assessment Screening analysis Engineering analysis Energy (and water) use determination Markups for determining product price Life-cycle cost and payback period analysis Shipments analysis National impact analysis Preliminary manufacturer impact analysis	Revised ANOPR analyses <u>Plus:</u> Life-cycle cost analysis for identified subgroups Manufacturer impact analysis Utility impact analysis Environmental assessment Employment impact analysis Regulatory impact analysis	Revised NOPR analyses

On March 27, 2006, DOE published in the *Federal Register* a *Rulemaking Framework for Commercial Clothes Washers and Residential Dishwashers, Dehumidifiers, and Cooking Products* (the framework document), which described the procedural and analytical approaches DOE anticipated using to evaluate the development of energy conservation standards for the named products. This document is available at www1.eere.energy.gov/buildings/appliance_standards/residential/cooking_products.html. At that time DOE also announced in the *Federal Register* the date, time, and place of a public meeting at which the framework document would be discussed.

DOE held the public meeting on April 27, 2006, to discuss procedural and analytical approaches to the rulemaking and to inform and facilitate stakeholder involvement in the rulemaking process. The analytical framework presented at the public meeting described the various analyses to be performed, such as the engineering analysis and the life-cycle cost (LCC)

and payback period (PBP) analysis; the methods proposed for conducting the analyses; and the relationships among the analyses.

During the April 2006 meeting, stakeholders commented about various issues related to the rulemaking for all the considered products. Comments relevant to the rulemaking for microwave oven standby power concerned:

1. current DOE test procedure;
2. definition of baseline units;
3. number of product classes;
4. consideration of limiting standby power as a design option for all considered products;
5. technology options for improving efficiency of all considered products;
6. type of approach to employ for the engineering analysis;
7. efficiency levels to consider for all considered products;
8. proposed approaches for specifying typical annual energy (and water) consumption for all considered products;
9. potential data sources for characterizing variability in annual energy (and water) consumption;
10. typical distribution channels and markups;
11. data sources for retail prices;
12. type of approach to employ for the LCC and PBP analysis;
13. variability of forecasted energy prices;
14. relationship of repair, maintenance, and installation costs to product efficiency;
15. product lifetimes;
16. development of consumer discount rates;
17. effects of purchase price on product shipments; and
18. identification of consumer subgroups.

Written stakeholder comments, submitted during the comment period for the framework document, elaborated on the issues raised at the public meeting. DOE worked with its contractors to provide that the analyses would address the identified issues.

In preparation for developing the ANOPR, DOE organized and held interviews with manufacturers of microwave ovens. DOE selected companies that ranged from small to large manufacturers, including both members of the Association of Home Appliance Manufacturers (AHAM) and non-AHAM member companies. The interviews were intended to achieve four objectives.

1. Solicit feedback on the draft engineering analysis (including methodology, production costs, manufacturing processes, and findings).
2. Solicit feedback on the preliminary manufacturer impact analysis.
3. Provide an opportunity, early in the rulemaking process, for manufacturers to express specific concerns to DOE.
4. Foster cooperation between the manufacturers and DOE.

Six general topics related to the preliminary engineering analysis and manufacturer impact analysis were discussed during the interviews, including:

1. key issues identified by DOE and/or the manufacturer;
2. shipment projections;
3. capital conversion costs;
4. product mix and profitability;
5. market shares and industry consolidation; and
6. cumulative regulatory burden.

To meet the objectives of the Process Rule, DOE developed spreadsheets models for the LCC, PBP, and national impact analyses for microwave ovens. DOE developed an LCC spreadsheet that calculates the LCC and PBP at various energy efficiency levels. DOE also developed a national impact analysis spreadsheet that calculates the national energy savings (NES) and national net present values at various energy efficiency levels. This spreadsheet includes a model that forecasts the effects of energy efficiency standards at various levels on product shipments. All the spreadsheets are available on the DOE website. Spreadsheets specific to cooking products, including microwave ovens, are found at www1.eere.energy.gov/buildings/appliance_standards/residential/cooking_products_anopr_tools.html

On November 15, 2007, DOE published in the *Federal Register* an *Advance Notice of Proposed Rulemaking for Residential Dishwashers, Dehumidifiers, and Cooking Products, and Commercial Clothes Washers*, which described potential new energy conservation standards for the named product types and announced a public meeting to receive comments. This document is available at www1.eere.energy.gov/buildings/appliance_standards/residential/cooking_products.html.

