This document is scheduled to be published in the
Federal Register on 06/17/2013 and available online at
http://federalregister.gov/a/2013-13535, and on FDsys.gov

[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket Number EERE–2011–BT–STD–0048]

RIN: 1904-AC07

Energy Conservation Program: Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act of 1975 (EPCA), as amended, prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment. Microwave ovens are covered products under EPCA, although there are no existing microwave oven standards. DOE has already previously determined that active mode standards are not warranted. The Energy Independence and Security Act of 2007 (EISA 2007) amended EPCA to require any final rule adopted after July 1, 2010 establishing or revising energy conservation standards for covered products, including microwave ovens, to address standby mode and off mode energy use. In this final rule, DOE is only adopting energy conservation standards for microwave oven standby mode and off mode. It has determined that the amended energy

conservation standards for these products in standby mode and off mode would result in significant conservation of energy, and are technologically feasible and economically justified.

DATES: The effective date of this rule is **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. Compliance with the amended standards established for microwave ovens in this final rule is **June 17, 2016**.

ADDRESSES: The docket for this rulemaking is available for review at www.regulations.gov, including Federal Register notices, framework documents, public meeting attendee lists and transcripts, comments, and other supporting documents/materials. All documents in the docket are listed in the regulations.gov index. However, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

A link to the docket web page can be found at: http://www.regulations.gov/#!docketDetail;rpp=10;po=0;D=EERE-2011-BT-STD-0048. The regulations.gov web page will contain simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

FOR FURTHER INFORMATION CONTACT:

Mr. John Cymbalsky, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-1692. E-mail: microwave_ovens@ee.doe.gov.

Mr. Ari Altman, Esq., U.S. Department of Energy, Office of the General Counsel, GC-71, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-6307. E-mail: Ari.Altman@hq.doe.gov.

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Summary of the Final Rule and Its Benefits

Title III, Part B[1] of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291–6309, as codified), established the Energy Conservation Program for Consumer Products Other Than Automobiles. Pursuant to EPCA, any new or amended energy conservation standard that DOE prescribes for certain products, such as microwave ovens, shall be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B)) In accordance with these and other statutory provisions discussed in this rulemaking, DOE is adopting amended energy conservation standards for microwave ovens to address standby mode and off mode energy use. The amended standards, which are the maximum allowable energy use when a product is in standby mode or off mode, are shown in Table I-1.[2] These amended standards apply to all products listed in Table I-1 and manufactured in, or imported into, the United States on or after **June 17, 2016**.

[1] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.
[2] DOE considered energy use in off mode for microwave ovens, but is not adopting a maximum allowable off mode power at this time because DOE is aware of less than 1 percent of microwave oven models in Product Class 1 and no models in Product Class 2 that are capable of operating in such a mode. DOE has already previously determined that active mode standards are not warranted. 74 FR 16040 (Apr. 8, 2009).

Table I-1 Energy Conservation Standards for Microwave Ovens (Compliance Starting June 17, 2016)

Product Classes	Effective June 17, 2016
Microwave-Only Ovens and Countertop Convection Microwave Ovens	Maximum Standby Power = 1.0 watt
Built-In and Over-the-Range Convection Microwave Ovens	Maximum Standby Power = 2.2 watts

A. Benefits and Costs to Consumers

Table I-2 presents DOE's evaluation of the economic impacts of today's standards on consumers of microwave ovens, as measured by the average life-cycle cost (LCC) savings and the median payback period. The average LCC savings are positive for 88 percent of consumers of microwave-only ovens and countertop convection microwave ovens and for all consumers of built-in and over-the-range convection microwave ovens.

Table I-2 Impacts of Today's Standards on Consumers of Microwave Ovens

Product Class	Average LCC Savings (2011$)	Median Payback Period (years)
Microwave-Only Ovens and Countertop Convection Microwave Ovens	11	3.5
Built-In and Over-the-Range Convection Microwave Ovens	12	3.3

Note: Average microwave oven lifetime is estimated at 10.9 years.

B. Impact on Manufacturers

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 (2013 to 2045). Using a real discount rate of 8.0 percent, DOE estimates that the INPV for manufacturers of microwave ovens is $1.4 billion in 2011$. Under today's standards, DOE expects that manufacturers may lose up to 7.0 percent of their INPV, which is approximately $96.6

million. Additionally, based on DOE's interviews with the manufacturers of microwave ovens, DOE does not expect any plant closings or significant loss of employment.

C. National Benefits

DOE's analyses indicate that today's standards would save a significant amount of energy. The lifetime savings for microwave ovens purchased in the 30-year period that begins in the year of compliance with amended standards (2016–2045) amount to 0.48 quads. The average annual primary energy savings in 2016-2045 is equivalent to the annual primary energy use of 70,000 households.

The cumulative net present value (NPV) of total consumer costs and savings of today's standards in 2011$ ranges from $3.38 billion (at a 3-percent discount rate) to $1.53 billion (at a 7-percent discount rate) for microwave ovens. This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for products purchased in 2016–2045, discounted to 2013.

In addition, today's standards would have significant environmental benefits. The energy savings would result in cumulative greenhouse gas emission reductions of approximately 38.11 million metric tons (Mt)[3] of carbon dioxide (CO_2), 27.14 thousand tons of sulfur dioxide (SO_2), 32.67 thousand tons of nitrogen oxides (NO_X) and 0.095 tons of mercury (Hg).[4]

[3] A metric ton is equivalent to 1.1 short tons. Results for NO_X and Hg are presented in short tons.
[4] DOE calculated emissions reductions relative to the Annual Energy Outlook (AEO) 2012 Reference case, which generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2011.

The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 (otherwise known as the Social Cost of Carbon, or SCC) developed by an interagency process. The derivation of the SCC values is discussed in section IV.L of this rulemaking. Using the most recent (2013) SCC values from the interagency group, DOE estimates that the present monetary value of the CO_2 emissions reductions is between $255 million and $3,615 million, expressed in 2011$ and discounted to 2013. DOE estimates that the present monetary value of the NO_X emissions reductions, expressed in 2011$ and discounted to 2013, is $21.8 million at a 7-percent discount rate, and $44.5 million at a 3-percent discount rate.[5]

Table I-3 summarizes the national economic costs and benefits expected to result from today's standards for microwave ovens. The monetary value of the CO_2 emissions reductions using the previous (2010) SCC estimates, and the benefits using those estimates, are presented for information purposes. Using the updated 2013 social cost of carbon estimates, the net benefits from the microwave oven standby power rule, discounted at 3 percent, are projected to be $4.6 billion (2011 dollars). For comparison purposes, the net benefits, discounted at 3 percent, are projected to be $4.2 billion using the 2010 SCC estimates. When discounted at 7 percent, the net benefits of the rule are projected to be $2.7 billion using the 2013 SCC estimates, compared with $2.3 billion using the 2010 SCC estimates.

[5]DOE has not monetized SO_2 and Hg emissions in this rulemaking.

Table I-3 Summary of National Economic Benefits and Costs of Microwave Oven Energy Conservation Standards

Category	Present Value (Million 2011$)	Discount Rate
Benefits		
Operating Cost Savings	2,306	7%
	4,717	3%
Using 2013 Social Cost of Carbon Values		
CO_2 Reduction Monetized Value ($12.6/t case)*	255	5%
CO_2 Reduction Monetized Value ($41.1/t case)*	1,179	3%
CO_2 Reduction Monetized Value ($63.2/t case)*	1,876	2.5%
CO_2 Reduction Monetized Value ($119.1/t case)*	3,615	3%
Total Benefits†	3,507	7%
	5,941	3%
Using 2010 Social Cost of Carbon Values		
CO_2 Reduction Monetized Value ($6.2/t case)**	150	5%
CO_2 Reduction Monetized Value ($25.6/t case)**	740	3%
CO_2 Reduction Monetized Value ($41.1/t case)**	1,243	2.5%
CO_2 Reduction Monetized Value ($78.4/t case)**	2,257	3%
NO_X Reduction Monetized Value (at $2,567/ton)**	21.8	7%
	44.5	3%
Total Benefits††	3,069	7%
	5,503	3%
Costs		
Incremental Installed Costs	776	7%
	1,341	3%
Net Benefits (using 2013 SCC values)		
Including CO_2 and NO_X Reduction Monetized Value†	2,731	7%
	4,600	3%
Net Benefits (using 2010 SCC values)		
Including CO_2 and NO_X Reduction Monetized Value††	2,293	7%
	4,162	3%

* The CO_2 values represent global values (in 2011$) of the social cost of CO_2 emissions in 2016 under several scenarios. The values of $12.6, $41.1, and $63.2 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $119.1 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The value for NO_X (in 2011$) is the average of the low and high values used in DOE's analysis.

** The CO_2 values represent global values (in 2011$) of the social cost of CO_2 emissions in 2016 under several scenarios. The values of $6.2, $25.6, and $41.1 per ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $78.4 per ton represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The value for NO_X (in 2011$) is the average of the low and high values used in DOE's analysis.

† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to SCC value of $41.1/t in 2016 (derived from the 3% discount rate value for SCC).

†† Total Benefits for both the 3% and 7% cases are derived using the series corresponding to SCC value of $25.6/t in 2016 (derived from the 3% discount rate value for SCC).

The benefits and costs of today's standards, for products sold in 2016–2045, can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value of the benefits from operating the product (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase and installation costs, which is another way of representing consumer NPV), plus (2) the annualized monetary value of the benefits of emission reductions, including CO_2 emission reductions.[6]

Although adding the value of consumer savings to the value of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and CO_2 savings are performed

[6] 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 2013, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table **I-3**. From the present value, DOE then calculated the fixed annual payment over a 30-year period (2016 through 2045) that yields the same present value. 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 is a steady stream of payments.

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 2016–2045. The SCC values, on the other hand, reflect the present value of all future climate-related impacts resulting from the emission of one metric ton of carbon dioxide in each year. These impacts continue well beyond 2100.

Estimates of annualized benefits and costs of today's standards are shown in Table I-4. (All monetary values below are expressed in 2011$). The results under the primary estimate, using the 2013 SCC values from the interagency group, are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reduction, for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of $41.1/ton in 2016, the cost of the standards in today's rule is $58.4 million per year in increased equipment costs, while the benefits are $174 million per year in reduced equipment operating costs, $58.4 million in CO_2 reductions, and $1.64 million in reduced NO_X emissions. In this case, the net benefit amounts to $175 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of $41.1/ton in 2016, the cost of the standards in today's rule is $66.4 million per year in increased equipment costs, while the benefits are $234 million per year in reduced operating costs, $58.4 million in CO_2 reductions, and $2.20 million in reduced NO_X emissions. In this case, the net benefit amounts to $228 million per year. The monetary value of the CO_2 emissions reductions using the previous (2010) SCC estimates, and the benefits using those estimates, are presented for information purposes.

Table I-4 Annualized Benefits and Costs of Amended Standards for Microwave Ovens

	Discount Rate	Primary Estimate*	Low Net Benefits Estimate	High Net Benefits Estimate
		(Million 2011$/year)		
Benefits				
Operating Cost Savings	7%	174	162	191
	3%	234	215	261
Using 2013 Social Cost of Carbon Values				
CO_2 Reduction ($12.6/t case)**	5%	15.8	14.7	17.4
CO_2 Reduction ($41.1/t case)**	3%	58.4	54.1	64.5
CO_2 Reduction ($63.2/t case)**	2.5%	87.4	80.9	96.7
CO_2 Reduction ($119/t case)**	3%	179	166	198
Total Benefits†	7% plus CO_2 range	191 to 354	178 to 329	210 to 391
	7%	234	218	258
	3%	294	271	328
	3% plus CO_2 range	252 to 415	232 to 383	281 to 462
Using 2010 Social Cost of Carbon Values				
CO_2 Reduction ($6.2/t case)***	5%	9.29	8.62	17.4
CO_2 Reduction ($25.6/t case)***	3%	36.7	34.0	40.6
CO_2 Reduction ($41.1/t case)***	2.5%	57.9	53.6	64.1
CO_2 Reduction ($78.4/t case)***	3%	111.8	103.5	123.6
NO_X Reduction at $2,567/ton**	7%	1.64	1.54	1.79
	3%	2.20	2.05	2.42
Total Benefits†	7% plus CO_2 range	185 to 287	172 to 267	203 to 317
	7%	212	198	234
	3%	273	251	304
	3% plus CO_2 range	245 to 348	226 to 321	274 to 388
Costs				
Incremental Installed Costs	7%	58.4	59.6	57.5
	3%	66.4	67.8	64.3
Net Benefits (using 2013 SCC values)				
Total†	7% plus	133 to 296	119 to 270	153 to 334

	Discount Rate	Primary Estimate*	Low Net Benefits Estimate	High Net Benefits Estimate
		(Million 2011$/year)		
	CO_2 range			
	7%	175	158	200
	3%	228	203	264
	3% plus CO_2 range	185 to 349	164 to 315	217 to 398
Net Benefits (using 2010 SCC values)				
Total††	7% plus CO_2 range	126 to 229	113 to 208	146 to 259
	7%	154	138	176
	3%	206	183	240
	3% plus CO_2 range	179 to 281	158 to 253	210 to 323

* This table presents the annualized costs and benefits associated with microwave ovens shipped in 2016–2045. These results include benefits to consumers which accrue after 2016 from the microwave ovens purchased from 2016–2045. Costs incurred by manufacturers, some of which may be incurred prior to 2016 in preparation for the rule, are not directly included, but are indirectly included as part of incremental equipment costs. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices and housing starts from the AEO 2012 Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental product costs reflect a medium decline rate for product prices in the Primary Estimate, constant product price in the Low Benefits Estimate, and a high decline rate for product prices in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.E.1 of this rulemaking.

** The CO_2 values represent global monetized values of the SCC, in 2011$, in 2016 under several scenarios. The values of $12.6, $41.1, and $63.2 per metric ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $119/t represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series increase over time. The value for NO_X (in 2011$) is the average of the low and high values used in DOE's analysis.

*** The CO_2 values represent global monetized values of the SCC, in 2011$, in 2016 under several scenarios. The values of $6.2, $25.6, and $41.1 per metric ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $78.4/t represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series increase over time. The value for NO_X (in 2011$) 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 series corresponding to SCC value of $41.1/t in 2016. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 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 CO_2 values.

†† Total Benefits for both the 3-percent and 7-percent cases are derived using the series corresponding to SCC value of $25.6/t in 2016. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 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 CO_2 values.

D. Conclusion

Based on the analyses culminating in this final rule, DOE found the benefits to the nation of the standards (energy savings, consumer LCC savings, positive NPV of consumer benefit, and emission reductions) (see section V.B.1.a. of this rulemaking) outweigh the burdens (loss of INPV and LCC increases for a very small percentage of users of these products) (see section V.B.2.a and section V.B.1.a.). DOE has concluded that the standards in today's final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in significant conservation of energy.

II. Introduction

The following section briefly discusses the statutory authority underlying today's final rule, as well as some of the relevant historical background related to the establishment of standards for microwave ovens.

A. Authority

Title III, Part B of the Energy Policy and Conservation Act of 1975 (EPCA or the Act), Pub. L. 94-163 (42 U.S.C. 6291–6309, as codified) established the Energy Conservation Program for Consumer Products Other Than Automobiles,[7] a program covering most major household appliances (collectively referred to as "covered products"), which includes the types of microwave ovens that are the subject of this rulemaking. (42 U.S.C. 6292(a)(10)) The National Appliance Energy Conservation Act

[7] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

of 1987 (NAECA), Public Law 100-12, amended EPCA to establish prescriptive standards for cooking products, specifically gas cooking products. No standards were established for microwave ovens. DOE notes that under 42 U.S.C. 6295(m), the agency must periodically review its already established energy conservation standards for a covered product. Under this requirement, the next review that DOE would need to conduct must occur no later than 6 years from the issuance of a final rule establishing or amending a standard for a covered product.

Pursuant to EPCA, DOE's energy conservation program for covered products consists essentially of four parts: (1) testing; (2) labeling; (3) the establishment of Federal energy conservation standards; and (4) certification and enforcement procedures. The Federal Trade Commission (FTC) is primarily responsible for labeling, and DOE implements the remainder of the program. Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of each covered product. (42 U.S.C. 6293) Manufacturers of covered products must use the prescribed DOE test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA and when making representations to the public regarding the energy use or efficiency of those products. (42 U.S.C. 6293(c) and 6295(s)) Similarly, DOE must use these test procedures to determine whether the products comply with standards adopted pursuant to EPCA. Id. The DOE test procedures for microwave ovens currently appear at title 10 of the Code of Federal Regulations (CFR) part 430, subpart B, appendix I.

DOE must follow specific statutory criteria for prescribing amended standards for covered products. As indicated above, any amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6295(o)(3)) Moreover, DOE may not prescribe a standard: (1) for certain products, including microwave ovens, if no test procedure has been established for the product, or (2) if DOE determines by rule that the amended standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)-(B)) In deciding whether an amended standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven factors:

1. The economic impact of the standard on manufacturers and consumers of the products subject to the standard;

2. The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered products that are likely to result from the imposition of the standard;

3. The total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard;

4. Any lessening of the utility or the performance of the covered products 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 and water conservation; and

7. Other factors the Secretary of Energy (Secretary) considers relevant. (42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

EPCA, as codified, also contains what is known as an "anti-backsliding" provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6295(o)(1)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States of any covered product type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States. (42 U.S.C. 6295(o)(4))

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. See 42 U.S.C. 6295(o)(2)(B)(iii).

Additionally, 42 U.S.C. 6295(q)(1) specifies requirements when promulgating a standard for a type or class of covered product that has two or more subcategories. DOE must specify a different standard level than that which applies generally to such type or class of products for any group of covered products that have the same function or intended use if DOE determines that products within such group (A) consume a different kind of energy from that consumed by other covered products within such type (or class); or (B) have a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of products, DOE must consider such factors as the utility to the consumer of such a feature and other factors DOE deems appropriate. Id. Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6295(q)(2))

Federal energy conservation requirements generally supersede State laws or regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6297(a)–(c)) DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions set forth under 42 U.S.C. 6297(d)).

Finally, pursuant to the amendments contained in section 310(3) of EISA 2007, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, are required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into the standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) DOE's current test procedure for microwave ovens addresses standby mode and off mode energy use, as do the amended standards adopted in this final rule.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011. 76 FR 3281 (Jan. 21, 2011). EO 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

DOE emphasizes as well that Executive Order 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in section I of this rulemaking, DOE determines that today's final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized. Consistent with EO 13563, and the range of impacts analyzed in this rulemaking, the energy efficiency standard adopted herein by DOE achieves maximum net benefits.

B. Background

1. Current Standards

Currently, there are no DOE energy conservation standards for microwave oven active mode, standby mode, or off mode energy consumption. Based on analyses and comments from interested parties, DOE decided in 2009 not to adopt energy conservation standards for microwave oven energy factor (microwave oven operation in active mode), but to develop a separate energy use metric for standby mode and off mode. 74 FR 16040 (Apr. 8, 2009).[8] As discussed in section II.A of this rulemaking, if DOE adopts amended standards for microwave ovens after July 1, 2010, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into the standard, or, if that is not feasible, adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)(A)–(B)) Because there is currently no test procedure or standard for microwave oven active mode, DOE has determined that proposing a combined metric for standby and active mode energy use is not feasible at this time. If DOE amends the test procedure to incorporate measurement of microwave oven active mode energy use, DOE will consider whether it is technically feasible to incorporate active mode, standby mode, and off mode energy use into a single metric for future energy conservation standards.

2. History of Standards Rulemaking for Microwave Ovens

On March 15, 2006, DOE published on its website a document titled, "Rulemaking Framework for Commercial Clothes Washers and Residential Dishwashers, Dehumidifiers, and Cooking Products" (Framework Document).[9] 71 FR 15059. The Framework Document described the procedural and analytical approaches that DOE anticipated using to evaluate energy conservation standards for these products, and

[8] DOE repealed the microwave oven active mode provisions from its test procedure on July 22, 2010, after determining that the active mode methodology did not produce repeatable and representative results. 75 FR 42579.

[9] This document is available on the DOE website at: http://www.regulations.gov/#!docketBrowser;rpp=25;po=0;D=EERE-2006-STD-0127. (Last accessed December 2012.)

identified various issues to be resolved in conducting the rulemaking. On December 4, 2006, DOE posted on its website two spreadsheet tools for this rulemaking.[10] The first tool calculates LCC and payback periods (PBPs). The second tool—the national impact analysis (NIA) spreadsheet—calculates the impacts on shipments and the national energy savings (NES) and NPV at various candidate standard levels. DOE subsequently published the advance notice of proposed rulemaking (ANOPR) for this rulemaking (72 FR 64432 (Nov. 15, 2007)), the November 2007 ANOPR) and on December 13, 2007, held a public meeting to present and seek comment on the analytical methodology and results in the ANOPR (the December 2007 Public Meeting).

At the December 2007 Public Meeting, DOE invited comment in particular on the following issues concerning microwave ovens: (1) incorporation of the International Electrotechnical Commission (IEC) test standard IEC Standard 62301[11] into DOE's microwave oven test procedure to measure standby mode and off mode power; (2) IEC Standard 62301 test conditions; and (3) a requirement that if the measured standby mode power varies as a function of the time displayed, the standby mode power test would run for 12 hours, with an initial clock setting of 12:00.

Interested parties' comments presented during the December 2007 Public Meeting and submitted in response to the November 2007 ANOPR addressed the standby mode and off mode energy use of microwave ovens and the ability to combine that energy use

[10] These spreadsheets are available on the DOE website at: http://www.regulations.gov/#!docketBrowser;rpp=25;po=0;D=EERE-2006-STD-0127. (Last accessed December 2012)
[11] IEC standards are available for purchase at: http://www.iec.ch/.

into a single metric with cooking energy use. Those concerns lead DOE to thoroughly investigate standby mode, off mode, and active mode power consumption of microwave ovens.

On October 17, 2008, DOE published a NOPR (the October 2008 NOPR) for cooking products and commercial clothes washers in the Federal Register proposing amended energy conservation standards. 73 FR 62034. In the October 2008 NOPR, DOE tentatively concluded that a standard for microwave oven standby mode and off mode energy use would be technologically feasible and economically justified. Id. at 62120. Therefore, concurrent with the standards NOPR, DOE published in the Federal Register a test procedure NOPR for microwave ovens to incorporate a measurement of standby mode and off mode power and to consider inclusion of such power as part of the energy conservation standards rulemaking. 73 FR 62134 (Oct. 17, 2008). DOE concluded, however, that, "although it may be mathematically possible to combine energy consumption into a single metric encompassing active (cooking), standby, and off modes, it is not technically feasible to do so at this time…." 73 FR 62034, 62043 (Oct. 17, 2008). The separate prescriptive standby mode and off mode energy conservation standards proposed in the October 2008 NOPR for microwave ovens are shown in Table II-1.

Table II-1 October 2008 NOPR Proposed Energy Conservation Standards for Microwave Oven Standby Mode and Off Mode

Product Class	Proposed Energy Conservation Standard
Microwave Ovens	Maximum Standby Power = 1.0 watt

In the October 2008 NOPR, DOE described and sought further comment on the analytical framework, models, and tools (e.g., LCC and NIA spreadsheets) it was using to analyze the impacts of energy conservation standards for this product. DOE held a public meeting in Washington, DC, on November 13, 2008 (the November 2008 Public Meeting), to present the methodologies and results for the October 2008 NOPR analyses.

Multiple interested parties commented in response to the October 2008 NOPR that insufficient data and information were available to complete this rulemaking, and requested that it be postponed to allow DOE to gather such inputs on which to base its analysis. DOE agreed with these commenters that additional information would improve its analysis and, in April 2009, it concluded that it should defer a decision regarding amended energy conservation standards that would address standby mode and off mode energy use for microwave ovens pending further rulemaking. 74 FR 16040, 16042 (Apr. 8, 2009). In the interim, DOE proceeded with consideration of energy conservation standards for microwave oven active mode energy use based on its proposals in the October 2008 NOPR, and its analysis determined that no new standards for microwave oven active mode (as to cooking efficiency) were technologically feasible and economically justified. Therefore, in a final rule published on April 8, 2009, DOE maintained the "no standard" standard for microwave oven active mode energy use. Id. at 16087. The final rule is available on DOE's website at: www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/74fr16040.pdf

After continuing its analysis of microwave oven standby mode and off mode through additional testing, research, and consideration of an updated version of IEC Standard 62301, DOE published an SNOPR on February 14, 2012 (77 FR 8526) (hereafter referred to as the February 2012 SNOPR) to enable interested parties to comment on revised product class definitions and standby power levels proposed for microwave oven standby mode and off mode energy use. As discussed further in section IV.B of this rulemaking, DOE determined that built-in and over-the range convection microwave ovens incorporate features required to handle the thermal loads associated with their installation and to provide consumer utility, thereby resulting in higher standby power consumption than for other microwave oven product types. DOE's product testing and reverse-engineering analysis additionally determined that over-the-range microwave-only ovens did not require features with higher standby power consumption than countertop microwave-only units, and thus DOE proposed the following two product classes and standby power levels for microwave oven energy conservation standards:

Table II-2 February 2012 SNOPR Proposed Energy Conservation Standards for Microwave Oven Standby Mode and Off Mode

Product Class	Proposed Energy Conservation Standard
Microwave-Only Ovens and Countertop Convection* Microwave Ovens	Maximum Standby Power = 1.0 watt
Built-In and Over-the-Range Convection* Microwave Ovens	Maximum Standby Power = 2.2 watts

* In earlier stages of this rulemaking, DOE referred to microwave ovens that incorporate convection features and any other means of cooking in a single compartment as "combination microwave ovens". In the final rule for DOE's microwave oven test procedure (78 FR 4015, 4017–4018 (Jan. 18, 2013), DOE defined such products as "convection microwave ovens", and DOE accordingly uses this terminology consistently in today's final rule rulemaking and amended microwave oven standards.

The compliance date for the amended energy conservation standards for microwave ovens is **June 17, 2016**.

III. General Discussion

A. Test Procedures

Section 310 of EISA 2007 amended EPCA to require DOE to amend the test procedures for covered products to address energy consumption of standby mode and off mode. If technically infeasible, DOE must prescribe a separate standby mode and off mode energy use test procedure. (42 U.S.C. 6295(gg)(2)(A))

In the final rule published on January 18, 2013 (hereafter referred to as the January 2013 TP Final Rule), DOE amended the microwave oven test procedure to incorporate by reference certain provisions of IEC Standard 62301 Edition 2.0 2011-01 (IEC Standard 62301 (Second Edition)), along with clarifying language, for the measurement of standby mode and off mode energy use. In the narrow case of microwave ovens with power consumption that varies as a function of the time displayed, DOE maintained the existing use of IEC Standard 62301 (First Edition) for measuring standby mode power to minimize manufacturer burden. DOE also determined that microwave ovens combined with other appliance functionality are covered under the definition of "microwave oven" at 10 CFR 430.2, but due to a lack of data and information, did not adopt provisions in the microwave oven test procedure to measure the standby mode and off mode energy use of the microwave component. 78 FR 4015 (Jan. 18, 2013).

The Association of Home Appliance Manufacturers (AHAM) and GE Consumer & Industrial (GE) commented that they support incorporation by reference of IEC Standard 62301 (Second Edition) in the DOE microwave oven test procedure, but stated that DOE cannot determine appropriate standard levels in this rulemaking without testing based on the final test procedure to be used to determine compliance. (AHAM, No. 16 at p. 4[12]; GE, No. 19 at p. 1)

DOE reviewed its testing that it had conducted in support of various stages of the microwave oven test procedure rulemaking, and determined that there were six microwave oven models that had been tested according to both the First and Second Editions of IEC Standard 62301. In order to supplement this sample, DOE additionally tested eight more microwave ovens as part of its final rule analysis so that a comparison could be made between the standby power consumption measurements obtained with the First Edition and Second Edition for various installation configurations, display types, and manufacturers/brands. Table III-1 presents the results of the comparison between testing to the First Edition and the Second Edition, which showed results for the two methodologies varying by no more than 5.5 percent, which DOE concludes demonstrates close enough agreement that manufacturers could apply the same design option pathways (see section IV.C.3 of this rulemaking) to achieve the varying standby power levels when measuring according to IEC Standard 62301 (Second Edition) as DOE's analysis identified based on testing to IEC Standard 62301 (First Edition).

[12] A notation in the form "AHAM, No. 16 at p. 4" identifies a written comment that DOE has received and has included in the docket of the standards rulemaking for microwave ovens (Docket No. EERE–2011–BT–STD–0048). This particular notation refers to a comment (1) submitted by the Association of Home Appliance Manufacturers (AHAM), (2) recorded in document number 16 in the docket of this rulemaking, and (3) which appears on page 4 of document number 16.

Table III-1 Comparison of Standby Power Measurements According to IEC Standard 62301 (First Edition) and IEC Standard 62301 (Second Edition)

Configuration	Display*	Standby Power (W), First Edition	Standby Power (W), Second Edition	% Difference
Countertop Microwave-Only	Backlit LCD	3.84	3.66	-4.7
Countertop Microwave-Only	Backlit LCD	2.18	2.18	-0.3
Countertop Microwave-Only	Backlit LCD	3.81	3.78	-1.0
Countertop Microwave-Only	LED	1.06	1.07	0.3
Countertop Microwave-Only	LED	1.76	1.77	0.8
Countertop Microwave-Only	LED	1.27	1.27	-0.4
Countertop Microwave-Only	VFD	3.44	3.42	-0.6
Countertop Microwave-Only	VFD	3.14	3.12	-0.7
Countertop Convection Microwave	LED	1.20	1.24	3.2
Countertop Convection Microwave	VFD	4.14	4.13	-0.1
Countertop Convection Microwave	VFD	3.23	3.05	-5.5
Over-the-Range Microwave-Only	VFD	1.66	1.67	0.4
Over-the-Range Microwave-Only	LED	0.78	0.78	0.0
Over-the-Range Convection Microwave	VFD	4.50	4.48	-0.4

* LCD = Liquid Crystal Display, LED = Light Emitting Diode, VFD = Vacuum Fluorescent Display

B. Technological Feasibility

1. General

In each standards rulemaking, DOE conducts a screening analysis based on information gathered on all current technology options and prototype designs that could improve the efficiency of the products or equipment that are the subject of the rulemaking. As the first step in such an analysis, DOE develops a list of technology options for consideration in consultation with manufacturers, design engineers, and other interested parties. DOE then determines which of those means for improving efficiency are technologically feasible. DOE considers technologies incorporated in commercially available products or in working prototypes to be technologically feasible. 10 CFR part 430, subpart C, appendix A, section 4(a)(4)(i).

After DOE has determined that particular technology options are technologically feasible, it further evaluates each technology option in light of the following additional screening criteria: (1) practicability to manufacture, install, or service; (2) adverse impacts on product utility or availability; and (3) adverse impacts on health or safety. 10 CFR part 430, subpart C, appendix A, section 4(a)(3) and (4). All technologically feasible design options that pass the three additional screening criteria are candidates for further assessment in the engineering and subsequent analyses in the NOPR stage. DOE may amend the list of retained design options in SNOPR analyses based on comments received on the NOPR and on further research. Section IV.D of this rulemaking discusses the results of the screening analysis for microwave ovens, particularly the designs DOE considered, those it screened out, and those that are the basis for the trial standard levels (TSLs) in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the final rule TSD.

DOE published a list of evaluated microwave oven technologies in the November 2007 ANOPR. 72 FR 64432 (Nov. 15, 2007). DOE identified lower-power display technologies, improved power supplies and controllers, and alternative cooking sensor technologies as options to reduce standby power. DOE conducted this research when it became aware of the likelihood of EISA 2007 being signed, which DOE understood was to contain provisions pertaining to standby mode and off mode energy use. Therefore, DOE presented details of each design option to interested parties at the December 2007 Public Meeting even though the results were not available in time for publication in the November 2007 ANOPR. DOE determined that all of these options were technologically feasible, and in the ANOPR invited comment on technology options that reduce standby power in microwave ovens. 72 FR 64432, 64513 (Nov. 15, 2007).

For the October 2008 NOPR, DOE conducted additional research on several microwave oven technologies that significantly affect standby power, including cooking sensors, display technologies, and control strategies and associated control boards. DOE determined that control strategies are available that enable manufacturers to make design tradeoffs between incorporating features that consume standby power (such as displays or cooking sensors) and including a function to turn power off to those components during standby mode. 73 FR 62034, 62052 (Oct. 17, 2008).

DOE received comments on each of these technology options in response to the October 2008 NOPR, and determined through additional research conducted for the February 2012 SNOPR and today's final rule that each of these technologies and control strategies are feasible means to reduce standby power for both product classes of microwave ovens. 77 FR 8526, 8537–40 (Feb. 14, 2012). For more details of these technology options and comments from interested parties, see chapter 3 of the final rule TSD and section IV.C of this rulemaking.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt an amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Using the design parameters that lead to creation of the highest available product efficiencies, in the engineering analysis DOE determined the maximum technologically feasible ("max-tech") standby power levels[13] for microwave ovens, as shown in Table III-2. The max-tech microwave oven standby power level corresponds to a unit equipped with a default automatic power-down function that disables certain power-consuming components after a specified period of user inactivity. The max-tech microwave oven standby power level was determined in the October 2008 NOPR to be 0.02 watts (W). 73 FR 62052 (Oct. 17, 2008). Based upon additional analyses for the February 2012 SNOPR, DOE determined that this max-tech level is applicable to the product class of microwave-only ovens and countertop convection microwave ovens. For built-in and over-the-range convection microwave ovens, DOE identified, based on its analysis, a max-tech standby power level of 0.04 W. 77 FR 8526, 8541–42 (Feb. 14, 2012). DOE has retained these max-tech levels for today's final rule. For more details of the max-tech levels, see chapter 5 of the final rule TSD and section IV.D.2 of this rulemaking.

[13] As noted elsewhere in today's final rule, DOE is aware of fewer than 1 percent of microwave oven models currently available that can operate in off mode. Therefore, efficiency levels for the purposes of evaluating standby mode and off mode energy use in microwave ovens are defined on the basis of standby power only at this time.

Table III-2 Max-Tech Microwave Oven Standby Power Levels

Product Class	Max-Tech Standby Power Level
Microwave-Only Ovens and Countertop Convection Microwave Ovens	0.02 watts
Built-In and Over-the-Range Convection Microwave Ovens	0.04 watts

C. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from the products that are the subject of this rulemaking purchased in the 30-year period that begins in the year of compliance with amended standards (2016–2045). The savings are measured over the entire lifetime of products purchased in the 30-year period.[14] DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. The base case represents a projection of energy consumption in the absence of amended mandatory efficiency standards, and considers market forces and policies that affect demand for more efficient products.

DOE used its NIA spreadsheet model to estimate energy savings from amended standards for the products that are the subject of this rulemaking. The NIA spreadsheet model (described in section IV.F of this rulemaking) calculates energy savings in site energy, which is the energy directly consumed by products at the locations where they are used. DOE reports national energy savings on an annual basis in terms of the source (primary) energy savings, which is the savings in the energy that is used to generate and

[14] In the past DOE presented energy savings results for only the 30-year period that begins in the year of compliance. In the calculation of economic impacts, however, DOE considered operating cost savings measured over the entire lifetime of products purchased in the 30-year period. DOE has chosen to modify its presentation of national energy savings to be consistent with the approach used for its national economic analysis.

transmit the site energy. To convert site energy to source energy, DOE derived annual conversion factors from the model used to prepare the Energy Information Administration's (EIA) Annual Energy Outlook 2012 (AEO 2012).

2. Significance of Savings

As noted above, 42 U.S.C. 6295(o)(3)(B) prevents DOE from adopting a standard for a covered product unless such standard would result in "significant" energy savings. Although the term "significant" is not defined in the Act, the U.S. Court of Appeals, in Natural Resources Defense Council v. Herrington, 768 F.2d 1355, 1373 (D.C. Cir. 1985), indicated that Congress intended "significant" energy savings in this context to be savings that were not "genuinely trivial." The energy savings for all of the TSLs considered in this rulemaking (presented in section V.C of this rulemaking) are nontrivial, and, therefore, DOE considers them "significant" within the meaning of section 325 of EPCA.

D. Economic Justification

1. Specific Criteria

EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

a. Economic Impact on Manufacturers and Consumers

In determining the impacts of an amended standard on manufacturers, DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include the INPV, which values the industry on the basis of expected future cash flows; cash flows by year; changes in revenue and income; and other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.
For more details on the manufacturer impact analysis (MIA), see section IV.H of this rulemaking and chapter 12 of the final rule TSD.

For individual consumers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. The LCC, which is specified separately in EPCA as one of the seven factors to be considered in determining the economic justification for a new or amended standard, 42 U.S.C. 6295(o)(2)(B)(i)(II), is discussed in the following section. For consumers in the aggregate, DOE also calculates the national net present value of the economic impacts applicable to a particular rulemaking.

b. Life-Cycle Costs

The LCC is the sum of the purchase price of a product (including its installation) and the operating expense (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC savings for the considered efficiency levels are calculated relative to a base case that reflects projected market trends in the absence of amended standards. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and consumer discount rates. For its analysis, DOE assumes that consumers will purchase the considered products in the first year of compliance with amended standards.

To account for uncertainty and variability in specific inputs, such as product lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value. DOE identifies the percentage of consumers estimated to receive LCC savings or experience an LCC increase, in addition to the average LCC savings associated with a particular standard level. DOE also evaluates the LCC impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a national standard. See section IV.E of this rulemaking for more details on the LCC and PBP analysis.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for imposing an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section IV.F of this rulemaking, DOE uses the NIA spreadsheet to project national energy savings. See chapter 10 of the final rule TSD for more details on this analysis.

d. Lessening of Utility or Performance of Products

In establishing classes of products, and in evaluating design options and the impact of potential standard levels, DOE evaluates standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) The standards adopted in today's final rule will not reduce the utility or performance of the products under consideration in this rulemaking.

e. Impact of Any Lessening of Competition

EPCA directs DOE to consider any lessening of competition that is likely to result from standards. It also directs the Attorney General of the United States (Attorney General) to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination to the Secretary within 60 days of the publication of a direct final rule and simultaneously published proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C.

6295(o)(2)(B)(i)(V) and (B)(ii)) DOE received the Attorney General's determination, dated December 16, 2008, on standards proposed in the October 2008 NOPR. The Attorney General's determination for October 2008 NOPR did not mention microwave oven standards. To assist the Attorney General in making a determination for microwave oven standards, DOE provided the Department of Justice (DOJ) with copies of the SNOPR and the TSD for review. DOJ concluded that the energy conservation standards for microwave standby power as proposed were unlikely to have a significant adverse impact on competition.

f. Need for National Energy Conservation

The energy savings from amended standards are likely to provide improvements to the security and reliability of the nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the nation's needed power generation capacity.

The amended standards also are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production. DOE reports the emissions impacts from today's standards, and from each TSL it considered, in chapter 15 of the final rule TSD. (42. U.S.C. 6295(o)(2)(B)(i)(VI)) See section IV.K of this rulemaking for more details on this analysis. DOE also reports estimates of the economic value of emissions reductions resulting from the considered TSLs.

g. Other Factors

EPCA allows the Secretary of Energy, in determining whether a standard is economically justified, to consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) In considering amended standards for today's rulemaking, the Secretary found no relevant factors other than those identified elsewhere in today's final rule.

2. Rebuttable Presumption

As set forth in 42 U.S.C. 6295(o)(2)(B)(iii), EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the consumer of a product that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. DOE's LCC and PBP analyses generate values used to calculate the effect potential amended energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the nation, and the environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.E.10 of this rulemaking and chapter 8 of the final rule TSD.

IV. Methodology and Revisions to the Analyses Employed in the February 2012 Proposed Rule

In weighing the benefits and burdens of amended standards for microwave oven standby mode and off mode energy use, DOE used economic models to estimate the impacts of each TSL. The LCC spreadsheet calculates the LCC impacts and payback periods for potential amended energy conservation standards. DOE used the engineering spreadsheet to develop the relationship between cost and efficiency and to calculate the simple payback period for purposes of addressing the rebuttable presumption that a standard with a payback period of less than 3 years is economically justified. The NIA spreadsheet provides shipments forecasts and then calculates NES and NPV impacts of potential amended energy conservation standards. DOE also assessed manufacturer impacts, largely through use of the Government Regulatory Impact Model (GRIM).

Additionally, DOE estimated the impacts of potential amended energy conservation standards on utilities and the environment. DOE used a version of the EIA's National Energy Modeling System (NEMS) for the utility and environmental analyses. The EIA has developed the NEMS model, which simulates the energy economy of the United States, over several years primarily for the purpose of preparing the AEO. The NEMS produces forecasts for the United States energy situation that are available in the public domain. The version of NEMS used for appliance standards analysis is called

NEMS-BT.[15] The NEMS-BT offers a sophisticated picture of the effect of standards, because it accounts for the interactions among the various energy supply and demand sectors and the economy as a whole.

A. Covered Products

At the time of the October 2008 NOPR, DOE's regulations codified at 10 CFR 430.2 defined a microwave oven as a class of kitchen ranges and ovens which is a household cooking appliance consisting of a compartment designed to cook or heat food by means of microwave energy. In the October 2008 NOPR, DOE proposed a single product class for microwave ovens that would encompass microwave ovens with and without browning (thermal) elements, but would not include microwave ovens that incorporate convection systems. 73 FR 62034, 62048 (Oct. 17, 2008).

As part of its microwave oven test procedure rulemaking, DOE reassessed what products would be considered microwave ovens under the regulatory definition, and whether multiple product classes would be appropriate. As discussed in the test procedure interim final rule that published on March 9, 2011 (the March 2011 TP Interim Final Rule), DOE amended the definition of microwave oven in 10 CFR 430.2 to clarify that it includes microwave ovens with or without thermal elements designed for surface browning of food and combination ovens (which at the time was the term DOE used to designate convection microwave ovens). DOE also determined that all ovens equipped

[15] The EIA approves the use of the name NEMS to describe only an AEO version of the model without any modification to code or data. Because the present analysis entails some minor code modifications and runs the model under various policy scenarios that deviate from AEO assumptions, the model used here has been named NEMS-BT. ("BT" stands for DOE's Building Technologies Program.) For more information on NEMS, refer to The National Energy Modeling System: An Overview, DOE/EIA–0581 (98) (Feb. 1998) (available at: http://tonto.eia.doe.gov/FTPROOT/forecasting/058198.pdf). (Last accessed November 10, 2012.)

with microwave capability would be considered a covered product, regardless of which cooking mode (i.e., radiant heating or microwave energy) is primary. Based on the preliminary analysis it conducted, DOE observed that the typical standby mode and off mode operation for microwave ovens that also incorporate other means of cooking food does not differ from that of microwave-only units. As a result, DOE amended the microwave oven test procedure in the March 2011 TP Interim Final Rule to require that the same standby mode and off mode testing methods be used for all microwave ovens. 76 FR 12825, 12828–30 (Mar. 9, 2011).

DOE received comments on the topic of covered products in response to the February 2012 SNOPR on microwave oven energy conservation standards. AHAM and GE stated that DOE should clarify the applicability of the proposed standards to products using both microwave energy and radiant heating. AHAM and GE also commented that the definition of "combination oven" as established by the March 2011 TP Interim Final Rule and proposed to be maintained in the February 2012 SNOPR should be revised to be sufficiently broad to include, generally, "other means of cooking" in order to account for current and future cooking technologies. According to AHAM and GE, DOE's definition was too vague and would lead to confusion as to which products are covered. These commenters further stated that DOE's proposal that, for products with multiple oven compartments but no integral cooking top, the compartment(s) that cook by means of microwave energy in combination with any other cooking or heating means would be classified as microwave ovens while the compartment(s) that cook or heat food by means of a gas flame or electric resistance heating without the use of microwave energy would be classified as conventional ovens, is contradictory, adds complexity, and is confusing. AHAM and GE agreed with DOE that a free-standing range with microwave capability should be excluded from coverage as a microwave oven, but stated that a built-in range with microwave capability should not be classified as a microwave oven either because the installation configuration does not affect how the product is used. AHAM, GE, and Whirlpool Corporation (Whirlpool) commented that the primary use should determine how the product is characterized, such that a built-in product with two separate cavities, one that uses microwave energy and one that uses conventional thermal energy, should be classified as a conventional range, not a microwave oven. AHAM and GE stated that this would be consistent with the exclusion of free-standing ranges with microwave capability. These commenters, therefore, recommended that DOE define a combination oven as “a microwave oven that incorporates means of cooking other than microwave energy, and does not mean free-standing or built-in conventional cooking tops, conventional ovens, or conventional ranges that include microwave ovens in separate cavities.” (AHAM, No. 16 at pp. 1, 3–4; GE, No. 19 at p. 1; Whirlpool, No. 15 at p. 1) Whirlpool commented that not all manufacturers produce a built-in cooking product with two separate cavities, one which uses microwave energy and one which uses conventional thermal energy, and which are controlled by a single control panel. Some of Whirlpool’s competitors have such built-in products with two separate control panels. Whirlpool stated that if DOE maintains the definition of combination oven, Whirlpool and other product manufacturers with similar product lines will be placed at a competitive disadvantage to those with separate control panels. (Whirlpool, No. 15 at p. 1)

DOE maintained in the January 2013 TP Final Rule that the definition of microwave oven also includes all products that combine a microwave oven with other appliance functionality. To aid in distinguishing such other "combined products" from the type of microwave oven that incorporates convection features and any other means of cooking, DOE adopted the term "convection microwave oven" to more accurately describe the latter, and provided a definition of convection microwave oven in 10 CFR 430.2. In this definition, DOE clarified that the microwave capability, convection features, and any other cooking means are incorporated in a single cavity. 78 FR 4015, 4017–4018 (Jan. 18, 2013).

In the January 2013 TP Final Rule, DOE further confirmed that all products that combine a microwave oven with other appliance functionality would be considered covered products, including microwave/conventional ranges, microwave/conventional ovens, microwave/conventional cooking tops, and other combined products such as microwave/refrigerator-freezer/charging stations. Regarding microwave/conventional ranges, DOE clarified that an appliance need not be free-standing to be covered as a microwave/conventional range. DOE, therefore, added a definition of "microwave/conventional cooking top" in 10 CFR 430.2 to state that it is a class of kitchen ranges and ovens that is a household cooking appliance consisting of a microwave oven and a conventional cooking top. Similarly, DOE added a definition in 10 CFR 430.2 of a "microwave/conventional oven" as a class of kitchen ranges and ovens which is a household cooking appliance consisting of a microwave oven and a conventional oven in separate compartments. DOE also clarified in the definition of microwave/conventional range that the microwave oven and conventional oven are incorporated as separate compartments. 78 FR 4015, 4018 (Jan. 18, 2013).

DOE determined in the January 2013 TP Final Rule that the microwave oven component of these combined products would meet the statutory requirements as a covered product for the purposes of measuring standby mode and off mode energy use under EPCA. (42 U.S.C. 6295(gg)(2)(B)(vi)) DOE stated that it does not believe that the presence of additional appliance functionality would eliminate the statutory requirement to evaluate standby mode and off mode energy use in the microwave oven component. DOE also concluded in the January 2013 TP Final Rule that the provisions related to the measurement of standby mode and off mode energy use in the test procedure should only measure such energy use associated with the microwave oven portion of combined products, and for that reason the amendments from the January 2013 TP Final Rule do not require any determination as to which appliance function of a combined product with a microwave oven component represents the primary usage of the product. Id. DOE notes that there are currently no active mode provisions for microwave ovens in its test procedure, although it has initiated a separate rulemaking to consider such amendments.