DOE held a public meeting on December 13, 2007, to provide stakeholders the opportunity to comment on the ANOPR and the analytical framework, models, and tools (e.g., LCC and NES spreadsheets) that DOE used to evaluate the impacts of energy conservation standards; the results of the preliminary analyses; and the candidate energy efficiency levels.

After stakeholders commented on the ANOPR at the public meeting and in writing during the comment period, DOE again interviewed manufacturers of microwave ovens in support of the manufacturer impact analysis for the NOPR. This second round of interviews addressed 13 topics, some of which revisited again and in greater detail the six topics discussed during initial interviews. The 13 topics were:

1. key issues identified by DOE and/or the manufacturer
2. overview of company and organizational characteristics;
3. company financial parameters;
4. breakdown of production costs;
5. shipment projections and market shares;
6. product mixes;
7. conversion costs;
8. markups and profitability;

9. cumulative regulatory burden;
10. exports, foreign competition, and outsourcing;
11. assessment of direct impacts on employment;
12. market consolidation; and
13. baseline products and alternative design options.

DOE incorporated the information gathered at the interviews, as well as during the public meeting and comment period, into its engineering analysis (chapter 5 of this TSD) and preliminary manufacturer impact analysis (chapter 13 of this TSD) for the NOPR. In addition, the Department conducted all the analyses listed in Table 1.3.1 that are required for the NOPR phase of a rulemaking. Taking into consideration the seven factors stipulated in 42 U.S.C. 6313(a)(6)(B)(i), which are listed in section 1.3, and comments received from interested parties, the Department analyzed four trial standard levels for microwave oven standby power.

This TSD for the Department's SNOPR for microwave oven standby power outlines the analytical methods used in this rulemaking and the results of the analyses performed.

1.5 STRUCTURE OF THE DOCUMENT

This TSD comprises 17 chapters and 16 appendices.

Chapter 1	Introduction: provides an overview of the appliance standards program and how it applies to this rulemaking, and outlines the structure of the document.
Chapter 2	Analytical Framework: describes the rulemaking process.
Chapter 3	Market and Technology Assessment: characterizes the market for microwave ovens and the technologies available for decreasing standby power consumption.
Chapter 4	Screening Analysis: identifies the technologies and design options available to decrease microwave oven standby power and determines which of those are viable for consideration in the engineering analysis.
Chapter 5	Engineering Analysis: discusses the methods used to develop the relationship between increased manufacturer price and increased efficiency.
Chapter 6	Markups Analysis: discusses the methods used for establishing markups for converting manufacturer costs to customer retail prices.

Chapter 7	Energy Use Analysis: discusses the process used for generating energy-use estimates for the considered products as a function of standard levels.
Chapter 8	Life-Cycle Cost and Payback Period Analysis: discusses the effects of standards on individual consumers and users of microwave ovens; compares the LCC and PBP of products with and without higher efficiency standards.
Chapter 9	Shipments Analysis: discusses the methods used for forecasting shipments with and without higher efficiency standards, including how product purchase decisions are economically influenced and how DOE models this relationship with econometric equations.
Chapter 10	National Impact Analysis: Discusses the methods used for forecasting national energy consumption and national economic impacts based on annual product shipments and estimates of future product energy efficiency distributions in the absence and presence of amended energy conservation standards.
Chapter 11	Life-Cycle Cost Subgroup Analysis: discusses the effects of standards on different subgroups of consumers and compares the LCC and PBP of products with and without higher efficiency standards for these consumers.
Chapter 12	Manufacturer Impact Analysis: discusses the effects of standards on the finances and profitability of product manufacturers.
Chapter 13	Employment Impact Analysis: discusses the effects of standards on national employment.
Chapter 14	Utility Impact Analysis: discusses the effects of standards on electric and gas utilities.
Chapter 15	Environmental Assessment: discusses the effects of standards on emissions of carbon dioxide (CO ₂), nitrogen oxides (NO _x), and mercury.
Chapter 16	Monetization of Emission Reductions Benefits: discusses the basis for the estimated monetary values used for the reduced emissions of CO ₂ and other pollutants that are expected to result from each of the TSLs considered.
Chapter 17	Regulatory Impact Analysis: discusses the impact of non-regulatory alternatives to efficiency standards.

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Appendix 10C	National Net Present Value of Consumer Benefits and Emissions Reductions using Alternative Product Price Forecasts
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Appendix 12B	Government Regulatory Impact Model (GRIM) Overview
Appendix 16A	Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866
Appendix 17A	Regulatory Impact Analysis Supporting Material