In the microwave oven standby mode and off mode test procedure rulemaking, DOE confirmed that the microwave oven portion of a combined product is covered under the definition of microwave oven, but due to a lack of data and information at the time, did not amend its test procedures in the January 2013 TP Final Rule to measure standby mode and off mode energy use for the microwave portion of combined products. Id. Therefore, DOE is not establishing amended energy conservation standards for standby mode and off mode energy use for these products in today's final rule. DOE may choose to initiate a separate rulemaking at a later date that would address standby and off mode energy use of combined products.

B. Product Classes

In general, when evaluating and establishing energy conservation standards, DOE divides covered products into classes by the type of energy used, capacity, or other performance-related features that affect consumer utility and efficiency. (42 U.S.C. 6295(q); 6316(a)) Different energy conservation standards may apply to different product classes. Id.

In order to determine whether specific types of microwave ovens should be separated into different product classes, DOE investigated whether there are any performance related features that would justify the establishment of a separate energy conservation standard. As discussed in the October 2008 NOPR, DOE tested a sample of 32 countertop microwave-only units and measured standby mode power ranging from 1.2 W to 5.8 W. 73 FR 62034, 62042 (Oct. 17, 2008). None of these units were capable of operation in off mode, nor was DOE aware at that time of any other microwave ovens capable of such operation. In the February 2012 SNOPR, DOE noted that standby power consumption for microwave-only units largely depended on the presence of a cooking sensor, the display technology, the power supply and control board, and implementation of a power-down feature. With regards to display technologies, DOE noted that microwave-only units incorporated Light Emitting Diode (LED) displays, Liquid Crystal Displays (LCDs), and Vacuum Fluorescent Displays (VFDs).

Based on comments received in response to the October 2008 NOPR, DOE conducted a survey of over-the-range microwave-only units available on the U.S. market. DOE determined that the display technologies used are similar to those used in countertop microwave-only units (i.e., LED displays, LCDs, and VFDs). DOE also conducted in-store standby mode testing on a limited sample of over-the-range microwave-only units which showed similar standby power consumption as countertop microwave-only units. For these reasons, DOE tentatively concluded in the February 2012 SNOPR that over-the-range microwave-only units would not warrant a separate product class. DOE understands that over-the-range microwave-only units may have additional components that are energized during active mode operation (i.e., exhaust fan motors). However, DOE's testing showed that the presence of such features did not increase the standby power consumption to warrant establishing a separate product class. 77 FR 8526, 8536 (Feb. 14, 2012).

DOE also conducted standby power testing on a sample of 13 representative convection microwave ovens, including 5 countertop convection microwave ovens, 6 over-the-range convection microwave ovens, and 2 built-in convection microwave ovens. DOE's testing showed that the countertop convection microwave ovens use similar display technologies as countertop microwave-only units, and had standby power consumption ranging from 1.2 W to 4.7 W, which is similar to the standby power consumption for countertop microwave-only units. As a result, DOE tentatively concluded in the February 2012 SNOPR that countertop convection microwave ovens would not warrant a product class separate from microwave-only ovens. Id.

DOE's testing of built-in and over-the-range convection microwave ovens for the February 2012 SNOPR showed that the standby power consumption for these products ranged from 4.1 W to 8.8 W, which was higher than the standby power consumption for other microwave oven product types (i.e., countertop microwave-only, over-the-range microwave-only, and countertop convection microwave ovens). DOE's reverse-engineering analysis suggested that the additional features in built-in and over-the-range convection microwave ovens required to handle the thermal loads associated with their installation and to provide consumer utility, such as additional exhaust fan motors, convection fan motors and heaters, and additional lights, require a significant number of additional relays on the control board, and thus require a larger power supply for the control of such relays. While the relays themselves do not consume power in standby mode, they increase the total power supply requirements of the control board and thus increase the standby losses of the power supply. As a result, DOE determined that a separate product class should be established for built-in and over-the-range convection microwave ovens. DOE recognized that built-in and over-the-range microwave-only units may similarly require some additional relays for exhaust fans and lights, and that countertop convection microwave ovens would require some additional relays for convection fans and heaters. However, DOE's product testing and reverse-engineering analyses indicated that these product types use similar-sized power supplies as those found in countertop microwave-only units, and as a result would not warrant a separate product class from countertop microwave-only units. Id.

Thus, for the February 2012 SNOPR, DOE determined that separate product classes for the purposes of setting energy conservation standards addressing standby mode and off mode energy use were warranted on the basis of different standby power performance. DOE did not evaluate whether the same product class distinction would also be appropriate for any active mode energy use standards because DOE eliminated the regulatory provisions establishing the cooking efficiency test procedure for microwave ovens in the a final rule published on July 22, 2010 (the July 2010 TP Final Rule). 75 FR 42579. If DOE adopts amendments to the microwave oven test procedure to include provisions for measuring active mode cooking efficiency, DOE may reevaluate these product classes as part of a future microwave oven energy conservation standards rulemaking. At that time, DOE may consider dividing countertop convection microwave ovens and over-the-range/built-in microwave-only units into separate product classes to account for the energy performance of heating components other than the microwave portion. In the February 2012 SNOPR, DOE proposed to establish the following two product classes for microwave ovens (77 FR 8526, 8536 (Feb. 14, 2012)):

Table IV-1 February 2012 SNOPR Proposed Microwave Oven Product Classes

Product Class
1. Microwave-Only Ovens and Countertop Convection Microwave Ovens
2. Built-in and Over-the-Range Convection Microwave Ovens

The Appliance Standards Awareness Project, Natural Resources Defense Council, National Consumer Law Center, Northwest Energy Efficiency Alliance, and Northwest Power Conservation Council, (hereafter referred to as the Joint Commenters), jointly supported the inclusion of all microwave-only and countertop convection microwave ovens in a single product class, stating that over-the-range microwave-only ovens do not have features that necessitate additional standby mode energy use. (Joint Comment, No. 17 at p. 2)

AHAM, GE, and Whirlpool objected to the lack of product class differentiation between countertop and over-the-range microwave-only ovens in Product Class 1. According to these commenters, there are significant differences in energy consumption and consumer utility between countertop and over-the-range microwave ovens. They stated that a countertop microwave oven is typically designed to operate at room temperature, whereas an over-the-range microwave oven is subject to higher temperatures. AHAM, GE, and Whirlpool further stated that certain features of over-the-range microwave ovens, such as a VFD display that can reliably withstand higher temperatures while still providing consumer utility, consumes more energy in standby mode than a countertop microwave oven display, which can use lower-power LED and LCD technologies. Whirlpool also noted that electronic controls for over-the-range microwave ovens must be constructed of materials which can operate in this environment. (AHAM, No. 16 at pp. 1–2; GE, No. 19 at p. 1; Whirlpool, No. 15 at p. 2)

In addition to standby mode considerations, AHAM, GE, and Whirlpool commented that the proposed product classes failed to consider the effects of active mode differences on a future microwave oven active mode test procedure or standard. These commenters noted that over-the-range units have energy consuming features such as air venting and circulation, forced cooling, and cooktop lighting that are not found in countertop units. (AHAM, No. 16 at p. 2; GE, No. 19 at p. 1; Whirlpool, No. 15 at pp. 2–3) AHAM and GE concluded that over-the-range microwave-only ovens should be included in Product Class 2. (AHAM, No. 16 at p. 2; GE, No. 19 at p. 1)

DOE agrees with commenters that over-the-range microwave ovens must operate under conditions that are harsher than countertop microwave ovens are typically exposed to, in terms of elevated temperatures and humidity levels. For the components that are associated with standby mode and off mode energy use, these conditions have the most effect on the displays. Under long-term exposure, displays may degrade in illuminance over time, resulting in a consumer's perception of reduced brightness, a significant element of consumer utility. As discussed further in section IV.C.2 of this rulemaking, DOE conducted accelerated lifetime testing of different microwave oven display types by subjecting a limited sample of microwave ovens to high temperatures and humidity levels for an extended period of operation in standby mode. The results of this testing demonstrated that the illuminance of each display tended to decrease over time to varying degrees, but did not reveal any correlation between display type and rate of illuminance reduction. In addition, DOE observed in its test sample a unit with an LED display that exhibited illuminance that was comparable to that of the VFD on another unit. Based on this lifetime testing, and the existence of multiple over-the-range microwave oven models on the market with each type of display technology, DOE concludes that over-the-range microwave ovens would not require certain display technologies (i.e., VFD) that have inherently higher power consumption than other display types that provide similar consumer utility. In addition, DOE is not aware of, nor did commenters provide information on, different standby power consumption that would be associated with controls that have the same functionality but different material selection.

In its final rule engineering analysis, DOE also examined more closely whether combinations of design options are available that would allow over-the-range microwave-only ovens to meet the same standby power levels as countertop microwave ovens. These "design pathways" are discussed in more detail in section IV.C.3 of this rulemaking. From its analysis, DOE concluded that design pathways exist for all over-the-range microwave-only ovens with LED displays and LCDs to meet a 1.0 W standard, so that none of these would warrant classification into Product Class 2 on the basis of energy use characteristics in standby mode. DOE further concludes that the range of these display technologies allows manufacturers to design over-the-range products with comparable consumer utility and durability of the display as for over-the-range microwave ovens with VFDs. Therefore, DOE is maintaining in today's final rule the two product classes that were proposed in the February 2012 SNOPR.

As noted in the February 2012 SNOPR, DOE acknowledges that over-the-range microwave ovens contain additional relays for components that are not found in countertop units, such as exhaust or cooling fans and cooktop lighting. However, these components were not found in DOE's analysis to require larger power supplies that would affect standby power consumption, and thus would not support the definition of a separate product class for over-the-range microwave-only ovens from countertop microwave ovens. In the future, if DOE establishes a test procedure that measures microwave oven active mode energy use and considers whether active mode energy conservation standards are warranted, it may consider redefining the product classes according to utility and energy use for both active mode and standby mode. Such revised product classes would not be precluded by the definition of product classes for standby mode considerations in today's final rule.

C. Technology Assessment

Product teardowns performed by DOE for this and past rulemakings gave DOE an insight into the strategies a manufacturer could adopt to achieve higher energy conservation standards. In the October 2008 NOPR, DOE presented information on several microwave oven technologies that significantly affect standby power, including cooking sensors, display technologies, and control strategies and associated control boards. 73 FR 62034, 62052 (Oct. 17, 2008). In the February 2012 SNOPR, DOE determined that the standby power characteristics for countertop convection microwave ovens and over-the-range microwave-only units are similar to that of counter-top microwave-only units, and therefore, the same technology options would apply to these products. Additional testing on over-the range convection microwave ovens conducted by DOE also showed that standby power in these products depends largely on the same factors. 77 FR 8526, 8536–37 (Feb. 14, 2012). DOE determined in the screening analysis for the final rule that all of the technology options identified in the February 2012 SNOPR meet the screening criteria and thus were considered as design options in the engineering analysis. The following sections discuss these technology options and additional analysis conducted for today's final rule.

1. Cooking Sensors

In the October 2008 NOPR, DOE reported that its teardown analysis had revealed one cooking sensor technology with no standby power consumption used in microwave ovens on the U.S. market: a piezoelectric steam sensor. DOE also found that infrared and weight sensors, which require little to no warm-up time or standby power, had been applied successfully in Japanese-market microwave ovens. Furthermore, DOE identified relative humidity sensors with no standby power consumption as a feasible microwave oven cooking sensor technology, but found no microwave ovens using these sensors at the time. Finally, DOE learned that a major microwave oven supplier to the U.S. market was preparing to introduce microwave ovens using a new type of absolute humidity sensor with no standby power requirement and no cost premium over that of a conventional absolute humidity sensor. 73 FR 62034, 62051 (Oct. 17, 2008).

In the February 2012 SNOPR, DOE noted that it was not aware of any intellectual property or patent infringement issues for infrared sensors, weight sensors, piezoelectric sensors, or relative humidity sensors. With respect to the accuracy and reliability of low- and zero-standby power cooking sensors, DOE noted that a significant number of microwave oven models using the alternate cooking sensor technologies discussed above are available on the international market, and have been available for a number of years. As discussed above, DOE was also aware of one zero-standby power cooking sensor technology used in microwave ovens on the U.S. market. DOE noted in the February 2012 SNOPR that it was not aware of any data indicating that the reliability and accuracy associated with these low- and zero-standby power cooking sensors significantly differs from that of the absolute humidity sensors currently employed in microwave ovens on the U.S. market. DOE was also unaware of data showing that fouling of infrared cooking sensors would significantly differ from that of absolute humidity sensors, or data on the decreased accuracy due to fouling as compared to the fouling of absolute humidity sensors. DOE stated that because it was not aware of any relative humidity cooking sensors used in microwave ovens currently on the market, it was also not aware of any data regarding the accuracy of these sensors for detecting the state of the cooking load to adjust the cooking time. However, DOE noted that multiple other cooking sensor technology options exist that have been employed in microwave ovens in place of an absolute humidity cooking sensor. Based on this information, DOE tentatively concluded in the February 2012 SNOPR that the low- and zero-standby-power cooking sensor technologies discussed above are viable design options. 77 FR 8526, 8537 (Feb. 14, 2012).

DOE requested data and information on the accuracy and reliability of low- and zero-standby power cooking sensors as compared to absolute humidity cooking sensors currently used in microwave ovens on the U.S. market, and whether these technologies would affect how consumers use their microwave ovens or their satisfaction in using them due to any lessening of the utility or the performance of microwaves imposed by the standard. DOE also sought information on the current commercial availability of this technology, the likelihood of future adoption, and the potential impact on the lessening of competition amongst manufacturers. DOE also requested comment on whether any intellectual property or patent infringement issues are associated with the cooking sensor technologies discussed above. 77 FR 8526, 8537–38 (Feb. 14, 2012).

The Joint Commenters stated that sensor cooking has previously relied on the use of absolute humidity sensors that require a warm-up time after a period in a lower-power state, which is typically avoided by maintaining constant power to the sensor. The Joint Commenters stated that placing this type of cooking sensor into a lower power state could affect the consumer experience as a result of the necessary warm-up time. Based on DOE's findings regarding the availability of zero or near-zero standby power cooking sensors without such warm-up times, the Joint Commenters supported DOE's conclusion that such technologies can be used without impacting consumer utility. (Joint Comment, No. 17 at pp. 1–2)

GE stated that:

- Zero-standby power cooking sensors, while limited in use at that time, had not been fully tested and evaluated as appropriate alternatives;
- DOE should provide data on the availability, reliability, and functionality of these sensors;

- Absolute humidity sensors with standby power consumption offer greater resolution than relative humidity sensors with no standby power consumption and therefore offer consumer utility;
- Some of the sensor technologies, such as infrared and weight sensors, are not feasible alternatives to the absolute humidity sensors used today; and
- DOE should provide further information about absolute humidity sensors with no standby power consumption and no cost premium over that of a conventional absolute humidity sensor. (GE, No. 19 at p. 3)

GE further commented that industry's experience and research do not support considering the same sensor technologies for all microwave oven platforms, and that different technologies are required for a countertop versus over-the-range application. GE stated that if evidence to support this conclusion is not available, DOE should determine that absolute humidity sensors provide consumers with utility that cannot be matched by zero-standby power cooking sensors. (GE, No. 19 at pp. 1–2) GE also commented that DOE should preserve the use of absolute humidity sensors for over-the-range microwave ovens. (GE, No. 19 at p. 3)

Whirlpool commented that most of its new microwave ovens use a humidity sensor that can be de-energized in standby mode and off mode. According to Whirlpool, these absolute humidity sensors use the same technology as older types of absolute humidity sensors and maintain similar performance. Whirlpool also stated that, unlike the older sensors that require a few minutes to stabilize after activation, the newer sensors are operational after a wake-up time of approximately 10 seconds, which is not noticeable to the consumer. Whirlpool commented that its products with this type of sensor have been on the market in Europe for almost 3 years, and there have been no issues with them. However, Whirlpool also commented that there are limited suppliers of these absolute humidity sensors and capacity is currently limited due to flooding in late 2011 in Thailand that destroyed the equipment and factory that had been producing sensors for Whirlpool. Whirlpool stated that adequate lead time and access to capital will be required for these suppliers to add sufficient capacity if such sensors are mandated. (Whirlpool, No. 15 at pp. 3–4) Whirlpool commented that a simple circuit with several transistors to shut down a cooking sensor would cost approximately $0.10. (Whirlpool, No. 15 at p. 4)

DOE contacted multiple cooking sensor manufacturers to further evaluate zero-standby power absolute humidity sensors. DOE identified one sensor manufacturer that supplies absolute humidity sensors to multiple microwave oven manufacturers that comprise a significant portion of the market (over 50 percent). This sensor manufacturer noted that all of its sensors are capable of short warm-up times (5–10 seconds). This sensor manufacturer also noted that the control circuits would only need to be modified to add transistors to de-energize the cooking sensors while in standby mode. Because these zero-standby power absolute humidity sensors can be energized in a period of time that is small compared to the duration of a cooking cycle in which they would be used, these sensors provide the same utility to consumers as absolute humidity sensors that must remain energized in standby mode. This sensor manufacturer also indicated that there are no patents on these short warm-up time humidity sensors that would restrict other sensor manufacturers from supplying similar products to microwave oven manufacturers.

The absolute humidity sensor manufacturer indicated that it has plans to expand manufacturing capacity and could expand further if market demands increase. DOE also determined, based on discussions with microwave oven manufacturers, that the cooking sensor manufacturing facility flooding issue discussed above has been resolved. As a result, DOE does not believe there are any issues limiting the supply of these zero-standby power absolute humidity sensors.

Based on microwave oven manufacturer interviews, DOE determined that reliability of these zero-standby power absolute humidity sensors has not been an issue. One manufacturer noted that the reliability is expected to be improved compared to previous sensor types because the zero-standby power absolute humidity sensors are only energized during the cooking cycle, whereas the previous sensors are energized continuously for the lifetime of the product.

Additionally, DOE's research confirms that multiple zero-standby power cooking sensors other than absolute humidity sensors are available at a similar cost to zero-standby power absolute humidity sensors. These include different methods for determining the state of the food load being cooked, using either piezoelectric steam, infrared, or weight sensors. As discussed above, DOE notes that piezoelectric steam sensors are currently used by one microwave oven manufacturer.

Based on this information, DOE has determined that zero-standby power cooking sensors with equivalent reliability and accuracy as the existing absolute humidity cooking sensors will be available on the scale necessary to serve the U.S. microwave oven market at the time of new standards. DOE concludes, therefore, that zero-standby power cooking sensors are a viable design option for reducing microwave oven standby power consumption.

2. Display Technologies

DOE stated in the October 2008 NOPR that it would consider three display technologies for reducing microwave oven standby power consumption: LED displays, LCDs with and without backlighting, and VFDs. DOE stated that LED displays and LCDs consume less power than VFDs. DOE also stated that each identified display technology provides acceptable consumer utility, including brightness, viewing angle, and ability to display complex characters. 73 FR 62034, 62051 (Oct. 17, 2008).

In response to comments received in the October 2008 NOPR, DOE researched microwave oven display technologies and found that multiple over-the-range microwave ovens with low-power displays, including the LED and LCD types, are currently available on the U.S. market. DOE also found that manufacturer temperature ratings for the three types of displays are comparable. Furthermore, DOE found that LED displays and LCDs in both countertop and over-the-range microwave ovens offer acceptable consumer utility features, including brightness, viewing angle, and ability to display complex characters. DOE found no microwave oven display technologies with intermittent backlighting or other features that impair consumer utility. As a result, DOE stated in the February 2012 SNOPR that LED displays and LCDs can be integrated into any countertop or over-the-range microwave oven, with proper heat shielding and without significant loss of consumer utility. 77 FR 8526, 8538 (Feb. 14, 2012).

AHAM and GE disagreed that LED displays and LCDs can be integrated into all countertop or over-the-range microwave ovens with proper heat shielding and without significant loss of consumer utility. (AHAM, No. 16 at p. 4; GE, No. 19 at p. 1) GE commented that DOE should preserve the use of VFDs in over-the-range microwave ovens. GE stated that DOE did not consider the reliability of low-power displays. According to GE, non-VFD displays deteriorate when exposed to high heat by darkening and becoming unreadable. GE stated that this is a serious deficiency in components that must be included in millions of products that operate in the extreme heat environments found in most over-the-range applications. GE stated that DOE should provide data from life testing under high-heat conditions before adopting a standard that would require low-power displays. (GE, No. 19 at pp. 2, 3)

Whirlpool commented that it uses LCD, VFD, and LED displays in microwave ovens, but that LCDs require more attention to cooling than the others. (Whirlpool, No. 15 at p. 4) Whirlpool also noted that the user appearance of LCD, VFD, and LED displays is different, and Whirlpool uses that to help brand appearance and differentiation. According to Whirlpool, VFDs allow for the display of bright text at a cost and performance level that is preferable to the other technologies. Whirlpool stated that the power used by VFDs is a function of the size of the display, and that a typical midrange over-the-range microwave oven with a VFD with a graphical area of 2 inches by 1 inch could meet the 2.2 W standby level. Whirlpool commented that very large VFDs that can be found in some built-in products will have issues reaching these levels. Whirlpool noted that there is technology available for VFDs that allows part of the display area to be shut down, while leaving a small area (e.g., the clock) to remain on. However, Whirlpool also noted that use of this technology would place other design restrictions on the display, such as restrictions on pattern design. Whirlpool stated that these restrictions would increase costs beyond DOE's estimate and/or reduce consumer functionality. (Whirlpool, No. 15 at p. 4)

Whirlpool commented that LCDs face more challenges in larger sizes, and the backlight intensity may need dimming or limiting of the available intensity setting. Whirlpool stated that the added functions needed to manage the power can range from a few cents to dollars, depending on the size and technology of the display. (Whirlpool, No. 15 at p. 4)

DOE conducted additional review of products available on the U.S. market and identified 25 over-the-range microwave oven models from multiple manufacturers that incorporated LCD or LED displays. To further evaluate the reliability and consumer utility of LED displays, LCDs, and VFDs in over-the-range environments, DOE contacted display manufacturers to discuss these issues. Display manufacturers indicated that most LED displays and VFDs have maximum operating temperatures of 85 degrees Celsius (°C), while most LCDs have maximum operating temperatures of 70 °C. DOE also noted that display reliability testing is generally conducted at 90-percent relative humidity (RH). According to display manufacturers, the rated lifetime (i.e., the time at which the display brightness will have decreased by 50 percent) for most LED displays is approximately 50,000 hours, whereas the lifetime for VFDs is between 35,000 and 50,000 hours. Display manufacturers also noted that LED displays and VFDs can achieve similar levels of brightness. For LCDs with LED backlighting, display manufacturers stated that the lifetime of approximately 50,000 hours is based on the LED backlights, because the LED backlighting will fail before the LCD itself as long as the display is operated within the rated temperature and humidity conditions. According to display manufacturers, if LED displays, LCDs, and VFDs are operated below their maximum rated operating temperature and humidity, the lifetime would not be affected.

To further investigate reliability under the conditions experienced in over-the-range installations, DOE conducted testing on a sample of over-the-range microwave ovens with different display types. DOE selected 2 LED, 2 LCD, and 3 VFD over-the-range microwave oven models for testing. For each model, DOE purchased two identical units to evaluate the reliability under two separate temperature and humidity conditions. Prior to the start of testing, the illuminance for each display was measured from a fixed distance under dark room conditions. In order to obtain consistent and comparable measurements, each clock display was set to 12:00 prior to the illuminance measurements. Because some displays may dim after a period of user inactivity, the illuminance for each unit was measured again after a period of 10 minutes of inactivity.

One set of the six microwave oven models were then operated in standby mode in an environmental chamber for twelve 20-hour periods at 82.5 ± 2.5 °C and 90 ± 5 percent RH, and the other set of six microwave ovens was operated in standby mode for twelve 20-hour periods at 67.5 ± 2.5 °C and 90 ± 5 percent RH. The temperature conditions were selected based on the maximum rated operating conditions for the different display types. After each 20-hour period at elevated temperature and humidity, the environmental chamber and microwave ovens were cooled to ambient room temperature (23 ± 5 °C), at which point the illuminance of each display was measured before and after a 10-minute period of inactivity using the same method described above. Each set of microwave ovens was exposed to the elevated temperature and humidity conditions for a total of 240 hours. DOE selected this number of hours based on its review of available information on the duration of lifetime testing under similar ambient conditions that display manufacturers conduct. The number of hours manufacturers used ranged from 48 to 240, and DOE selected the maximum 240 hours for its testing. The illuminance was measured twice at ambient room conditions after each 20-hour cycle. In addition, power consumption and current were measured throughout each 20-hour cycle and subsequent 10-minute illuminance measurement period for each test unit.

The test results showed that display illuminance tended to degrade over time at these elevated conditions for most of the units tested, but the data did not reveal a correlation between the rate of degradation and display type. VFDs in DOE's test sample degraded both more and less rapidly than the LED displays under both temperature/humidity conditions, including an LED display with illuminance comparable to the VFDs in the test sample. DOE notes that the test units for one of the models with a backlit LCD failed after 20 hours at 82.5 °C and after 60 hours at 67.5 °C. Other backlit LCD model had similar illuminance levels as two of the VFD models and showed little to no degradation. Based on these test data, DOE concludes that all display types can be used in over-the-range microwave oven applications without a loss in consumer utility. For further details on the display reliability testing, see chapter 5 of the final rule TSD.

3. Power Supply and Control Boards

In the October 2008 NOPR, DOE discussed several technologies available to increase power supply and control board efficiency that would reduce microwave oven standby power consumption. DOE found some microwave ovens on the U.S. market using switch-mode power supplies with up to 75-percent conversion efficiencies and 0.2 W or less no-load standby losses, though these models came with a higher cost, higher part count, and greater complexity. DOE stated that switch-mode power supplies were, at the time, unproven in long-term microwave oven applications, and the greater complexity of these power supplies could also lower overall reliability. DOE was also aware of options to improve the energy efficiency of linear power supplies, such as low-loss transformers or unregulated voltages closer to the voltages used for logic and control, but these were not found on commercially available microwave ovens at the time. 73 FR 62034, 62051 (Oct. 17, 2008).

In response to the October 2008 NOPR, some commenters stated that certain switch-mode power supplies used in computers have efficiencies greater than 90 percent, while others questioned the reliability of switch-mode power supplies for use in microwave ovens, and that electromechanical controls will be needed to meet standby power requirements. In its analysis for the February 2012 SNOPR, DOE observed that switch-mode power supplies are found in products such as computers, battery chargers, clothes washers, and clothes dryers, suggesting that the reliability and durability of switch-mode power supplies has been proven in residential appliance applications. DOE also noted that microwave ovens incorporating switch-mode power supplies have been available for multiple years and are still used, as evidenced by such power supplies observed in DOE's most recent test sample of convection microwave ovens. DOE's research suggested that switch-mode power supplies for appliance applications in power capacities similar to those utilized in microwave ovens achieve no greater than 75-percent efficiency,[16] and DOE was unaware of data indicating that the reliability of switch-mode power supplies is significantly worse than conventional linear power supplies over the lifetime of the product. DOE was also not aware at that time of any microwave ovens on the market at that time with electromechanical controls. As a result, in the February 2012 SNOPR, DOE proposed considering only microwave ovens with electronic controls in determining standby power levels, and determined that electromechanical controls would not be required to achieve any of the standby power levels proposed in the February 2012 SNOPR. 77 FR 8526, 8538–39 (Feb. 14, 2012).

[16] Information on the design and efficiency of switch-mode power supplies can be found at http://www.powerint.com/en/applications/major-appliances. (Last accessed December 2012.)

Whirlpool commented that it uses switch-mode power supplies in many of its microwave ovens. According to Whirlpool, such power supplies will cost more than conventional linear power supplies with traditional transformers, depending on the particular design and product features. For a new design optimized for low standby power consumption, Whirlpool believes that the cost increase would be in the range of DOE's SNOPR analysis for both countertop and built-in/over-the-range microwave ovens. Whirlpool also commented, however, that if an existing design needs to be modified, the incremental manufacturing cost will exceed DOE's estimates for both product classes. Whirlpool stated that DOE underestimates the impact on manufacturers, which will either incur greater costs in designing new control systems or added product cost to adapt existing control systems. Whirlpool further stated that although it has not investigated the use of solid state relays to reduce the power requirements for power supplies, it believes that the reduction in power consumption would be minimal. (Whirlpool, No. 15 at p. 5)

In response to these comments, DOE expanded the scope of its microwave oven power supply analysis. First, DOE conducted an updated, comprehensive survey of microwave oven brands and models available on the U.S. market. The database contains 459 entries for Product Class 1 and 81 for Product Class 2. The database categorizes each microwave oven by installation configuration (i.e., built-in, over-the-range, or counter-top), heating technology (i.e., microwave-only, microwave plus thermal heating elements, or microwave plus convection), magnetron power supply type (i.e., conventional or inverter), and display type (i.e., LED, LCD, backlit LCD, VFD, or none).

As part of this research, DOE identified four countertop microwave-only models produced by two manufacturers that have electromechanical rotary dial controls and no displays, and which, therefore, are capable of operation in off mode. Because these units represent less than 1 percent of the models in Product Class 1 and because their power consumption is already low due to the lack of a display, any energy savings associated with off mode energy conservation standards for microwave ovens would be trivial. For these reasons, DOE is not adopting standards for microwave oven off mode at this time.

DOE conducted further standby power testing on a representative sample of built-in and over-the-range units from both Product Class 1 and Product Class 2 to supplement the existing inputs into the analysis. DOE determined the portion of overall product standby power consumption that is associated with baseline power supply and control board configurations for each product type based on these laboratory measurements.

DOE then identified options for reducing power supply and control board power consumption, which include low-loss transformers, switch-mode power supplies, and three different relay options of varying energy efficiency.[17] Based on this new set of standby power and design option information, DOE identified 39 different power supply design pathways for the various microwave oven configurations that could be used to achieve the standby power levels analyzed in this final rule. Each pathway comprises the combination of power supply and control board design options that would decrease standby power requirements.

[17] Please see: http://orbit.dtu.dk/fedora/objects/orbit:56806/datastreams/file_4175071/content. (Last accessed November 28, 2012).

For each standby power level analyzed, DOE took into consideration the specific power consumption needs for the product type being analyzed. For example, DOE confirmed in each case that the power supply could power at least three 3 ampere (A)-rated relays and one 16 A-rated relay concurrently, in addition to the other microwave oven base loads. MWO control boards may contain more relays than that, but DOE research suggests that not all relays will be active at the same time. The 16 A-rated relay is typically used to control the power input into the magnetron assembly, while the 3 A-rated relays are typically used for other functions, such as controlling a blower fan, turntable motor, or interior light.

DOE research also suggests that power supplies inside microwave ovens typically feature multiple direct current (DC) voltages with varying levels of line regulation. The voltages used to drive relays are usually the highest and the least regulated, as relays do not need very stable voltages. In a microwave oven with a linear power supply, unregulated power is the result of the line voltage being converted to a lower voltage by a transformer, rectified via a bridge rectifier, and smoothed somewhat with a capacitor. On control boards with linear power supplies, a linear regulator and additional capacitors provide a very smooth power supply suitable for microprocessors at even lower voltages than the unregulated supply. Boards featuring switch-mode power supplies will produce the two DC voltages with similar regulation characteristics through the use of integrated circuits directly from rectified line power.

Switch-mode power supplies differ from linear regulators in conversion efficiency. Linear regulators produce a constant output voltage by dissipating the difference between the target voltage and the input voltage times the current drawn into heat. Thus, the higher the input voltage or the lower the target voltage, the higher the power dissipation and the lower the power supply efficiency. Switch-mode power supplies, however, turn line power on and off as needed, thus avoiding a significant portion of the energy losses associated with linear power supplies. While switch-mode power supplies typically offer higher conversion efficiencies, they are more complicated and difficult to design, and still not widespread in microwave oven applications.

DOE research suggests that inverter-based microwave ovens consume, on average, 0.9 W more in standby mode than non-inverter microwave ovens featuring the same display technology and installation configuration. All inverter-driven units that DOE reverse-engineered originated from one manufacturer and featured linear regulators supplied by an unregulated bus voltage of 18 volts (V). Based on the above discussion, one likely contributing factor to the higher standby power of these units is the high unregulated bus voltage. Additionally, the inverter board powering the magnetron contained a number of microprocessors and other components that appear to be powered continuously. DOE research suggests that the standby power requirements of these microwave ovens could be reduced substantially by reducing the unregulated bus voltage and fitting a disconnect relay/transistor for the inverter control board. For such systems, DOE's design pathways include a relay option to shut down the power to the inverter board altogether when in standby mode. Similarly, the manufacturer could redesign the units to feature a lower unregulated bus voltage of 9 V or 12 V, potentially doubling the efficiency of the linear power supply.

Since the sample of microwave ovens reverse-engineered by DOE research only included two units with a switch-mode power supply, DOE chose to use reference designs published by a major power supply manufacturer instead. The reference power supplies selected by DOE are intended to be drop-in replacements for the current linear power supplies assumed for the baseline. All switch-mode power supplies used in the analysis feature two typical output voltage options (12 V and 5 V) to allow manufacturers to continue using the same relay and microprocessor families as in their present designs.

DOE research suggests that a small percentage of microwave ovens would not be able to achieve baseline standby power levels without incorporating switch-mode power supplies. For example, DOE tore down two microwave ovens in Product Class 2 which featured switch-mode power supplies for which average standby power consumption ranged from 4.1–4.3 W. DOE research suggests that the same microwave oven using a linear power supply would draw about twice as much standby power. For the purpose of the analysis and the potential design pathways, the standby requirements were adjusted accordingly, and the adjusted measurements became an input into the average for all standby measurements of this particular microwave oven sub-type (back-lit LCD, over-the-range, with cooking sensor).

DOE also developed updated costs for power supply options that were based on additional review of past teardowns, inputs from subject matter experts, and analysis of reference designs by a major supplier of switch-mode power supplies. DOE research suggests that the component prices for switch-mode power supplies and traditional linear power supplies are currently nearly equivalent. However, DOE concludes that the industry will likely transition to switch-mode power supplies as it gains more experience with them, causing switching component prices to fall further as volumes increase. Additionally, the adoption of switch-mode power supplies would facilitate standardized control boards for world-wide use, thereby reducing testing and development costs.

For each design pathway for the different product types that can be used to achieve the various standby power levels, DOE determined the corresponding manufacturing cost based on the cost of the components and the typical markups that printed circuit board manufacturers charge for the manufacture and testing of the control boards. Details of the costs at each standby power level are presented in the engineering analysis in section IV.D.3 of this rulemaking, and in chapter 5 of the final rule TSD.

4. Power-Down Options

In the October 2008 NOPR, DOE determined that control strategies are available to allow microwave oven manufacturers to make design tradeoffs between incorporating power-consuming features such as displays or cooking sensors and including a function to cut power to those components during standby mode. DOE found at that time that a large number of microwave ovens incorporating this automatic power-down feature were available in other markets such as Japan. 73 FR 62034, 62051–52 (Oct. 17, 2008).

In response to the October 2008 NOPR, interested parties commented that: 1) the industry lacks data on control board circuitry to allow for a function to cut off power during standby mode, 2) such features must be reliable in high-temperature environments, and 3) DOE had allowed no time for manufacturers to evaluate the viability or feasibility of the proposed technologies. In the February 2012 SNOPR, DOE noted that its research had not identified any technical barrier that would prevent microwave oven manufacturers from successfully integrating such control board circuitry with proper heat shielding and other design elements. DOE stated it was also aware of similar automatic power-down control technologies incorporated in products such as clothes washers and clothes dryers, which utilize an additional transformer-less power supply to provide just enough power to maintain the microcontroller chip while the unit is powered down, resulting in very low standby power levels. Therefore, DOE determined in the February 2012 SNOPR that an automatic power-down feature is technically feasible in microwave applications. 77 FR 8526, 8539 (Feb. 14, 2012).

Commenters on the October 2008 NOPR also requested clarification on whether an on/off switch, particularly a consumer-activated one, would be considered a design option for the purpose of standby mode energy use. Under the mode definitions adopted by the amended microwave oven test procedure from the March 2011 TP Interim Final Rule (76 FR 12825, 12834–37 (Mar. 9, 2011)), a product for which an on/off switch has turned off the display would be considered to be in off mode, unless other energy consuming features associated with standby mode remain energized (i.e., features to facilitate the activation of other modes by remote switch, internal sensor, or timer; or continuous functions, including other information or status displays or sensor-based features). In the latter case, the microwave oven would remain in standby mode even with the display turned off. DOE was not aware at the time of the February 2012 SNOPR of any products incorporating a user-activated control to turn the display on or off, and did not have information to evaluate how often consumers might make use of such a feature. Therefore, DOE determined in the February 2012 SNOPR that it was unable to analyze such a control as a design option. DOE however agreed that such a feature, if provided, could result in decreased energy usage in standby mode or off mode, and noted that manufacturers would not be precluded from incorporating such a feature in their products under the proposed standards. 77 FR 8526, 8539–40 (Feb. 14, 2012). As part of the latest market survey, DOE noted several microwave ovens which allow consumers to turn the display off. DOE notes, however, that the power savings are highly dependent on the type of display, the mechanism by which the display is turned off, and the power supply.

Whirlpool commented that certain features for the microwave oven may not be available if a relay is used to turn off a secondary power supply. Whirlpool provided an example in which the oven cavity light may not turn on if the door is opened while the control is in standby mode. In this scenario, a user may have to press a button to wake up part of the control first or put food in with the light off. According to Whirlpool, consumers would likely find this unacceptable. Whirlpool commented that the cost of adding the relay is under $1 if it is added early in the design process, or as much as $4 if added to existing designs. Whirlpool also commented that monitoring only certain keys on the keypad or monitoring them at a slower rate, especially on glass touch interfaces, can reduce standby mode energy consumption, although a user may have to press an "on" key first before pressing other keys. Whirlpool stated that the additional cost for this feature is approximately $0.25. (Whirlpool, No. 15 at p. 5)

For today's final rule, DOE further examined automatic power-down strategies. DOE notes that there are many design pathways available to implement automatic power-down and re-awakening feature. For example, the microwave oven could be designed to return to a fully-on state every time a consumer opens the door, as there are at least three micro-switches that monitor the state of the door. DOE determined that achieving the max-tech standby power levels would likely require a relay-driven disconnect between line power and the power filtration board typically incorporated in microwave ovens. The automatic power-down module that DOE included for this design option features a 1.5 W switch-mode power supply that can respond to a simple switch signal to power up and enable microwave oven operation via a relay on the power filtration board.[18] If the existing door switches do not suffice, an additional door switch could provide the necessary signal to enable this power supply, for which power consumption is otherwise nearly 0 W. Thus, the microwave oven would power up, enabling a light to be energized, with a delay short enough to be perceived as instantaneous when the consumer opens the door. For such an approach, the costs for automatic power-down increased slightly compared to the costs that were included in the analysis for the February 2012 SNOPR. Details of the costs for this design option are included in the engineering analysis in section IV.D.3 of this rulemaking and in chapter 5 of the final rule TSD.

[18] Please see: http://powerintegrations.com/sites/default/files/PDFFiles/der260.pdf.

D. Engineering Analysis

The purpose of the engineering analysis is to characterize the relationship between the energy use and the cost of standby mode features of microwave ovens. DOE used this standby power/cost relationship as input to the payback period, LCC, and NIA analyses. The engineering analysis provides data that can be used to establish the manufacturer selling price of more efficient products. Those data include manufacturing costs and manufacturer markups.

DOE has identified three basic methods for generating manufacturing costs: (1) the design-option approach, which provides the incremental costs of adding to a baseline model design options that will improve its efficiency (i.e., lower its energy use in standby mode and off mode); (2) the efficiency-level approach, which provides the incremental costs of moving to higher energy efficiency levels (in this case, levels of reduced standby power), without regard to the particular design option(s) used to achieve such increases; and (3) the cost-assessment (or reverse-engineering) approach, which provides "bottom-up" manufacturing cost assessments for achieving various levels of increased efficiency, based on detailed data on costs for parts and material, labor, shipping/packaging, and investment for models that operate at particular efficiency levels. DOE conducted the engineering analysis for this rulemaking using the efficiency-level approach. For this analysis, DOE relied on laboratory testing of representative microwave ovens. DOE supplemented the standby power data with data gained through reverse-engineering analysis and primary and secondary research, as appropriate. To identify microwave oven design options, DOE performed a reverse-engineering analysis on a representative sample of microwave ovens, and presented the details of the engineering analysis in chapter 5 of the February 2012 SNOPR TSD. DOE updated this analysis for today's final rule through additional teardowns and testing that are detailed in chapter 5 of the final rule TSD.

1. Energy Use Metric

In the October 2008 NOPR, DOE explored whether it would be technically feasible to combine the existing measure of energy efficiency during the cooking cycle per use (i.e., active mode) with standby mode and off mode energy use over time to form a single metric, as required by EISA 2007. (42 U.S.C. 6295(gg)(2)(A)) DOE tentatively concluded that, although it may be mathematically possible to combine energy consumption into a single metric encompassing active, standby, and off modes, it is not technically feasible to do so due to the high variability in the cooking efficiency measurement based on the microwave oven test procedure at that time and because of the significant contribution of standby power to overall microwave oven energy use. Therefore, DOE proposed a separate metric to measure standby power as provided by EISA 2007. 73 FR 62034, 62042–43 (Oct. 17, 2008).

Interested parties agreed with DOE's determination that it is not technically feasible to integrate standby mode and off mode energy use into a single efficiency metric with the active mode energy use for microwave ovens, or stated that it would not be practical to do so. One commenter questioned if there were any legal prohibition on establishing a prescriptive standby power standard for microwave ovens, especially since DOE was at that time also proposing a prescriptive standard for other cooking products (i.e., standing pilots in gas cooking products). DOE eliminated the active mode cooking efficiency provisions in the July 2010 TP Final Rule after it determined that those provisions did not produce accurate and repeatable results. 75 FR 42579 (July 22, 2010). Therefore, in the February 2012 SNOPR, DOE determined that the absence of active mode provisions results in a de facto separate energy use descriptor for microwave oven standby mode and off mode energy use. 77 FR 8526, 8540 (Feb. 14, 2012).

DOE did not receive any comments in response to the February 2012 SNOPR regarding the use of a metric for measuring standby mode and off mode energy use separate from any active mode energy use metric for microwave ovens. For the reasons discussed above, DOE is adopting energy conservations based on maximum allowable standby power levels in today's final rule.

2. Standby Power Levels

DOE considered standby mode and off mode standards based on a maximum allowable standby power, in W, for microwave ovens. For the reasons noted previously, the standards do not include off mode power. As discussed in section IV.A, in the October 2008 NOPR, DOE proposed a single product class for microwave ovens that would encompass microwave ovens with and without browning (thermal) elements, but would not include microwave ovens that incorporate convection systems. For the October 2008 NOPR, DOE's analysis estimated the incremental manufacturing cost for microwave ovens having standby power consumption less than the baseline level of 4 W. For the purposes of that analysis, a baseline microwave oven was considered to incorporate an absolute humidity cooking sensor. To analyze the cost-energy use relationship for microwave oven standby power, DOE defined standby power levels expressed as a maximum allowable standby power in W. To analyze the impacts of standards, DOE defined the following four standby power levels for analysis: (1) the Federal Energy Management Program (FEMP) procurement efficiency recommendation; (2) the International Energy Agency's (IEA's) 1-Watt Plan; (3) a standby power level as a gap-fill between the FEMP Procurement Efficiency Recommendation and IEA 1-Watt Plan; and (4) the current maximum microwave oven standby technology (max-tech; i.e., lowest standby power) that DOE determines is or could be commercially available when the energy conservation standards become effective, based on a review of microwave ovens currently on the market worldwide. Table IV-2 provides the microwave oven standby power levels and the reference source for each level that DOE analyzed for the October 2008 NOPR. Due to the definition of only four standby power levels, a TSL was defined for each standby power level and thus standby power levels may also be referred to as TSLs.

Table IV-2 October 2008 NOPR Proposed Microwave Oven Standby Power Levels

Standby Power Level (TSL)	Source	Standby Power (W)
Baseline	Baseline	4.0
1	FEMP Procurement Efficiency Recommendation	2.0
2	Gap Fill	1.5
3	IEA 1-Watt Program	1.0
4	Max Tech	0.02

In response to the October 2008 NOPR, interested parties commented that while the microwave oven standby power TSLs were appropriate, over-the-range microwave ovens that use VFDs would not be able to meet the 1.0 W standard (TSL 3) proposed in the October 2008 NOPR, and that use of other display technologies for over-the-range microwave ovens would reduce consumer utility. Commenters also stated that DOE should conduct additional testing of over-the-range microwave ovens with VFDs, and that manufacturers should be allowed a variety of pathways to reduce standby power consumption to each TSL. 77 FR 8526, 8541 (Feb. 14, 2012).

DOE research for the February 2012 SNOPR established that multiple over-the-range microwave ovens are currently available on the market that incorporate low-power display technologies, including LED displays and LCDs. DOE also determined that manufacturer temperature ratings for the three types of displays are comparable, and that LED displays and LCDs in both countertop and over-the-range microwave ovens offer acceptable consumer utility features, including brightness, viewing angle, and ability to display complex characters. Based on these findings, DOE determined for the February 2012 SNOPR that the TSLs and the associated analyses from the October 2008 NOPR were still valid and would apply to the revised product class encompassing microwave-only ovens (including countertop, built-in, and over-the-range units) and countertop convection microwave ovens. DOE also determined that multiple pathways exist to reach each TSL, based on the selection of the display technology, power supply/control boards, and cooking sensors, and the possible incorporation of algorithms to automatically reduce standby power after a period of inactivity, as stated in the October 2008 NOPR. Id.

Based on the October 2008 NOPR, interested parties also requested additional information about the functionality associated with a microwave oven that meets the max-tech level, including response time from power-down, and whether such a model has as many display features and included all the features of the baseline models. In the February 2012 SNOPR, DOE stated that the max-tech microwave oven standby power level of 0.02 W corresponds to a unit equipped with a default automatic power-down function that disables certain power-consuming components after a specified period of user inactivity. The standby power at max-tech was obtained from a microwave oven on the market at that time in Korea, which incorporated such a feature. 73 FR 62034, 62045 (Oct. 17, 2008). Although DOE did not have operational information on this specific model, DOE analyzed the components necessary to achieve an automatic power-down function, and determined that such a feature would not limit the selection of display technologies or other features that provide consumer utility. DOE analysis suggested that response times for startup would be short enough (less than 1 second) to be acceptable to consumers. 77 FR 8526, 8541 (Feb. 14, 2012).

As noted previously, DOE proposed a separate product class for built-in and over-the-range convection microwave ovens in the February 2012 SNOPR, and therefore also separately analyzed these microwave ovens in the engineering analysis. DOE's analysis estimated the incremental manufacturing cost for built-in and over-the-range convection microwave ovens having standby power consumption less than a baseline value of 4.5 W. To determine that baseline level, DOE measured the standby power consumption of a representative sample of built-in and over-the-range convection microwave ovens on the market at that time. For the purpose of that standby power analysis, a baseline built-in/over-the-range convection microwave oven was considered to incorporate an absolute humidity cooking sensor. In order to analyze the cost-energy use relationship for this product class, DOE defined each standby power level as a maximum allowable standby power in watts. Id.

To determine the maximum allowable standby power at each level in Product Class 2, DOE reverse-engineered a representative sample of built-in and over-the-range convection microwave ovens to analyze the various components that contributed to the standby power consumption of the unit. DOE also measured the standby power consumed by these components individually. In its analysis, DOE observed that the absolute humidity cooking sensors used in these convection microwave ovens on average consume 0.9 W of standby power. For Standby Power Level (SL) 1, DOE determined that standby power can be reduced by incorporating a zero-standby cooking sensor. For SL 2, DOE analyzed potential improvements to the power supply design. DOE noted that microwave ovens at the baseline standby energy use incorporate a linear power supply. DOE measured the standby power consumption of the power supply and found that the transformer used to step down the line input voltage contributes most significantly to the standby power consumption. DOE then performed a power budget analysis to determine the size of the transformer needed to operate a microwave at full load, and the results suggested that replacing the conventional linear power supply with a more efficient switch-mode power supply would reduce the standby power associated with the power supply. DOE thus estimated the standby power for SL 2 based on the improvement associated with changing from a conventional linear power supply with an efficiency of 55 percent to a switch-mode power supply with an efficiency of 75 percent DOE developed this estimate for the efficiency of a switch-mode power supply based on research of such power supply designs for appliance applications. For SL 3, DOE analyzed the impact relays have in determining the size of a power supply. DOE compared the power budget of a control board with electromechanical relays to that with solid state relays, and observed that the power requirement of a control board, with similar input and load, was lower with solid state relays than with electromechanical relays. Therefore, DOE estimated the standby power at SL 3 based on design improvements associated with using more efficient components in a switch-mode power supply that incorporates solid state relays. For SL 4, DOE analyzed an automatic function that turns off power to standby power-consuming components after a certain period of inactivity and that uses a transformer-less power supply to maintain the microcontroller chip while the microwave oven is not powered on. DOE estimated the standby power at SL 4 based on the standby power requirements of the microcontroller chip. 77 FR 8526, 8541–42 (Feb. 14, 2012).

In light of the above analysis, DOE proposed in the February 2012 SNOPR the standby power levels for the two product classes shown in Table IV-3.

Table IV-3 February 2012 SNOPR Proposed Microwave Oven Standby Power Levels

Standby Power Level	Standby Power (W)	
	Microwave-Only and Countertop Convection	Built-In and Over-the-Range Convection
Baseline	4.0	4.5
1	2.0	3.7
2	1.5	2.7
3	1.0	2.2
4	0.02	0.04

DOE did not receive comments on these standby power levels in response to the February 2012 SNOPR. Whirlpool, however, submitted information regarding an off mode power level. Whirlpool stated that it is technically possible to achieve off mode power consumption below 0.1 W, but that it would add significant cost, as well as restrict design choices and product functionality, both of which would be unacceptable to the consumer. Whirlpool commented that it has been complying with a 1 W microwave oven off mode limit in Europe for several years, which will be reduced to 0.5 W in 2013. According to Whirlpool, most of its European built-in microwave ovens currently consume 0.6–0.9 W in off mode. Whirlpool expects to reduce this power consumption to 0.3–0.45 W by the end of 2012, noting the following contributors that prevent off mode power consumption from being 0 W:

- Certain circuitry must be powered at all times to "wake up" the product (power supply circuits, keyboard scanning, and micro controller(s)).
- A mains filter is required to comply with electromagnetic interference (EMI) regulations. Such filters include certain capacitors that must be discharged to prevent electric shock if the user touches the terminals of the mains plug after unplugging the appliance from the wall. There is normally a "bleed resistor"

in the filter design to discharge the capacitors, which consumes power as soon as the appliance is connected to the mains.

- The filter itself has certain losses, and normally it is not possible to disconnect the filter in standby mode or off mode, as that would impact product function in active mode.

(Whirlpool, No. 15 at p. 3)

DOE considered these comments, but noted that Whirlpool's inclusion of circuitry that is powered at all times to sense a user input and "wake up" indicates that the product is operating in standby mode, as these components comprise a sensor to activate other mode(s). Furthermore, DOE concludes that this particular operating state is equivalent to the automatic power-down function associated with SL 4. DOE research suggests that the filter circuitry referenced by Whirlpool serves primarily to reduce the interference caused by the magnetron and its power supply, and that the power supply for at least some logic components inside a microwave oven do not necessarily have to be placed 'behind' the filtration board. Instead, these logic components could derive their inputs directly from line power and disconnect the filtration board and the rest of the microwave oven from line power until a need arises. Additionally, DOE notes that at least one microchip manufacturer has commercialized a product to eliminate power losses associated with bleed resistors using a single component that isolates the bleed resistor(s) as long as line power is connected.

Past reverse-engineering by DOE has uncovered several strategies to minimize standby power requirements. One option is to have a drop-capacitor power supply feeding a low-power circuit whose sole function is to sense user interaction and to then activate the (much higher-capacity) regular linear power supply for the logic components as needed. Thus, the transformer losses of the linear power supply are avoided. Another option is to have a switch-mode power supply that normally is 'asleep' wake and activate the rest of the controls when the door is opened. The automatic power-down approach at SL 4 chosen by DOE consists of such a 1.5 W-capable power supply, a door switch, assorted wiring, and a relay that isolates the microwave filtration board (and hence the rest of the microwave oven) from line power whenever it is deep sleep mode.

In addition, DOE's current research indicates that conventional linear power supplies have efficiencies of 40 percent or less, as compared to the 55-percent efficiency that was estimated for the February 2012 SNOPR. DOE accounted for this relative increase in efficiency improvement when changing to a switch-mode power supply by considering different design pathways to reach the standby power levels associated with this design option.

Therefore, for the reasons discussed above for the standby power levels proposed in the February 2012 SNOPR, DOE has retained the same levels for the final rule analysis.

3. Manufacturing Costs

In this rulemaking, DOE determined the estimated manufacturing cost for microwave ovens at each standby power level. The manufacturing costs are the basis of inputs for other analyses, including the LCC, national impact, and GRIM analyses.

For microwave oven standby mode and off mode energy use, DOE estimated a cost-energy use relationship (or "curve") in the form of the incremental manufacturing costs associated with incremental reductions in baseline standby power. In the October 2008 NOPR, DOE determined that microwave oven standby power depends on, among other factors, the display technology used, the associated power supplies and controllers, and the presence or lack of a cooking sensor. From testing and reverse engineering, DOE observed correlations between (1) specific components and technologies, or combinations thereof, and (2) measured standby power. DOE obtained preliminary incremental manufacturing costs associated with standby power levels by considering combinations of those components as well as other technology options identified to reduce standby power. In the October 2008 NOPR, DOE presented manufacturing cost estimates based on quotes obtained from suppliers, interviews with manufacturers, interviews with subject matter experts, research and literature review, and numerical modeling. 73 FR 62034, 62055 (Oct. 17, 2008). They are shown in Table IV-4. As noted above, for the October 2008 NOPR, DOE analyzed a single product class for microwave ovens encompassing microwave ovens with and without browning (thermal) elements, but not including microwave ovens that incorporate convection systems.

Table IV-4 October 2008 NOPR Proposed Microwave Oven Standby Power Incremental Manufacturing Costs

Standby Power Level	Standby Power (W)	Incremental Cost (2007$)
Baseline	4.0	NA
1	2.0	$0.30
2	1.5	$0.67
3	1.0	$1.47
4	0.02	$5.13

DOE noted that it had observed several different cooking sensor technologies. Follow-on testing after the December 2007 public meeting showed that some sensors were zero-standby (relative humidity) cooking sensors. During the MIA interview for the October 2008 NOPR, one manufacturer indicated that its supplier of cooking sensors had developed zero-standby absolute humidity cooking sensors that would have the same manufacturing cost as the higher-standby power devices they would replace. Based on the number of available approaches to zero-standby cooking sensors from which manufacturers can choose, DOE concluded at that time that all manufacturers can and likely would implement zero-standby cooking sensors by the effective date of standby mode and off mode energy conservation standards, and maintain the consumer utility of a cooking sensor without affecting unit cost. DOE also concluded that a standard at standby power levels of 1 or 2 W would not affect consumer utility, because all display types could continue to be used. At SL 3 for VFDs and SL 4 for all display technologies, DOE analysis suggested the need for a separate controller (automatic power-down) that automatically turns off all other power-consuming components during standby mode. Such a feature would affect the consumer utility of having a clock display only if the consumer could not opt out of auto power-down. 73 FR 62034, 62055 (Oct. 17, 2008).

In response to the October 2008 NOPR, interested parties questioned the source of the incremental cost data associated with each standby power level, the need for incremental manufacturing costs to reflect both a one-time cost as well as the possibility of multiple paths to achieve each TSL, and questioned the cost associated with upgrading power supplies to reach TSL 3.

In the February 2012 SNOPR, DOE noted that it had developed incremental cost estimates for each standby power level using the design-option approach, and that one-time costs are evaluated as part of the MIA. DOE estimated costs for each of the components and technologies based on quotes from component suppliers, interviews with manufacturers, interviews with subject matter experts, research and literature review, and numerical modeling. The incremental manufacturing costs for each standby power level were determined by considering different combinations of these components as well as other technology options identified to reduce standby power. DOE stated that it was aware that manufacturers may employ a number of strategies to achieve the different standby power levels. The estimated manufacturing costs for each standby power level represent the approach DOE determined manufacturers would most likely use to achieve the standby power at each level. For each level, DOE assumed manufacturers would implement design options with the lowest associated manufacturing cost. If DOE determined there were multiple paths with similar costs to reach a certain level, it assumed manufacturers would be equally likely to choose either strategy. 77 FR 8526, 8543 (Feb. 14, 2012).

Interested parties also commented that the analysis did not consider consumer education costs on proper operation of microwave ovens with automatic power-down features, and that the manufacturing costs did not include cost implications on appliance manufacturers for including variables such as component readability and/or utility. DOE observed that it had considered the potential conversion costs associated with changes to consumer utility and reliability in the MIA. However, as previously discussed, DOE found no reliability or consumer utility concerns with switching from VFD to LCD or LED displays. Through discussions with manufacturers and OEMs, DOE determined that zero-standby cooking sensors could be implemented with no effect on consumer utility or reliability. DOE noted that an automatic power-down feature required at SL 3 for VFDs and at SL 4 for all display types could affect consumer utility, and considered these impacts in the selection of the proposed standards. Id.

Therefore, in the February 2012 SNOPR, DOE determined that the standby power levels and corresponding incremental manufacturing costs presented in the October 2008 NOPR remained fundamentally valid for the microwave-only and countertop convection microwave oven product class. DOE was unaware of any technologies that became available after the October 2008 NOPR that would alter the incremental cost for any standby power level. However, the costs presented in the October 2008 NOPR were in 2008 dollars. DOE scaled these costs to 2010 dollars using the producer price index (PPI) to reflect more current values.[19] The relevant PPI for microwave ovens is a subset of the household cooking appliance manufacturing industry, specifically for electric (including

[19] Information on the PPI databases can be found at http://www.bls.gov/ppi/data.htm. (Last accessed December 2012.)

microwave) household ranges, ovens, surface cooking units, and equipment. Thus, DOE revised the incremental costs for each standby power level for Product Class 1, scaled to 2010 dollars, as presented in Table IV-5.

Table IV-5 February 2012 SNOPR Proposed Microwave Oven Product Class 1 Standby Power Incremental Manufacturing Costs

Standby Power Level	Standby Power (W)	Incremental Cost (2010$)
Baseline	4.0	NA
1	2.0	$0.27
2	1.5	$0.60
3	1.0	$1.31
4	0.02	$4.58

DOE conducted additional analyses on a test sample of 13 convection microwave ovens for the February 2012 SNOPR to evaluate the built-in and over-the-range convection microwave oven product class. DOE again used the design-option approach to determine the incremental manufacturing costs of convection microwave ovens for each standby power level.

As discussed in the February 2012 SNOPR, DOE estimated the incremental cost associated with reductions in baseline standby power of built-in and over-the-range convection microwave ovens. DOE performed engineering teardowns and control board cost analyses to determine the cost of the baseline control board used in these units. DOE estimated the cost associated with each standby power level by using quotes from various component suppliers to determine the cost of the components used in each design option. 77 FR 8526, 8543 (Feb. 14, 2012).

For SL 1, DOE estimated that the manufacturing cost of a zero-standby cooking sensor would be the same as that of the cooking sensor with high standby power. To estimate the manufacturing cost for SL 2, DOE used reverse engineering to determine the cost of the components used in a design of a switch-mode power supply capable of delivering the same output power as the baseline conventional linear power supply. In its analysis for the manufacturing cost of SL 3, DOE determined the cost of the components used to design a control board with a switch-mode power supply and solid state relays capable of driving the same loads as the electromechanical relays. DOE estimated the manufacturing cost for SL 4 based on the cost of the components needed to design an automatic power-down function that uses a transformer-less power supply. The results of these analyses for the February 2012 SNOPR are presented in Table IV-6.

Table IV-6 February 2012 SNOPR Proposed Microwave Oven Product Class 2 Standby Power Incremental Manufacturing Costs

Standby Power Level	Standby Power (W)	Incremental Cost (2010$)
Baseline	4.5	NA
1	3.7	$0
2	2.7	$2.29
3	2.2	$9.44
4	0.04	$5.18

Whirlpool stated that the incremental manufacturing costs for SL 3 would consist only of component costs and would not require additional processing and labor costs. Whirlpool estimated the total incremental cost at SL 3 as the sum of the costs it provided for each of the design options it had commented on, and stated that the largest contributor would be the cost of changing to a switch-mode power supply for those microwave ovens that don’t currently have them. (Whirlpool, No. 15 at pp. 5–6) DOE observes that Whirlpool did not provide estimated costs for a implementing a zero-standby power cooking sensor or a switch-mode power supply, although, as noted previously in section IV.C.3 of this rulemaking, Whirlpool agreed with DOE's estimate for the cost associated with a switch-mode power supply for a new product design but stated that the cost would be too low for existing designs. The sum of the upper range of estimated costs which Whirlpool did provide were approximately $5.00, which is greater than the costs DOE estimated at SL 3 for Product Class 1 and approximately half DOE's estimate for Product Class 2.

DOE, therefore, expanded its evaluation of manufacturing costs to consider all of the design pathways it had identified for each product type and class. DOE aggregated and weighted the cost results from the design pathway studies using the distribution of features by stock-keeping-units (SKUs). For example, about 22 percent of microwave oven SKUs in Product Class 1 incorporate a VFD and a cooking sensor. DOE also conducted additional research and interviews with suppliers to update the component costs for the individual design options. The resulting updated incremental manufacturing costs for both product classes are presented in Table IV-7 and Table IV-8. Because DOE's analysis for today's final rule was based on a more comprehensive model database, the greater sample size combined with the updated component cost estimates and significantly more design pathways affected the manufacturing cost results. For example, at the higher efficiency levels, the pathway for some product types requires automatic power-down at SL 3 rather than SL 4. In addition, DOE determined that for several product types in Product Class 2, the baseline model already incorporates a switch-mode power supply. As a result, the weighted average cost at SL 3 is lower than proposed in the February 2012 SNOPR. For more details of the manufacturing costs developed as part of the engineering analysis, see chapter 5 of the final rule TSD.

Table IV-7 Final Rule Microwave Oven Product Class 1 Standby Power Incremental Manufacturing Costs

Standby Power Level	Standby Power (W)	Incremental Cost (2011$)
Baseline	4.0	NA
1	2.0	$0.26
2	1.5	$0.38
3	1.0	$3.28
4	0.02	$6.23

Table IV-8 Final Rule Microwave Oven Product Class 2 Standby Power Incremental Manufacturing Costs

Standby Power Level	Standby Power (W)	Incremental Cost (2011$)
Baseline	4.5	NA
1	3.7	$0.06
2	2.7	$0.08
3	2.2	$5.01
4	0.04	$5.86

E. Life Cycle Cost and Payback Period Analysis

In response to the requirements of section 325(o)(2)(B)(i) of the Act, DOE conducted LCC and PBP analyses to evaluate the economic impacts of possible amended energy conservation standards for consumers of microwave ovens having standby mode and off mode features. (42 U.S.C. 6295(o)(2)(B)(i)) DOE conducted the analyses using a spreadsheet model, which is described in chapter 8 of the final rule TSD.)

The LCC represents the total consumer expense over the life of a product, including purchase and installation expenses and operating costs (energy expenditures, repair costs, and maintenance costs). The PBP is the number of years it would take for the consumer to recover the increased costs of a higher efficiency product through energy savings. To calculate the LCC, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product. DOE forecasts the change in LCC and the change in PBP associated with a given efficiency level relative to the base-case product efficiency. The base-case forecast reflects the market in the absence of amended mandatory energy conservation standards. As part of the LCC and PBP analyses, DOE develops data that it uses to establish product prices, annual energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates.

For the February 2012 SNOPR, DOE developed a consumer sample for microwave ovens having standby mode and off mode features from EIA's 2005 Residential Energy Consumption Survey (RECS). For today's final rule, it developed a consumer sample from the 2009 RECS. It used this sample to establish the variability and uncertainty in microwave oven electricity use.

The variability in electricity pricing was characterized by incorporating regional energy prices. DOE calculated the LCC associated with a baseline microwave oven having standby mode and off mode features. To calculate the LCC savings and PBP associated with products that could meet potential amended energy conservation standards, DOE substituted the baseline unit with more efficient designs.

Table IV-9 summarizes the approaches and data DOE used to derive the inputs to the LCC and PBP calculations for the October 2008 NOPR, and the changes it made for today's final rule. DOE did not introduce changes to the LCC and PBP analysis methodology described in the October 2008 NOPR. As the following sections discuss in more detail, however, DOE revised some of the inputs to the analysis. Chapter 8 of the final rule TSD contains a detailed discussion of the methodology utilized for the LCC and PBP analysis as well as the inputs developed for the analysis.

Table IV-9 Summary of Inputs and Key Assumptions in LCC and PBP Analyses

Inputs	October 2008 NOPR	Changes for the SNOPR	Changes for the Final Rule
Affecting Installed Costs			
Product Cost	Derived by multiplying manufacturer cost by manufacturer, distributor markups and sales tax.	Used experience curve fits to forecast a price scaling index to forecast product costs.	Increased the geographic resolution of sales tax data.
Affecting Operating Costs			
Annual Energy Use	Annual energy use determined from the annual usage (average daily use cycles).	No change.	No change.
Energy Prices	Electricity: Updated using EIA's 2006 Form 861 data. Variability: Regional energy prices determined for 13 regions.	Electricity: Updated using EIA's 2009 Form 861 data. Variability: No change.	Electricity: Updated using EIA's 2010 Form 861 data. Variability: Energy prices determined by RECS Reportable Domain (27 individual States or State groupings).
Energy Price Trends	Energy: Forecasts updated with EIA's Annual Energy Outlook 2008 (AEO 2008).	Reference Case, High Growth, and Low Growth forecasts updated with EIA's AEO 2010 May Release.	Reference Case, High Growth, and Low Growth forecasts updated with EIA's AEO 2012 June Release.
Repair and Maintenance Costs	Assumed no repair or maintenance costs.	No change.	No change.
Affecting Present Value of Annual Operating Cost Savings			
Product Lifetime	Estimated using survey results from RECS (1990, 1993, 1997, 2001, 2005) and the U.S. Census American Housing Survey (2005, 2007), along with historic data on appliance shipments.	No change.	Updated LCC lifetime methodology to reflect methodology used in the NIA
Discount Rates	Variability: Characterized using Weibull probability distributions.	No change.	No change.
Affecting Installed and Operating Costs			
Compliance Date of New Standard	2012.	2014.	2016.

1. Product Costs

To calculate the product costs paid by microwave oven purchasers, DOE multiplied the manufacturing product costs (MPCs) developed from the engineering analysis by industry markups to derive manufacturers' selling prices (MSPs). The MSPs in turn are multiplied by supply chain markups (along with sales taxes) to estimate the initial cost to the consumer. DOE used the same supply chain markups for today's final rule that were developed for the October 2008 NOPR. These include separate markups on the baseline MSP and the incremental cost of each higher efficiency level considered.

AHAM submitted an attachment to its comment in which Shorey Consulting argues against using a lower incremental retail markup on the added costs of higher-efficiency products. (AHAM, No. 16, Attachment 1; GE, No. 19 at p. 1) Shorey Consulting claims that DOE ignores relevant, consistent and reliable data and attempts to apply pure, unconfirmed theory (whose validity and applicability Shorey Consulting questions). Shorey used retail industry data to measure competition in appliance retailing and argues that DOE's approach requires a level of competition that does not exist. Stating that several decades of experience provide information about what actually happens at the retail level, Shorey argues that DOE should base its analyses on actual practices rather than theory. It notes that retailers have experience with the markups on

products in the post-standards situation. It states that to the extent that manufacturers are aware of the markup practices at the retail level, those practices seem consistent with the long-term pattern of stable gross margins.

DOE continues to believe that microwave oven retail markets are reasonably competitive, so that an increase in the manufacturing cost of microwave ovens is not likely to contribute to a proportionate rise in retail profits, as would be expected to happen without incremental markups. DOE believes that Shorey's measure of competition is inaccurate for microwave ovens, primarily because it assumes that the market shares for major appliances adequately represent the market shares for microwave ovens. Microwave ovens are sold in some retail channels not included in Shorey's list of the major appliance retailers (e.g., drugstores), as well as on the Internet.

In response to Shorey's comments regarding the lack of empirical evidence underlying DOE's markup analysis, DOE has previously examined historical retail price data for several appliances.[20] The data do not support the use of a constant markup. DOE acknowledges that detailed information on actual retail practices would be helpful in evaluating markups on products after appliance standards take effect. DOE currently is collecting information that would shed more light on actual practices by retailers selling microwave ovens and other appliances. To date, the limited evidence DOE has collected provides no clear answer, but it does not support the idea that retail profits rise as a result of efficiency standards. Thus, DOE continues to use an approach to markups that is

[20] Larry Dale, et al. "Retrospective Evaluation of Appliance Price Trends," Energy Policy 37 (2009). pp. 597–605.

consistent with economic theory of firm behavior in competitive markets. See chapter 6 of the final rule TSD for additional information.

In the February 2012 SNOPR, DOE examined historical PPIs for electric cooking equipment generally and microwave ovens specifically and found a consistent, long-term declining real price trend. Consistent with the method used in other rulemakings, DOE used experience curve fits to develop a price scaling index to project product costs for this rulemaking. For the LCC and PBP analysis, the experience rate (defined as the fractional reduction in price expected from each doubling of cumulative production) is based on historical PPI data for electric cooking products from the Bureau of Labor Statistics,[21] along with a time-series of annual shipments for 1969–2009 for electric household cooking products.

AHAM and GE continue to oppose the use of experience curves. (AHAM, No. 16 at p. 4; GE, No. 19 at p. 1) AHAM submitted an attachment prepared by Shorey Consulting that presents arguments against using experience curves to project product costs. Shorey states that DOE has not rebutted the comments on the lack of theoretical foundation for its experience curve analysis made by Shorey Consulting and AHAM in response to DOE's Notice of Data Availability (NODA) and Request for Comment Regarding Equipment Price Forecasting in Energy Conservation Standards Analysis. 76 FR 9696 (Feb. 22, 2011). It claims that DOE has identified some data (whose reliability

[21] Although electric cooking products represent a higher level of aggregation than microwave ovens only, because no PPI data specific to microwave ovens were available, DOE used PPI data for electric cooking products as representative of microwave ovens. Additionally, shipments of microwave ovens have become a significant part of total shipments of electric household cooking products since 1975.

and relevance Shorey Consulting continues to question) and tries to apply it even though its own sources question the theoretical underpinnings of such usage. Shorey recommends that DOE substitute a sensitivity analysis for experience curve costing in the national impact analysis. (AHAM, No. 16, Attachment 1)

DOE responded to the comments on the NODA by AHAM and other interested parties in the final rule for energy conservation standards for refrigerators, refrigerator-freezers, and freezers. 76 FR 57549 (Sep. 15, 2011). There is an extensive literature, spanning several decades, supporting the use of experience curves for a broad range of products. As discussed in a recent publication by researchers at Lawrence Berkeley National Laboratory,[22] the approach used by DOE is consistent with the experience curves that have been empirically demonstrated in numerous studies. In addition, well-known energy models such as NEMS already incorporate experience curves. DOE is not aware of the sources to which Shorey refers. DOE believes that the specific sensitivity analysis proposed by Shorey would be impractical. It also seems unnecessary because DOE incorporates sensitivity analysis in its current methodology.

Shorey also suggests that DOE not use the experience effect for the period preceding the compliance date of standards because the engineering analysis uses cost projections that already have some effects of production cost reductions built into them. The costs DOE developed in the engineering analysis for microwave ovens through teardowns and cost modeling reflect the year of analysis, not the year of compliance.

---

[22] Desroches, L.-B., K. Garbesi, C. Kantner, R. Van Buskirk, H.-C. Yang (2012), "Incorporating Experience Curves in Appliance Standards Analysis," accepted to Energy Policy. http://dx.doi.org/10.1016/j.enpol.2012.09.066

(AHAM, No. 16, Attachment 1) DOE estimated costs for each of the components and technologies that contribute to standby power based on quotes from suppliers, interviews with manufacturers, interviews with subject matter experts, review of research and literature, and numerical modeling. Preliminary incremental manufacturing costs associated with various standby levels then were obtained by considering combinations of those components as well as other technology options identified to reduce standby power. Manufacturer interviews were conducted also to obtain greater insight into design strategies and the associated costs for improving efficiency. Based on the incremental manufacturing costs at various standby power levels, DOE developed cost-efficiency curves. DOE did not specifically solicit information regarding manufacturing costs at the time of the compliance date of any standby power standards. Furthermore, the AHAM data requests and manufacturer interview guides used in recent energy conservation standards rulemakings for other residential products, such as dishwashers, dehumidifiers, clothes washers, clothes dryers, and room air conditioners, reveal that incremental costs were solicited from manufacturers in a manner consistent with the approach taken in the microwave oven standby power standards rulemaking. Because the costs estimated in the engineering analysis are based on the year of analysis, DOE believes it is appropriate to apply the derived experience rate beginning the following year, as was done for the February 2012 SNOPR and today's final rule.

Shorey also questioned DOE's use of the PPI for electric cooking equipment in the experience curve derivation for microwave ovens. Shorey notes that the PPI for electric cooking equipment does not measure a significant number of microwave ovens, since microwave ovens represent only 2 to 3 percent of the shipments and value of electric cooking products. In addition, approximately 99 percent of microwave ovens are imported and thus excluded from the PPI. (AHAM, No. 16, Attachment 1)

In response, DOE acknowledges that there is no PPI category specific to microwave ovens. DOE investigated an experience rate using price data specific to microwave ovens, but did not use that as the default case because the estimate is not particularly robust given the limited data. Instead, DOE used the most disaggregated category that includes microwave ovens, which is electric cooking equipment. Although this approach may introduce some inaccuracy, it more closely reflects real price trends (as indicated by the price data specific to microwave ovens) than an assumption of no price trend. The paper cited above explores the role of imports and how the PPI compares to retail prices have been explored for several appliances. It found that PPI data track retail prices in a manner that lends confidence to the use of PPI data when constructing experience curves. Although the PPI does not include imports, the trend does not appear to be systematically biased compared to retail prices (for either imports or domestically produced products) for the appliances analyzed.

In summary, DOE believes that its use of the experience curve approach to estimate a future price trend for microwave ovens is reasonable and appropriate. For the final rule, DOE made minor changes to its calculation method to match the approach used in other recent rulemakings. A more detailed discussion of DOE’s price trend modeling and the various sensitivity analyses is provided in appendix 8-C of the final rule TSD.

For the October 2008 NOPR, DOE analyzed only countertop models of microwave ovens and considered installation costs to be zero. For today's final rule, DOE analyzed both countertop and over-the-range microwave ovens and considered both installation and incremental installation costs to be zero.

2. Annual Energy Consumption

DOE determined the annual energy consumption of the standby mode and off mode of microwave ovens by estimating the number of hours of operation throughout the year and assuming that the unit would be in standby mode or off mode the rest of the time. In the October 2008 NOPR, DOE determined the average hours of operation for microwaves to be 71 hours per year. DOE has no reason to believe that this number has changed.

To estimate variability in microwave oven hours of operation for each household in the RECS sample, DOE calculated a relative usage factor (with an average of 1.0) for each household. DOE multiplied the reported number of hot meals by the frequency of microwave oven usage and then normalized the result as an index value. DOE then multiplied the relative usage factor for each household by the average of 71 hours per year.

Finally, DOE subtracted the number of calculated operating hours from the total number of hours in a year and multiplied that difference by the standby mode and off mode power usage at each efficiency level to determine annual standby mode and off mode energy consumption.

AHAM and GE continue to strongly oppose DOE's reliance on RECS for these analyses, noting that it is difficult to compare the results to the energy use measured in a controlled test procedure situation. (AHAM, No. 16 at p. 4; GE, No. 19 at p. 1) Whirlpool claimed that use of the RECS data in calculation of the LCC and PBP is highly suspect because the sample size would be too small to be statistically valid. (Whirlpool, No. 15 at p. 2)

The purpose of the energy use analysis is to estimate the range of product energy use in the field, not the energy use in a controlled test procedure situation. By so doing, DOE is able to estimate how the energy savings would vary among households for each considered efficiency level. This allows DOE to develop a more accurate characterization of the impacts of potential standards on consumers, as required by EPCA. (42 U.S.C. 6295(o)(2)(B)(i)(I)) The sample that DOE used contained 11,616 records and is large enough to provide statistically valid results for microwave oven utilization.

3. Energy Prices

DOE estimated residential electricity prices for each of the 27 geographic areas used in RECS 2009 based on data from EIA Form 861, "Annual Electric Power Industry

Report." DOE calculated an average residential electricity price by first estimating an average residential price for each utility, and then calculating an average price by weighting each utility having customers in a region by the number of residential customers served in that region. The calculations for today's final rule used the most recent available data (2010).

To estimate trends in electricity prices for the supplemental notice, DOE used the price forecasts in EIA's AEO 2010. For today's final rule, DOE used the forecasts in AEO 2012. To arrive at prices in future years, DOE multiplied the average prices described above by the forecast of annual average price changes in AEO 2012. Because the AEO forecasts prices only to 2035, DOE followed past guidelines that EIA provided to the Federal Energy Management Program and used the average rate of change during 2020–2035 to estimate price trends beyond 2035.[23]

AHAM, GE, and Whirlpool objected to the inclusion of cap-and-trade program impacts in the energy price forecasts in the February 2012 SNOPR because there are no tangible facts upon which to base an analysis. (AHAM, No. 16 at p. 4; GE, No. 19 at p. 1; Whirlpool, No. 15, p. 2) The electric power sector module in the NEMS used for AEO 2012 Reference Case accounts for estimated impacts of the Northeast Regional Greenhouse Gas Initiative and the cap-and-trade program being implemented in California as a result of California Assembly Bill 32. DOE believes that, given the known constraints on CO_2 emissions associated with these programs, the electric power sector

[23] The spreadsheet tools used to conduct the LCC and PBP analysis allow users to select energy price forecasts for either the AEO's High economic growth case or Low economic growth case to estimate the sensitivity of the LCC and PBP to different energy price forecasts.

module in NEMS provides a reasonable estimate of how electricity providers would behave with respect to power plant construction and dispatch, which in turn would affect electricity prices in a small way. Thus, DOE believes that the energy price forecasts used for the final rule are appropriate.

4. Repair and Maintenance Costs

Repair costs are those associated with repairing or replacing components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. For the October 2008 NOPR, DOE did not include repair or maintenance costs in its analyses by assuming higher efficient products do not warrant increased costs for repair or maintenance. DOE maintained the same approach for this final rule.

5. Product Lifetime

Because the lifetime of appliances varies depending on utilization and other factors, DOE develops a distribution of lifetimes from which specific values are assigned to the appliances in the samples. DOE conducted an analysis of microwave oven lifetimes in the field based on a combination of shipments data and RECS data on the ages of the microwave ovens reported in the household stock. The analysis yielded an estimate of mean age for microwave ovens of approximately 10.9 years. It also yielded a survival function that DOE incorporated as a probability distribution in its LCC analysis. See chapter 8 of the final rule TSD for further details on the method and sources DOE used to develop microwave oven lifetimes.

6. Discount Rates

In the calculation of LCC, DOE applies discount rates to estimate the present value of future operating costs. DOE estimated a distribution of residential discount rates for microwave ovens. See chapter 8 in the final rule TSD for further details on the development of consumer discount rates.

To establish residential discount rates for the LCC analysis in the October 2008 NOPR and today's final rule, DOE identified all debt or asset classes that consumers might use to purchase household appliances, including household assets that might be affected indirectly. It estimated average percentage shares of the various debt or asset classes for the average U.S. household using data from the Federal Reserve Board's "Survey of Consumer Finances" (SCF) for 1989, 1992, 1995, 1998, 2001, 2004, and 2007. Using the SCF and other sources, DOE then developed a distribution of rates for each type of debt and asset to represent the rates that may apply in the year in which new standards would take effect. DOE assigned each sample household a specific discount rate drawn from one of the distributions. The average rate across all types of household debt and equity, weighted by the shares of each class, is 5.1 percent. DOE used the same approach for today's final rule.

7. Compliance Date of New Standards

The compliance date is the future date when parties subject to the requirements of a new energy conservation standard must begin compliance. For the October 2008

NOPR, DOE assumed that any new standards adopted in this rulemaking would become effective in March 2012, 3 years after the month when it expected the final rule would be published in the Federal Register. Today's final rule is being published with new standards requiring compliance 3 years later. Thus, DOE calculated the LCC for appliance consumers as if they would purchase new products in 2016.

8. Product Energy Efficiency in the Base Case

For the LCC and PBP analysis, DOE analyzes higher efficiency levels relative to a base case (i.e., the case without new energy conservation standards). However, some consumers may already purchase products having efficiencies greater than the baseline product levels. Thus, to accurately estimate the percentage of consumers that would be affected by a particular standard level, DOE estimates the distribution of product efficiencies that consumers are expected to purchase under the base case. DOE refers to this distribution of product energy efficiencies as a base-case efficiency distribution. For the October 2008 NOPR and today's final rule, DOE used recent shares of available models at specific standby power levels to establish the base-case efficiency distributions. Table IV-10 presents the market shares of the standby power levels in the base case for standby mode and off mode energy use of microwave ovens.

Table IV-10 Microwave Ovens: Base-Case Efficiency Market Shares

	Product Class 1		**Product Class 2**	
Level	**Standby Power (W)**	**Share (%)**	**Standby Power (W)**	**Share (%)**
Baseline	4.00	46.2	4.50	100.0
TSL1*	2.00	34.6	3.70	0.0
TSL 2	1.50	19.2	2.70	0.0
TSL 3	1.00	0.0	2.20	0.0
TSL 4	0.02	0.0	0.04	0.0

* TSL = Trial Standard Level

9. Inputs to Payback Period Analysis

The PBP is the amount of time (expressed in years) it takes the consumer to recover the additional installed cost of a more efficient product through operating cost savings, compared to the baseline product. The simple payback period does not account for changes in operating expenses over time or the time value of money. The inputs to the PBP calculation are the total installed cost of the product to the consumer for each efficiency level and the annual (first-year) operating expenditures for each efficiency level. For the October 2008 NOPR and today's final rule, the PBP calculation uses the same inputs as the LCC analysis, except that energy price trends and discount rates are not needed.

10. Rebuttable-Presumption Payback Period

As noted above, EPCA, as amended (42 U.S.C. 6295(o)(2)(B)(iii)) establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the test procedure in place for that standard. For each TSL, DOE determined the value of the first year's energy savings by calculating the quantity of those savings in accordance with DOE's test procedure, and multiplying that amount by the average energy price projection for the year in which a new standard first would be effective—in this case, 2016.

F. National Impact Analysis – National Energy Savings and Net Present Value Analysis

1. General

DOE's NIA assesses the national energy savings, as well as the national NPV, of total consumer costs and savings expected to result from new or amended standards at specific efficiency levels. DOE applied the NIA spreadsheet to calculate energy savings and NPV, using the annual energy consumption and total installed cost data from the LCC analysis. DOE forecasted the energy savings, energy cost savings, product costs, and NPV for the two product classes from 2016 to 2045. The forecasts provide annual and cumulative values for all four parameters. In addition, DOE incorporated into its NIA spreadsheet the capability to analyze sensitivity of the results to forecasted energy prices and product efficiency trends. Table IV-11 summarizes the approach and data DOE used to derive the inputs to the NES and NPV analyses for the October 2008 NOPR, February 2012 SNOPR, and the changes made in the analyses for today's final rule. A discussion of the 2008 inputs and the changes follows. (See chapter 10 of the final rule TSD for further details.)

Table IV-11 Approach and Data Used to Derive Inputs to the National Energy Savings and NPV Analyses

Inputs	2008 NOPR Description	Changes for the 2012 SNOPR	Changes for the Final Rule
Shipments	Annual shipments from shipments model.	See Table IV.12	See Table IV-12
Compliance Date of Standard	2012.	2014.	2016.
Base-Case Forecasted Efficiencies	Shipment-weighted efficiency (SWEF) determined in 2005. SWEF held constant over forecast period.	No change.	No change.
Standards-Case Forecasted Efficiencies	Analyzed as one product class. Roll-up scenario used for determining SWEF in the year that standards become effective for each standards case. SWEF held constant over forecast period.	Analyzed as two product classes. Roll-up scenario used for determining SWEF in the year that standards become effective for each standards case. SWEF held constant over forecast period.	No change.
Annual Energy Consumption per Unit	Annual weighted-average values as a function of SWEF.	No change.	No change.
Total Installed Cost per Unit	Annual weighted-average values as a function of SWEF.	Incorporated learning rate to forecast product prices.	Product price forecasting updated to reflect most current methodology.
Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy (and water) prices.	No change.	No change.
Repair Cost and Maintenance Cost per Unit	Incorporated changes in repair costs as a function of standby power.	No change.	No change.
Escalation of Energy Prices	AEO 2008 forecasts (to 2030); extrapolated to 2042.	Updated to AEO 2010 May release forecasts (to 2035); extrapolated to 2043.	Updated to AEO 2012 June release forecasts (to 2035); extrapolated to 2045.
Energy Site-to-Source Conversion	Conversion varies yearly and is generated by DOE/EIA's NEMS program (a time-series conversion factor; includes electric generation, transmission,	No change.	No change.

Inputs	2008 NOPR Description	Changes for the 2012 SNOPR	Changes for the Final Rule
	and distribution losses).		
Discount Rate	3 and 7 percent real.	No change.	No change
Present Year	Future expenses discounted to 2007.	Future expenses discounted to 2011.	Future expenses discounted to 2013.

2. Shipments

The shipments portion of the NIA spreadsheet is a model that uses historical data as a basis for projecting future shipments of the products that are the subject of this rulemaking. In projecting microwave oven shipments, DOE accounted for two market segments: (1) new construction; and (2) replacement of failed products. Because shipments for new construction and replacements were not enough to account for all product shipments, DOE developed another market segment to calibrate its shipments model. In addition to normal replacements, DOE's shipments model also assumed that a small fraction of the stock would be replaced early. It also considered retired units not replaced. DOE used the non-replacement market segment to calibrate the shipments model to historical shipments data.

To estimate the impacts of prospective standards on product shipments (i.e., to forecast standards-case shipments), DOE considered the combined effects of changes in purchase price, annual operating cost, and household income on the magnitude of shipments.

Table IV-12 summarizes the approach and data DOE used to derive the inputs to the shipments analysis for the October 2008 NOPR, the February 2012 SNOPR, and the changes it made for today's final rule. The general approach for forecasting microwave shipments for today's final rule remains unchanged from the October 2008 NOPR.

Table IV-12 Approach and Data Used to Derive Inputs to the Shipments Analysis

Inputs	**2008 NOPR Description**	**Changes for the 2012 SNOPR**	**Changes for the Final Rule**
Number of Product Classes	One product class. Market share data provided by AHAM.	Two product classes: (1) all microwave oven-only and countertop convection microwave oven; (2) over-the-range convection microwave oven. Market share data provided by AHAM; 99% product class #1 and 1% product class #2. Product class market shares held constant over forecast period.	No change.
New Construction Shipments	Housing forecasts updated with EIA AEO 2008 April release forecasts for the Reference case, High growth case, and Low growth case.	No change in approach. Housing forecasts updated with EIA AEO 2010 forecasts for the Reference case, High growth case, and Low growth case.	No change in approach. Housing forecasts updated with EIA AEO 2012 forecasts for the Reference case, High growth case, and Low growth case.
Replacements	Determined by tracking total product stock by vintage and establishing the failure of the stock using retirement functions from the LCC and PBP analysis. Retirement functions revised to be based on Weibull lifetime distributions.	No change.	No change.
Retired Units not Replaced (i.e., non-replacements)	Used to calibrate shipments model to historical shipments data.	No change.	No change.
Historical Shipments	Data sources include AHAM data submittal and Appliance magazine.	No change.	No change.
Purchase Price, Operating Cost, and Household Income Impacts due to Efficiency Standards	Developed "relative price" elasticity, which accounts for the purchase price and the present value of operating cost savings divided by household income. Used purchase price and efficiency data specific to	No change.	No change.

	residential refrigerators, clothes washers, and dishwashers between 1980 and 2002 to determine a "relative price" elasticity of demand of -0.34.		
Fuel Switching	Not applicable.	No change.	No change.

a. New Construction Shipments

To estimate shipments for new construction, DOE used forecasts of housing starts coupled with microwave oven saturation data. In other words, to forecast the shipments for new construction in any given year, DOE multiplied the housing forecast by the forecasted saturation of microwave ovens for new housing.

New housing comprises single- and multi-family units (also referred to as "new housing completions") and mobile home placements. For the final rule, DOE forecasted new housing based on EIA's AEO 2012 for 2009–2035. AEO 2012 provides three sets of forecasts: the Reference case, the High economic growth case, and the Low economic growth case. DOE used the forecasts from the Reference case for the NIA results reported in this rulemaking. For 2035−2045, DOE kept completions at the level in 2035.

b. Replacements and Non-replacements

To determine shipments for the replacement market, DOE used an accounting method that tracks the total stock of units by vintage. DOE estimated a stock of microwave ovens by vintage by integrating historical shipments starting from 1972. Over time, some units are retired and removed from the stock, triggering the shipment of a replacement unit. Depending on the vintage, a certain percentage of each type of unit will fail and need to be replaced. To determine when a microwave oven fails, DOE used data from RECS and American Housing Survey (AHS) to estimate a product survival function. This function was modeled as a Weibull distribution. Based on this method, the average calculated microwave oven lifetime is 9.3 years. For a more complete discussion of microwave lifetimes, refer to chapter 8 of the final rule TSD.

3. Purchase Price, Operating Cost, and Income Impacts

To estimate the combined effects of increases in product purchase price and decreases in product operating costs on microwave oven shipments, for the October 2008 NOPR DOE used a literature review and a statistical analysis on a limited set of appliance price, efficiency, and shipments data. DOE used purchase price and efficiency data specific to microwave ovens between 1980 and 2002 to conduct regression analyses. DOE's analysis suggested that the relative short-run price elasticity of demand is -0.34.

Because DOE's forecast of shipments and national impacts attributable to standards spans more than 30 years, DOE also considered how the relative price elasticity is affected once a new standard takes effect. After the purchase price changes, price elasticity becomes more inelastic over the years until it reaches a terminal value. For the October 2008 NOPR and today's final rule, DOE incorporated a relative price elasticity change that resulted in a terminal value of approximately one-third of the short-run elasticity. In other words, DOE determined that consumer purchase decisions, in time, become less sensitive to the initial change in the product's relative price. See chapter 9 of the final rule TSD for further discussion.

4. Other Inputs

a. Forecasted Efficiencies

A key input to the calculations of NES and NPV are the energy efficiencies that DOE forecasts for the base case (without new standards). The forecasted efficiencies represent the annual shipment-weighted energy efficiency (SWEF) of the product under consideration during the forecast period (i.e., from the estimated effective date of a new standard to 30 years after that date). Because DOE had no data to reasonably estimate how microwave oven standby power levels might change during the next 30 years, it assumed that forecasted efficiencies will stay at the 2016 standby power levels until the end of the forecast period.

For its determination of the cases under alternative standard levels ("standards cases"), DOE used a "roll-up" scenario in the October 2008 NOPR to establish the SWEF for 2012. For today's final rule, DOE established the SWEF for 2016 and assumed that the market share of products in the base case that do not meet the standard level under consideration (i.e. are less efficient than the standard) would shift to products that meet the new standard level. DOE assumed that all product efficiencies in the base case that are above the standard level under consideration would remain the same in the standard case.

DOE made the same assumption regarding forecasted standards-case efficiencies as for the base case; namely, that efficiencies will remain at the 2016 standby power level until the end of the forecast period. By maintaining the same rate of increase for forecasted efficiencies in the standards case as in the base case (i.e., no change), DOE retained a constant efficiency difference between the two cases throughout the forecast period. Although the no-change trends may not reflect what would happen to base-case and standards-case product efficiencies in the future, DOE believes that maintaining a constant efficiency difference between the base case and each standards case provides a reasonable estimate of the impact that standards would have on product efficiency. It is more important to accurately estimate the efficiency difference between the standards case and base case than to accurately estimate the actual product efficiencies in the standards and base cases. DOE retained the approach used in the October 2008 NOPR for today's final rule. Because the effective date of the standard is now assumed to be 2016, DOE applied the "roll-up" scenario in 2016 to establish the SWEF for each standards case.

b. Annual Energy Consumption

The annual energy consumption per unit depends directly on product efficiency. For the October 2008 NOPR and today's final rule, DOE used the SWEFs associated with the base case and each standards case, in combination with the annual energy use data, to estimate the shipment-weighted average annual per-unit energy consumption under the base case and standards cases. The national energy consumption is the product of the annual energy consumption per unit and the number of units of each vintage, which depends on shipments.

As noted above, DOE used a relative price elasticity to estimate standards-case shipments for microwave ovens. To avoid the inclusion of energy savings from any reduction in shipments attributable to a standard, DOE used the standards-case shipments projection and the standards-case stock to calculate the annual energy consumption in the base case. For microwave ovens, DOE assumed that any drop in shipments caused by standards would result in the purchase of used machines. DOE retained the use of the base-case shipments to determine the annual energy consumption in the base case for today's final rule.

c. Site-to-Source Energy Conversion

To estimate the national energy savings expected from appliance standards, DOE uses a multiplicative factor to convert site energy consumption (energy use at the location where the appliance is operated) into primary or source energy consumption (the energy required to deliver the site energy). For the October 2008 NOPR, DOE used annual site-to-source conversion factors based on the version of NEMS that corresponds to AEO 2008. For today's final rule, DOE used AEO 2012. For electricity, the conversion factors vary over time because of projected changes in generation sources (i.e., the types of power plants projected to provide electricity to the country). Because the AEO does not provide energy forecasts beyond 2035, DOE used conversion factors that remain constant at the 2035 values throughout the rest of the forecast.

d. Total Installed Costs and Operating Costs

The increase in total annual installed cost is equal to the difference in the per-unit total installed cost between the base case and standards case, multiplied by the shipments forecasted in the standards case.

As discussed in section IV.F.1 of this rulemaking, DOE applied an experience rate to project the prices of microwave ovens sold in each year in the forecast period (2016–2045). The experience rate expresses the change in price associated with a doubling in cumulative production. The price in each year is a function of the learning rate and the cumulative production of microwave ovens forecast in each year. DOE applied the same values to forecast prices for each product class at each considered efficiency level.

To evaluate the impact of the uncertainty of the price trend estimates, DOE performed price trend sensitivity calculations in the national impact analysis. DOE considered three experience rate sensitivities, which are described in appendix 8-C of the final rule TSD.

The annual operating cost savings per unit include changes in energy, repair, and maintenance costs. DOE forecasted energy prices for the February 2012 SNOPR based on AEO 2010; it updated the forecasts for the final rule using data from AEO 2012. For the February 2012 SNOPR and today's final rule, DOE assumed no increases in repair and maintenance costs for more efficient standby mode and off mode features of microwave ovens.

e. Discount Rates

DOE multiplies monetary values in future years by a discount factor to determine their present value. DOE estimated national impacts using both a 3-percent and a 7-percent real discount rate, in accordance with guidance provided by the Office of Management and Budget (OMB) to Federal agencies on the development of regulatory analysis (OMB Circular A-4 (Sept.17, 2003), section E, "Identifying and Measuring Benefits and Costs").

An individual commenter objected to DOE's use of 3-percent and a 7-percent discount rates. The comment stated that, according to a holding in NRDC v. Herrington (NRDC v. Herrington, 768 F.2d 1355, 1367 (D.C. Cir. 1985)), DOE cannot rely on the OMB alone to justify its choice to use 3-percent and 7-percent discount rates. (Private Citizen, No. 10 at pp. 3–4) In response, DOE notes that the 7-percent discount rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector. When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. The alternative most often used is sometimes called societal rate of time preference, which is the rate at which society discounts future consumption flows to their present value. The real rate of return on long-term government debt may provide a fair approximation of the societal rate of time preference. Over the last 30 years, this rate has averaged around 3 percent in real terms on a pre-tax basis.

G. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a national standard. In the October 2008 NOPR, DOE analyzed the potential effects of microwave oven standby mode and off mode standards on two subgroups: (1) low-income consumers, and (2) consumers living in senior-only households. DOE used the same approach for today's final rule.

H. Manufacturer Impact Analysis

In determining whether an amended energy conservation standard for microwave ovens subject to this rulemaking is economically justified, DOE is required to consider the economic impact of the standard on the manufacturers and consumers of the products subject to the standards. (42 U.S.C. 6295(o)(2)(B)(i)(I)) The statute also calls for an assessment of the impact of any lessening of competition as determined by the Attorney General that is likely to result from the adoption of a standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) DOE conducted the MIA to estimate the financial impact of standby mode and off mode energy conservation standards on microwave oven manufacturers, and to calculate the impact of such standards on domestic employment and manufacturing capacity.

The MIA has both quantitative and qualitative aspects. The quantitative part of the MIA primarily relies on the GRIM—an industry-cash-flow model customized for this rulemaking. The GRIM inputs are data characterizing the industry cost structure, shipments, and revenues. The key output is the INPV. Different sets of assumptions (scenarios) will produce different results. The qualitative part of the MIA addresses factors such as product characteristics, characteristics of particular firms, as well as market and product trends. It also includes an assessment of the impacts of standards on subgroups of manufacturers. DOE outlined its methodology for the MIA in the February 2012 SNOPR. 77 FR 8526, 8550–52 (Feb. 14, 2012). The complete MIA is presented in chapter 12 of the final rule TSD.

For today's final rule, DOE updated the MIA results in the February 2012 SNOPR based on several changes to other analyses that impact the MIA. DOE revised the analysis to account for the impacts on manufacturers resulting from standby mode and off mode standards for Product Class 1 (Microwave-Only Ovens and Countertop Convection Microwave Ovens) and Product Class 2 (Built-In and Over-the-Range Convection Microwave Ovens). As discussed in section IV.D.3 of this rulemaking, based on additional research for the engineering analysis, DOE included updated MPCs in 2011$ for both Product Class 1 and Product Class 2. DOE also incorporated updated price trends into the analysis rather than assuming prices remain fixed in real terms throughout the analysis period. DOE used the same price trends in the NIA starting in the base year of the analysis (2013) and continuing through the end of the analysis period

(2045). DOE also assumed that MPCs and MSPs were similarly impacted by price trends in both the base case and standards cases. See section IV.F of this rulemaking for a description of how DOE implemented price trends into the analysis.

The total shipments and efficiency distributions were updated using the new estimates described in the final rule NIA. The MIA also uses the new analysis period in the NIA (2016–2045) and has updated the base year of analysis to 2013. See section IV.F of this rulemaking for a description of the changes to the NIA.

As was done for the February 2012 SNOPR MIA, DOE considered product and capital conversion costs associated with the analyzed TSLs in today's final rule. Product conversion costs are one-time investments in research, development, testing, and marketing, focused on ensuring product designs comply with new energy conservation standards. DOE investigated available product information to update the estimated number of product platforms that would need to be altered at each TSL to determine conversion costs for the entire industry. DOE also used information provided in manufacturer interviews to verify the estimates used to determine product conversion costs. For each TSL, DOE assumed that most of the product conversion costs would be used for product development expenses. To account for the majority of the cost to upgrade the designs of product platforms that did not meet the standby power requirements at each TSL, DOE estimated a per-platform cost for engineering time, reliability testing, and product development that varied depending on the complexity of the design options.

To allocate total product and capital conversion costs across Product Class 1 and Product Class 2 for the final rule MIA, DOE used the same ratio between these two product classes as used in the final rule NIA. DOE used the same per-platform costs at each standby power level for both product classes as developed in the February 2012 SNOPR, but converted these product and capital conversion costs to 2011$ using the PPI.

DOE received comments pertaining to the manufacturer impact analysis in the February 2012 SNOPR from a private citizen, who commented that the loss in INPV would disproportionally and negatively impact small business microwave oven manufacturers around the world (Private Citizen, No.10 at pp. 2, 10). DOE did not identify any manufacturers classified as a small business selling microwave ovens in the United States. Additionally, the INPV figure in the February 2012 SNOPR is industry-wide, and does not represent the impact on any one manufacturer.

The private citizen also commented that small and medium-size businesses would have a difficult time complying with a standard with a compliance date in 2014 or 2015, and that some could go out of business (Private Citizen, No. 10 at p. 7). In addition to the fact that DOE identified no small microwave oven manufacturers, DOE points out that the compliance date is 3 years from the publication of today's final rule, which is consistent with other new standards. DOE also notes that no manufacturers objected to the compliance date as part of this rulemaking.

I. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a proposed standard. Employment impacts include direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the products subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) reduced spending by end users on energy; (2) reduced spending on new energy supply by the utility industry; (3) increased spending on new products to which the new standards apply; and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics (BLS).[24] The BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy. [25] There are many reasons for these differences, including wage

[24] Data on industry employment, hours, labor compensation, value of production, and the implicit price deflator for output for these industries are available upon request by calling the Division of Industry Productivity Studies (202-691-5618) or by sending a request by e-mail to dipsweb@bls.gov. Available at: www.bls.gov/news.release/prin1.nr0.htm. (Last accessed December 2012.)

[25] See Bureau of Economic Analysis, Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). Washington, DC. U.S. Department of Commerce, 1992.

differences and the fact that the utility sector is more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (i.e., the utility sector) to more labor-intensive sectors (e.g., the retail and service sectors). Thus, based on the BLS data alone, DOE believes net national employment will increase due to shifts in economic activity resulting from amended standards for microwave ovens.

For the standard levels considered in today's direct final rule, DOE estimated indirect national employment impacts using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 3.1.1 (ImSET).[26] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" (I–O) model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I–O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and understands the uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price

[26] J. M. Roop, M. J. Scott, and R. W. Schultz, ImSET 3.1: Impact of Sector Energy Technologies, PNNL-18412, Pacific Northwest National Laboratory, 2009. Available at: www.pnl.gov/main/publications/external/technical_reports/PNNL-18412.pdf. (Last accessed December 2012.)

changes, the employment effects predicted by ImSET may overestimate actual job impacts over the long run for this rule. Because ImSET predicts small job impacts resulting from this rule, regardless of these uncertainties, the actual job impacts are likely to be negligible in the overall economy. DOE may consider the use of other modeling approaches for examining long run employment impacts. DOE also notes that the employment impacts estimated with ImSET for the entire economy differ from the employment impacts in the microwave oven manufacturing sector estimated using the GRIM in the MIA. The methodologies used and the sectors analyzed in the ImSET and GRIM models are different.

For further details, see chapter 13 of the final rule TSD.

J. Utility Impact Analysis

The utility impact analysis estimates the change in the forecasted power generation capacity for the Nation that would be expected to result from adoption of new or amended standards. The analysis determines the changes to electricity supply as a result of electricity consumption savings due to standards. For the October 2008 NOPR and today's final rule, DOE used the NEMS-BT computer model to calculate these changes. The analysis output provides a forecast for the needed generation capacities at each TSL. The estimated net benefit of a standard is the difference between the generation capacities forecasted by NEMS-BT and the AEO Reference case. DOE obtained the energy savings inputs from the NIA. Those inputs reflect the effects of standby mode and off mode energy use reduction on electricity consumption of microwave ovens. Chapter 14 of the final rule TSD presents results of the utility impact analysis.

K. Emissions Analysis

In the emissions analysis, DOE estimated the reduction in power sector emissions of CO_2, SO_2, NO_X, and Hg from amended energy conservation standards for microwave ovens. DOE conducted the emissions analysis using emissions factors that were derived from data in EIA's AEO 2012, supplemented by data from other sources. DOE developed separate emissions factors for power sector emissions and upstream emissions. The method that DOE used to derive emissions factors is described in chapter 15 of the final rule TSD.

EIA prepares the Annual Energy Outlook using the National Energy Modeling System (NEMS). Each annual version of NEMS incorporates the projected impacts of existing air quality regulations on emissions. AEO 2012 generally represents current legislation and environmental regulations, including recent government actions, for which implementing regulations were available as of December 31, 2011.

SO_2 emissions from affected electric generating units (EGUs) are subject to nationwide and regional emissions cap and trading programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia (D.C.). SO_2 emissions from 28 eastern States and D.C. were also limited under the Clean Air Interstate Rule (CAIR), which created an allowancebased trading program that operates along with the Title IV program. 70 FR 25162 (May 12, 2005). CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia Circuit, but it remained in effect. See North Carolina v. EPA, 550 F.3d 1176 (D.C. Cir. 2008); North Carolina v. EPA, 531 F.3d 896 (D.C. Cir. 2008). On July 6, 2011 EPA issued a replacement for CAIR, the Cross-State Air Pollution Rule (CSAPR). 76 FR 48208 (Aug. 8, 2011). The AEO 2012 emissions factors used for today's rule assume the implementation of CSAPR.[27]

The attainment of emissions caps typically is flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. In past rulemakings, DOE recognized that there was uncertainty about the effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, but it concluded that no reductions in power sector emissions would occur for SO_2 as a result of standards.

Beginning in 2015, however, SO_2 emissions will fall as a result of the Mercury and Air Toxics Standards (MATS) for power plants, which were announced by EPA on

[27] On December 30, 2011, the D.C. Circuit stayed the new rules while a panel of judges reviews them, and told EPA to continue enforcing CAIR. See EME Homer City Generation, LP v. EPA, Order, No. 11-1302, Slip Op. at *2 (D.C. Cir. Dec. 30, 2011). On August 21, 2012, the D.C. Circuit vacated CSAPR and related Federal Implementation Plans that would have superseded the State Implementation Plans that EPA typically approves for compliance with Clean Air Act stationary source regulations. See EME Homer City Generation, LP v. EPA, No. 11-1302, 2012 WL 3570721 at *24 (D.C. Cir. Aug. 21, 2012). The court required EPA to continue administering CAIR. See id. The AEO 2012, however, had been finalized prior to both these decisions. DOE understands, however, that CAIR and CSAPR are similar with respect to their effect on emissions impacts of energy efficiency standards.

December 21, 2011. 77 FR 9304 (Feb. 16, 2012). In the final MATS rule, EPA established a standard for hydrogen chloride as a surrogate for acid gas hazardous air pollutants (HAP), and also established a standard for SO_2 (a non-HAP acid gas) as an alternative equivalent surrogate standard for acid gas HAP. The same controls are used to reduce HAP and non-HAP acid gas; thus, SO_2 emissions will be reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. AEO 2012 assumes that, in order to continue operating, coal plants must have either flue gas desulfurization or dry sorbent injection systems installed by 2015. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions. Under the MATS, NEMS shows a reduction in SO_2 emissions when electricity demand decreases (e.g., as a result of energy efficiency standards). Emissions will be far below the cap that would be established by CSAPR, so it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by any regulated EGU. Therefore, DOE believes that efficiency standards will reduce SO_2 emissions in 2015 and beyond.

Under CSAPR, there is a cap on NO_x emissions in 28 eastern States and the District of Columbia. Energy conservation standards are expected to have little effect on NO_x emissions in those States covered by CSAPR because excess NO_x emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_x emissions. However, standards would be expected to reduce NO_x

emissions in the States not affected by the caps, so DOE estimated NO_x emissions reductions from the standards considered in today's rule for these States.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would likely reduce Hg emissions. For this rulemaking, DOE estimated mercury emissions reductions using the NEMS-BT based on AEO 2012, which incorporates the MATS.

Chapter 15 of the final rule TSD provides further information on the emissions analysis.

L. Monetizing Carbon Dioxide and Other Emissions Impacts

As part of the development of this final rule, DOE considered the estimated monetary benefits from the reduced emissions of CO_2 and NO_X that are expected to result from each of the TSLs considered. In order to make this calculation similar to the calculation of the NPV of customer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the forecast period for each TSL. This section summarizes the basis for the monetary values used for each of these emissions and presents the values considered in this rulemaking.

For today's final rule, DOE is relying on sets of values for the social cost of carbon (SCC) that were developed by an interagency process. A summary of the basis for those values is provided below, and a more detailed description of the methodologies used is provided in appendix 16-A and appendix 16-B of the final rule TSD.

1. Social Cost of Carbon

The SCC is an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services. Estimates of the SCC are provided in dollars per metric ton of carbon dioxide. A domestic SCC value is meant to reflect the value of damages in the United States resulting from a unit change in carbon dioxide emissions, while a global SCC value is meant to reflect the value of damages worldwide.

Under section 1(b)(6) of Executive Order 12866, “Regulatory Planning and Review,” 58 FR 51735 (Oct. 4, 1993), agencies must, to the extent permitted by law, assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. The purpose of the SCC estimates presented here is to allow agencies to incorporate the monetized social benefits of reducing CO_2 emissions into cost-benefit analyses of regulatory actions that have small, or “marginal,” impacts on cumulative global emissions. The estimates are presented with an acknowledgement of the many uncertainties involved and with a clear understanding that they should be updated over time to reflect increasing knowledge of the science and economics of climate impacts.

As part of the interagency process that developed the SCC estimates, technical experts from numerous agencies met on a regular basis to consider public comments, explore the technical literature in relevant fields, and discuss key model inputs and assumptions. The main objective of this process was to develop a range of SCC values using a defensible set of input assumptions grounded in the existing scientific and economic literatures. In this way, key uncertainties and model differences transparently and consistently inform the range of SCC estimates used in the rulemaking process.

a. Monetizing Carbon Dioxide Emissions

When attempting to assess the incremental economic impacts of carbon dioxide emissions, the analyst faces a number of serious challenges. A recent report from the National Research Council points out that any assessment will suffer from uncertainty, speculation, and lack of information about: (1) future emissions of greenhouse gases; (2) the effects of past and future emissions on the climate system; (3) the impact of changes in climate on the physical and biological environment; and (4) the translation of these environmental impacts into economic damages. As a result, any effort to quantify and monetize the harms associated with climate change will raise serious questions of science, economics, and ethics and should be viewed as provisional.

Despite the serious limits of both quantification and monetization, SCC estimates can be useful in estimating the social benefits of reducing carbon dioxide emissions. Most Federal regulatory actions can be expected to have marginal impacts on global emissions. For such policies, the agency can estimate the benefits from reduced emissions in any future year by multiplying the change in emissions in that year by the SCC value appropriate for that year. The net present value of the benefits can then be calculated by multiplying the future benefits by an appropriate discount factor and summing across all affected years. This approach assumes that the marginal damages from increased emissions are constant for small departures from the baseline emissions path, an approximation that is reasonable for policies that have effects on emissions that are small relative to cumulative global carbon dioxide emissions. For policies that have a large (non-marginal) impact on global cumulative emissions, there is a separate question of whether the SCC is an appropriate tool for calculating the benefits of reduced emissions. This concern is not applicable to this rulemaking, however.

It is important to emphasize that the interagency process is committed to updating these estimates as the science and economic understanding of climate change and its impacts on society improves over time. In the meantime, the interagency group will continue to explore the issues raised by this analysis and consider public comments as part of the ongoing interagency process.

b. Social Cost of Carbon Values Used in Past Regulatory Analyses

Economic analyses for Federal regulations have used a wide range of values to estimate the benefits associated with reducing carbon dioxide emissions. In the final model year 2011 CAFE rule, the U.S. Department of Transportation (DOT) used both a "domestic" SCC value of $2 per metric ton of CO_2 and a "global" SCC value of $33 per metric ton of CO_2 for 2007 emission reductions (in 2007$), increasing both values at 2.4 percent per year. DOT also included a sensitivity analysis at $80 per metric ton of CO_2.[28] A 2008 regulation proposed by DOT assumed a domestic SCC value of $7 per metric ton of CO_2 (in 2006$) for 2011 emission reductions (with a range of $0–$14 for sensitivity analysis), also increasing at 2.4 percent per year.[29] A regulation for packaged terminal air conditioners and packaged terminal heat pumps finalized by DOE in October of 2008 used a domestic SCC range of $0 to $20 per metric ton CO_2 for 2007 emission reductions (in 2007$). 73 FR 58772, 58814 (Oct. 7, 2008). In addition, EPA's 2008 Advance Notice of Proposed Rulemaking on Regulating Greenhouse Gas Emissions Under the Clean Air Act identified what it described as "very preliminary" SCC estimates subject to revision. 73 FR 44354 (July 30, 2008). EPA's global mean values were $68 and $40 per metric ton CO_2 for discount rates of approximately 2 percent and 3 percent, respectively (in 2006$ for 2007 emissions).

[28] See Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, 74 FR 14196 (March 30, 2009) (Final Rule); Final Environmental Impact Statement Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011-2015 at 3-90 (Oct. 2008) (Available at: http://www.nhtsa.gov/fuel-economy). (Last accessed December 2012.)

[29] See Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011-2015, 73 FR 24352 (May 2, 2008) (Proposed Rule); Draft Environmental Impact Statement Corporate Average Fuel Economy Standards, Passenger Cars and Light Trucks, Model Years 2011-2015 at 3-58 (June 2008) (Available at: http://www.nhtsa.gov/fuel-economy). (Last accessed December 2012).

In 2009, an interagency process was initiated to offer a preliminary assessment of how best to quantify the benefits from reducing carbon dioxide emissions. To ensure consistency in how benefits are evaluated across agencies, the Administration sought to develop a transparent and defensible method, specifically designed for the rulemaking process, to quantify avoided climate change damages from reduced CO_2 emissions. The interagency group did not undertake any original analysis. Instead, it combined SCC estimates from the existing literature to use as interim values until a more comprehensive analysis could be conducted. The outcome of the preliminary assessment by the interagency group was a set of five interim values: global SCC estimates for 2007 (in 2006$) of $55, $33, $19, $10, and $5 per metric ton of CO_2. These interim values represented the first sustained interagency effort within the U.S. government to develop an SCC for use in regulatory analysis. The results of this preliminary effort were presented in several proposed and final rules.

c. Current Approach and Key Assumptions

Since the release of the interim values, the interagency group reconvened on a regular basis to generate improved SCC estimates. Specifically, the group considered public comments and further explored the technical literature in relevant fields. The interagency group relied on three integrated assessment models commonly used to estimate the SCC: the FUND, DICE, and PAGE models. These models are frequently cited in the peer-reviewed literature and were used in the last assessment of the Intergovernmental Panel on Climate Change. Each model was given equal weight in the SCC values that were developed.

Each model takes a slightly different approach to model how changes in emissions result in changes in economic damages. A key objective of the interagency process was to enable a consistent exploration of the three models while respecting the different approaches to quantifying damages taken by the key modelers in the field. An extensive review of the literature was conducted to select three sets of input parameters for these models: climate sensitivity, socio-economic and emissions trajectories, and discount rates. A probability distribution for climate sensitivity was specified as an input into all three models. In addition, the interagency group used a range of scenarios for the socio-economic parameters and a range of values for the discount rate. All other model features were left unchanged, relying on the model developers' best estimates and judgments.

The interagency group selected four SCC values for use in regulatory analyses. Three values are based on the average SCC from three integrated assessment models, at discount rates of 2.5 percent, 3 percent, and 5 percent. The fourth value, which represents the 95th-percentile SCC estimate across all three models at a 3-percent discount rate, is included to represent higher-than-expected impacts from climate change further out in the tails of the SCC distribution. The values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although preference is given to consideration of the global benefits of reducing CO_2 emissions. **Error!**

Reference source not found. presents the values in the 2010 interagency group report,[30] which is reproduced in appendix 16-A of the final rule TSD.

Table IV.13 Annual SCC Values from 2010 Interagency Report, 2010–2050 (in 2007 dollars per metric ton CO_2)

Year	Discount Rate %			
	5	3	2.5	3
	Average	Average	Average	95th Percentile
2010	4.7	21.4	35.1	64.9
2015	5.7	23.8	38.4	72.8
2020	6.8	26.3	41.7	80.7
2025	8.2	29.6	45.9	90.4
2030	9.7	32.8	50.0	100.0
2035	11.2	36.0	54.2	109.7
2040	12.7	39.2	58.4	119.3
2045	14.2	42.1	61.7	127.8
2050	15.7	44.9	65.0	136.2

The SCC values used for today's notice were generated using the most recent versions of the three integrated assessment models that have been published in the peer-reviewed literature.[31] Table IV.14 shows the updated sets of SCC estimates in five year increments from 2010 to 2050. The full set of annual SCC estimates between 2010 and 2050 is reported in appendix 16-B of the final rule TSD. The central value that emerges is the average SCC across models at the 3 percent discount rate. However, for purposes of capturing the uncertainties involved in regulatory impact analysis, the interagency group emphasizes the importance of including all four sets of SCC values.

[30] Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government, 2010. URL

[31] Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Interagency Working Group on Social Cost of Carbon, United States Government. April 2013. See appendix 16-B of the final rule TSD.

Table IV.14 Annual SCC Values from 2013 Interagency Update, 2010–2050 (in 2007 dollars per metric ton CO_2)

Year	**Discount Rate %**			
	5	3	2.5	3
	Average	Average	Average	95th Percentile
2010	11	33	52	90
2015	12	38	58	109
2020	12	43	65	129
2025	14	48	70	144
2030	16	52	76	159
2035	19	57	81	176
2040	21	62	87	192
2045	24	66	92	206
2050	27	71	98	221

It is important to recognize that a number of key uncertainties remain, and that current SCC estimates should be treated as provisional and revisable since they will evolve with improved scientific and economic understanding. The interagency group also recognizes that the existing models are imperfect and incomplete. The National Research Council report mentioned above points out that there is tension between the goal of producing quantified estimates of the economic damages from an incremental ton of carbon and the limits of existing efforts to model these effects. There are a number of concerns and problems that should be addressed by the research community, including research programs housed in many of the Federal agencies participating in the interagency process to estimate the SCC. The interagency group intends to periodically review and reconsider those estimates to reflect increasing knowledge of the science and economics of climate impacts, as well as improvements in modeling.

In summary, in considering the potential global benefits resulting from reduced CO2 emissions, DOE used the values from the 2013 interagency report, adjusted to 2011$ using the Gross Domestic Product price deflator. For each of the four cases specified, the values used for emissions in 2016 were $12.6, $41.1, $63.2, and $119 per metric ton avoided (values expressed in 2011$). DOE derived values after 2050 using the growth rate for the 2040-2050 period in the interagency update.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SCC value for that year in each of the four cases. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the four cases using the specific discount rate that had been used to obtain the SCC values in each case.

2. Valuation of Other Emissions Reductions

DOE investigated the potential monetary benefit of reduced NO_X emissions from the potential standards it considered. As noted above, DOE has taken into account how amended energy conservation standards would reduce NO_X emissions in those 22 States not affected by emissions caps. DOE estimated the monetized value of NO_X emissions reductions resulting from each of the TSLs considered for today's final rule based on estimates found in the relevant scientific literature. Available estimates suggest a very wide range of monetary values per ton of NO_X from stationary sources, ranging from $455 to $4,679 per ton in 2011$).[32] In accordance with OMB guidance, DOE calculated

[32] For additional information, refer to U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, 2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities, Washington, DC.

the monetary benefits using each of the economic values for NO_X and real discount rates of 3 percent and 7 percent.

DOE is evaluating appropriate monetization of avoided SO_2 and Hg emissions in energy conservation standards rulemakings. It has not included monetization in the current analysis.

M. Discussion of Other Comments

1. Significance of Energy Savings for the Built-in and Over-the-Range Product Class

In the February 2012 SNOPR, the total cumulative energy savings for the proposed standby power standard for the built-in and over-the-range convection microwave oven product class estimated for products shipped in 2016–2045 were 0.01 quad. AHAM, Whirlpool, and GE questioned whether that amount could be considered large enough to justify standards for that product class. They requested that DOE issue a "no standard" standard for the product class. (AHAM, No. 16 at p. 1; Whirlpool, No.15 at p. 2; GE, No. 19 at p. 1)

In the past, DOE has issued standards for a product class for which the total savings were 0.01 quad or less. For the 2010 standards on direct heating equipment (DHE), for example, the combined total energy savings from the standards were 0.23 quad, but the savings for several DHE product classes were each 0.01 quad or less. 75 FR 20185 (Apr. 16, 2010). Using the interpretation of "non-trivial" energy savings that DOE has applied in previous rulemakings (see section III.C.2 of this rulemaking), DOE concludes that the energy savings estimated for the standard for the built-in and over-the-range convection microwave oven product class are non-trivial and thus significant within the meaning of 42 U.S.C. 6295(o)(3)(B).

2. Standard Levels

The Joint Commenters stated that they support the standards at TSL 3. According to these commenters, such energy conservation standards will help harmonize the United States with standby mode and off mode power standards developed by the European Union in 2009. (Joint Comment, No. 17 at p. 1)

Whirlpool stated that the payback period shown for built-in and over-the-range convection microwave ovens at the proposed standard level (TSL 3) is 6.3 years, which exceeds the timeframe consumers will accept to recoup the cost of a more efficient product. It stated that this excessive payback period calls into question whether TSL 3 is the proper level for built-in and over-the-range convection microwave ovens. (Whirlpool, No. 15 at p. 2)

DOE is not aware of evidence for a specific payback period that consumers require to recoup the incremental cost of a more efficient product. As shown in Table V-2 and Table V-3 in section V.B.1.a of this rulemaking, the median payback period calculated for the final rule for built-in and over-the-range convection microwave ovens at TSL 3 is 3.5 years. The payback period is lower than estimated for the February 2012 SNOPR due to the aforementioned change in the estimated manufacturing cost of meeting higher efficiency levels. DOE believes that the majority of consumers would find such a payback acceptable.

V. Analytical Results

A. Trial Standard Levels

DOE analyzed the benefits and burdens of a number of TSLs for the microwave oven standby mode and off mode energy use that are the subject of today's final rule. For the October 2008 NOPR, DOE based the TSLs on standby power levels explored in the November 2007 ANOPR, and selected the TSLs on consideration of economic factors and current market conditions. As discussed previously in section IV.D.2 of this rulemaking, given the small number of standby power levels analyzed, DOE maintained all four of the standby power levels to consider as TSLs.

Table V-1 shows the TSLs for microwave oven standby mode and off mode energy use. TSL 1 corresponds to the first candidate standard level from each product class and represents the standby power level for each class with the least significant design change. TSL 4 corresponds to the max-tech efficiency levels. TSLs 2 and 3 are intermediate levels between TSL 1 and TSL 4.

Table V-1 Trial Standard Levels for Microwave Oven Standby Mode and Off Mode Energy Use

Trial Standard Level	Standby Power (W)	
	Product Class 1: Microwave-Only and Countertop Convection Microwave Oven	**Product Class 2: Built-In and Over-the-Range Convection Microwave Oven**
TSL 1	2.00	3.70
TSL 2	1.50	2.70
TSL 3	1.00	2.20
TSL 4	0.02	0.04

B. Economic Justification and Energy Savings

1. Economic Impacts on Consumers

a. Life-Cycle Cost and Payback Period

To evaluate the net economic impact of standards on consumers, DOE conducted LCC and PBP analyses for each TSL. In general, a higher efficiency product would affect consumers in two ways: (1) annual operating expense would decrease; and (2) purchase price would increase. Section IV.E of this rulemaking discusses the inputs DOE used for calculating the LCC and PBP.

The key outputs of the LCC analysis are a mean LCC savings relative to the base-case efficiency distribution, as well as a probability distribution or likelihood of LCC reduction or increase, for each TSL and product class. The LCC analysis also estimates the fraction of consumers for which the LCC will decrease (net benefit), increase (net cost), or exhibit no change (no impact) relative to the base-case product forecast. No impacts occur when the product efficiencies of the base-case forecast already equal or exceed the efficiency at a given TSL.

Table V-2 and Table V-3 show the LCC and PBP results for both microwave oven product classes. Note that for built-in and over-the-range convection microwave ovens, 100 percent of consumers of such products in 2016 are assumed to be using a convection microwave oven in the base case. Any decrease in standby power would affect 100 percent of the market.

Table V-2 Microwave-Only Ovens and Countertop Convection Microwave Ovens: Life-Cycle Cost and Payback Period Results

TSL	Standby Power (W)	Life-Cycle Cost ($)			Life-Cycle Cost Savings				Payback Period (years)
		Average Installed Price	Average Standby Operating Cost	Average LCC	Average Savings $	% Households with			Median
						Net Cost	No Impact	Net Benefit	
Baseline	4.00	234	35	269	NA	0	100	0	NA
1	2.00	234	18	252	8	0	54	46	0.2
2	1.50	234	13	247	11	0	19	81	0.3
3	1.00	239	9	248	11	12	0	88	3.5
4	0.02	243	0	244	15	5	0	95	3.5

Table V-3 Built-In and Over-the-Range Convection Microwave Ovens: Life-Cycle Cost and Payback Period Results

TSL	Standby Power (W)	Life-Cycle Cost ($)			Life-Cycle Cost Savings				Payback Period (years)
		Average Installed Price	Average Standby Operating Cost	Average LCC	Average Savings	% Households with			Median
						Net Cost	No Impact	Net Benefit	
Baseline	4.50	506	40	545	NA	0	100	0	NA
1	3.70	506	33	538	7	0	0	100	0.1
2	2.70	506	24	529	16	0	0	100	0.1
3	2.20	513	19	533	12	0	0	100	3.3
4	0.04	515	0	515	30	0	0	100	2.0

b. Consumer Subgroup Analysis

Using the LCC spreadsheet model, DOE determined the impact of the standards on the following microwave oven consumer subgroups: senior-only households and low-income households. Table V-4 and Table V-5 compare the average LCC savings for senior-only households and low-income households with those for all households. The LCC impacts for senior-only and low-income households are essentially the same as they are for the general population.

Table V-4 Microwave-Only Ovens and Countertop Convection Microwave Ovens: Comparison of Average LCC Savings for Consumer Subgroups and All Households

TSL	Standby Power (W)	Senior-Only Households	Low-Income Households	All Households
1	2.00	$8	$8	$8
2	1.50	$11	$11	$11
3	1.00	$11	$11	11
4	0.02	$14	$14	$15

Table V-5 Built-In and Over-the-Range Convection Microwave Ovens: Comparison of Average LCC Savings for Consumer Subgroups and All Households

TSL	Standby Power (W)	Senior-Only Households	Low-Income Households	All Households
1	$6	$7	$7	7
2	$14	$16	$16	$16
3	$10	$12	$12	$12
4	$25	$30	$30	$30

c. Rebuttable-Presumption Payback

As discussed above, EPCA establishes a rebuttable presumption that, in essence, an energy conservation standard is economically justified if the increased purchase cost for a product that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. (42 U.S.C. 6295(o)(2)(B)(iii)) DOE calculated a rebuttable-presumption payback period for each TSL to determine whether DOE could presume that a standard at that level is economically justified. Table V-6 shows the rebuttable-presumption payback periods for the microwave oven standby mode and off mode TSLs. Because only a single, average value is necessary for establishing the rebuttable-presumption payback period, rather than using distributions for input values, DOE used discrete values. As required by EPCA, DOE based the calculation on the assumptions in the DOE test procedures for microwave ovens. (42 U.S.C. 6295(o)(2)(B)(iii)) As a result, DOE calculated a single rebuttable-presumption payback value, and not a distribution of payback periods, for each TSL.

Table V-6 Rebuttable-Presumption Payback Periods for Microwave Oven Standby Mode and Off Mode

TSL	Payback Period (years)	
	Microwave-Only Ovens and Countertop Convection Microwave Ovens	**Built-In and Over-the-Range Convection Microwave Ovens**
1	0.2	0.1
2	0.2	0.1
3	3.5	3.3
4	3.5	2.0

All the TSLs in the above tables have rebuttable-presumption payback periods of less than 4 years. DOE believes that the rebuttable-presumption payback period criterion (i.e., a limited payback period) is not sufficient for determining economic justification. Therefore, DOE has considered a full range of impacts, including those to consumers, manufacturers, the Nation, and the environment. Section IV of this rulemaking provides a complete discussion of how DOE considered the range of impacts to select the standards in today's rule.

2. Economic Impacts on Manufacturers

For today's final rule, DOE used INPV to compare the financial impacts of potential energy conservation standards on microwave oven manufacturers at different TSLs. The INPV is the sum of all net cash flows discounted by the industry's cost of capital (discount rate). DOE used the GRIM to compare the INPV of the base case (no new energy conservation standards) to that of each TSL for the microwave oven industry. To evaluate the range of cash-flow impacts on the microwave oven industry, DOE constructed different scenarios using different markups that correspond to the range of anticipated market responses. Each scenario results in a unique set of cash flows and corresponding industry value at each TSL. These steps allowed DOE to compare the potential impacts on the industry as a function of TSLs in the GRIM. The difference in INPV between the base case and the standards case is an estimate of the economic impacts that implementing that standard level would have on the entire industry. See chapter 12 of the final rule TSD for additional information on MIA methodology and results.

a. Industry Cash-Flow Analysis Results

To assess the lower end of the range of potential impacts for the microwave oven industry, DOE considered the scenario reflecting the preservation of gross margin percentage. As production cost increases with efficiency, this scenario implies manufacturers will be able to maintain gross margins as a percentage of revenues. To assess the higher end of the range of potential impacts for the microwave oven industry, DOE considered the scenario reflecting preservation of gross margin in absolute dollars. Under this scenario, DOE assumed that the industry can maintain its gross margin in absolute dollars after the compliance date of the energy conservation standard by accepting lower gross margins as a percentage of revenue, but maintaining these margins in absolute dollars. Table V-7 through Table V-12 show MIA results for standby mode and off mode energy conservation standards using both markup scenarios described above for microwave oven manufacturers.

Table V-7 Product Class 1 Manufacturer Impact Analysis Under the Preservation of Gross Margin Percentage Markup Scenario

	INPV	Change in INPV	Change in INPV	Product Conversion Costs	Capital Conversion Costs	Total Investment Required
Units	**Millions 2011$**	**Millions 2011$**	**%**	**Millions 2011$**	**Millions 2011$**	**Millions 2011$**
Base Case	1,356.8	-	-	-	-	-
TSL 1	1,341.9	(14.9)	(1.1)	16.7	3.9	20.6
TSL 2	1,332.5	(24.3)	(1.8)	30.0	4.3	34.3
TSL 3	1,317.3	(39.5)	(2.9)	38.0	4.7	42.7
TSL 4	1,281.4	(75.4)	(5.6)	73.4	7.8	81.3

Parentheses indicate negative (-) values.

Table V-8 Product Class 1 Manufacturer Impact Analysis Under the Preservation of Gross Margin in Absolute Dollars Markup Scenario

	INPV	Change in INPV	Change in INPV	Product Conversion Costs	Capital Conversion Costs	Total Investment Required
Units	**Millions 2011$**	**Millions 2011$**	**%**	**Millions 2011$**	**Millions 2011$**	**Millions 2011$**
Base Case	1,356.8	-	-	-	-	-
TSL 1	1,339.7	(17.1)	(1.3)	16.7	3.9	20.6
TSL 2	1,328.6	(28.2)	(2.1)	30.0	4.3	34.3
TSL 3	1,261.6	(95.2)	(7.0)	38.0	4.7	42.7
TSL 4	1,174.0	(182.8)	(13.5)	73.4	7.8	81.3

Parentheses indicate negative (-) values.

Table V-9 Product Class 2 Manufacturer Impact Analysis Under the Preservation of Gross Margin Percentage Markup Scenario

	INPV	Change in INPV	Change in INPV	Product Conversion Costs	Capital Conversion Costs	Total Investment Required
Units	**Millions 2011$**	**Millions 2011$**	**%**	**Millions 2011$**	**Millions 2011$**	**Millions 2011$**
Base Case	29.7	-	-	-	-	-
TSL 1	29.5	(0.1)	(0.5)	0.2	0.0	0.2
TSL 2	29.4	(0.2)	(0.8)	0.3	0.0	0.3
TSL 3	29.2	(0.5)	(1.5)	0.4	0.0	0.4
TSL 4	28.9	(0.8)	(2.5)	0.7	0.1	0.8

Parentheses indicate negative (-) values.

Table V-10 Product Class 2 Manufacturer Impact Analysis Under the Preservation of Gross Margin in Absolute Dollars Markup Scenario

	INPV	Change in INPV	Change in INPV	Product Conversion Costs	Capital Conversion Costs	Total Investment Required
Units	**Millions 2011$**	**Millions 2011$**	**%**	**Millions 2011$**	**Millions 2011$**	**Millions 2011$**
Base Case	29.7	-	-	-	-	-
TSL 1	29.5	(0.2)	(0.5)	0.2	0.0	0.2
TSL 2	29.4	(0.3)	(0.9)	0.3	0.0	0.3
TSL 3	28.3	(1.4)	(4.6)	0.4	0.0	0.4
TSL 4	27.8	(1.8)	(6.1)	0.7	0.1	0.8

Parentheses indicate negative (-) values.

Table V-11 Combined Product Classes Manufacturer Impact Analysis Under the Preservation of Gross Margin Percentage Markup Scenario

	INPV	Change in INPV	Change in INPV	Product Conversion Costs	Capital Conversion Costs	Total Investment Required
Units	**Millions 2011$**	**Millions 2011$**	**%**	**Millions 2011$**	**Millions 2011$**	**Millions 2011$**
Base Case	1,386.5	-	-	-	-	-
TSL 1	1,371.4	(15.1)	(1.1)	16.9	4.0	20.8
TSL 2	1,361.9	(24.6)	(1.8)	30.3	4.3	34.7
TSL 3	1,346.5	(40.0)	(2.9)	38.3	4.7	43.1
TSL 4	1,310.3	(76.1)	(5.5)	74.2	7.9	82.1

Parentheses indicate negative (-) values.

Table V-12 Combined Product Classes Manufacturer Impact Analysis Under the Preservation of Gross Margin in Absolute Dollars Markup Scenario

	INPV	Change in INPV	Change in INPV	Product Conversion Costs	Capital Conversion Costs	Total Investment Required
Units	**Millions 2011$**	**Millions 2011$**	**%**	**Millions 2011$**	**Millions 2011$**	**Millions 2011$**
Base Case	1,386.5	-	-			
TSL 1	1,369.2	(17.3)	(1.2)	16.9	4.0	20.8
TSL 2	1,358.0	(28.5)	(2.1)	30.3	4.3	34.7
TSL 3	1,289.9	(96.6)	(7.0)	38.3	4.7	43.1
TSL 4	1,201.9	(184.6)	(13.3)	74.2	7.9	82.1

Parentheses indicate negative (-) values.

TSL 1 represents an improvement in standby power from the baseline level of 4.0 W to 2.0 W for Product Class 1 and an improvement in standby power from the baseline level of 4.5 W to 3.7 W for Product Class 2. At TSL 1, the impact on INPV and cash flow varies depending on the manufacturers' ability to pass on increases in MPCs to their customers. DOE estimated the impacts in INPV at TSL 1 to range -$15.1 million to -$17.3 million, or a change in INPV of -1.1 percent to -1.2 percent. At this level, the industry cash flow decreases by approximately 6.0 percent, to $99.7 million, compared to the base-case value of $106.1 million in the year leading up to the standards.

TSL 2 represents an improvement in standby power from the baseline level of 4.0 W to 1.5 W for Product Class 1 and an improvement in standby power from the baseline level of 4.5 W to 2.7 W for Product Class 2. At TSL 2, the impact on INPV and cash flow would be similar to TSL 1 and depend on whether manufacturers can fully recover the increases in MPCs from their customers. DOE estimated the impacts in INPV at TSL 2 to range from -$24.6 million to -$28.5 million, or a change in INPV of -1.8 percent to -2.1 percent. At this level, the industry cash flow decreases by approximately 9.7 percent, to

$95.8 million, compared to the base-case value of $106.1 million in the year leading up to the standards.

TSL 3 represents an improvement in standby power from the baseline level of 4.0 W to 1.0 W for Product Class 1 and an improvement in standby power from the baseline level of 4.5 W to 2.2 W for Product Class 2. At TSL 3, the impact on INPV and cash flow continues to vary depending on the manufacturers and their ability to pass on increases in MPCs to their customers. DOE estimated the impacts in INPV at TSL 3 to range from approximately -$40.0 million to -$96.6 million, or a change in INPV of -2.9 percent to -7.0 percent. At this level, the industry cash flow decreases by approximately 12.0 percent, to $93.4 million, compared to the base-case value of $106.1 million in the year leading up to the standards.

TSL 4 represents an improvement in standby power from the baseline level of 4.0 W to 0.02 W for Product Class 1 and an improvement in standby power from the baseline level of 4.5 W to 0.04 W for Product Class 2. At TSL 4, DOE estimated the impacts in INPV to range from approximately -$76.1 million to -$184.6 million, or a change in INPV of -5.5 percent to -13.3 percent. At this level, the industry cash flow decreases by approximately 22.7 percent, to $82.0 million, compared to the base-case value of $106.1 million in the year leading up to the standards. At higher TSLs, manufacturers have a harder time fully passing on larger increases in MPCs to their customers. At TSL 4, the conversion costs are higher than the other TSLs because the design of all microwave platforms must be altered more significantly.

For new standby mode and off mode energy conservation standards, conversion costs increase at higher TSLs as the complexity of further lowering standby power increases, substantially driving up engineering, product development, and testing time. If the increased production costs are fully passed on to consumers (the preservation of gross margin percentage scenario), the operating revenue from higher prices is still not enough to overcome the negative impacts from the substantial conversion costs. The incremental costs are small for each TSL, meaning the positive impact on cash flow is small compared to the conversion costs required to achieve these efficiencies. As a result of the small incremental costs and large conversion expenses, INPV is negative for all TSLs under the preservation of gross margin percentage scenario. If the incremental costs are not fully passed along to customers (the preservation of gross margin in absolute dollars scenario), the negative impacts on INPV are amplified at each TSL.

b. Employment Impacts

DOE discussed the domestic employment impacts on the microwave oven industry in the February 2012 SNOPR. DOE concluded that since more than 98 percent of microwave ovens are already imported and the employment impacts in the GRIM are small, the actual impacts on domestic employment would depend on whether any U.S. manufacturer decided to shift remaining U.S. production to lower-cost countries. 77 8526, FR 8561 (Feb.14, 2012). DOE maintains this conclusion for today's final rule.

c. Impacts on Manufacturing Capacity

As stated in the October 2008 NOPR, minor tooling changes would be necessary at all TSLs for standby mode and off mode energy conservation standards. For all standby power levels, the most significant conversion costs are the research and development, testing, and certification of products with more-efficient components, which does not affect production line capacity. Thus, DOE determined that manufacturers will be able to maintain manufacturing capacity levels and continue to meet market demand under new energy conservation standards. 73 FR 62034, 62103 (Oct. 17, 2008). DOE reached the same conclusion in today's final rule.

d. Impacts on Subgroups of Manufacturers

DOE used the results of the industry characterization to group manufacturers exhibiting similar characteristics. However, DOE did not identify any manufacturer subgroups for microwave ovens that would justify a separate manufacturer subgroup.

e. Cumulative Regulatory Burden

During previous stages of this rulemaking DOE identified a number of requirements with which manufacturers of these microwave ovens must comply and which take effect within 3 years of the compliance date of the new standards. DOE discusses these and other requirements, and includes the full details of the cumulative regulatory burden, in chapter 12 of the final rule TSD.

3. National Impact Analysis

a. Significance of Energy Savings

For each TSL, DOE projected energy savings for microwave ovens purchased in the 30-year period that begins in the year of compliance with amended standards (2016–2045). The savings are measured over the entire lifetime of products purchased in the 30-year period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the base case. Table V-13 presents the estimated energy savings for each TSL. The savings were calculated using the approach described in section IV.E of this rulemaking.[33]

Table V-13 Cumulative National Energy Savings for Microwave Oven Standby Mode and Off Mode Power for Units Sold in 2016-2045

TSL	Microwave-Only Ovens and Countertop Convection Ovens (quads)	Built-In and Over-the-Range Convection Microwave Ovens (quads)	Total* (quads)
1	0.24	0.00	0.24
2	0.35	0.00	0.35
3	0.47	0.01	0.48
4	0.72	0.01	0.73

Circular A-4 requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. DOE believes its standard 30-year analysis is fully compliant with the procedures outlined in Circular A-4. For this rulemaking,

[33] Chapter 10 of the TSD presents tables that show the magnitude of the energy savings discounted at rates of 3 percent and 7 percent. Discounted energy savings represent a policy perspective in which energy savings realized farther in the future are less significant than energy savings realized in the nearer term.

DOE undertook an additional sensitivity analysis of its standard 30-year analysis, using a 9-year analytical period. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[34] We would note that the review timeframe established in EPCA generally does not overlap with the product lifetime, product manufacturing cycles or other factors specific to microwave ovens. Thus, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology. The NES results based on a 9-year analytical period are presented in Table V-14. The impacts are counted over the lifetime of products purchased in 2016–2024. The sensitivity analysis results based on a 9-year analytical period are presented in Table V.14.

Table V-14 Cumulative National Energy Savings for Microwave Oven Standby Mode and Off Mode Power for Units Sold in 2016-2024

TSL	Microwave-Only Ovens and Countertop Convection Microwave Ovens (quads)	Built-In and Over-the-Range Convection Microwave Ovens (quads)	Total* (quads)
1	0.07	0.00	0.07
2	0.10	0.00	0.10
3	0.14	0.00	0.14
4	0.21	0.00	0.22

[34] EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6 year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some consumer products, the compliance period is 5 years rather than 3 years.

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV to the Nation of the total costs and savings for consumers that would result from particular standard levels for microwave oven standby mode and off mode. In accordance with the OMB's guidelines on regulatory analysis,[35] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. The 7-percent rate is an estimate of the average before-tax rate of return on private capital in the U.S. economy, and reflects the returns on real estate and small business capital as well as corporate capital. DOE used this discount rate to approximate the opportunity cost of capital in the private sector, because recent OMB analysis has found the average rate of return on capital to be near this rate. DOE used the 3-percent rate to capture the potential effects of standards on private consumption (e.g., through higher prices for products and reduced purchases of energy). This rate represents the rate at which society discounts future consumption flows to their present value. This rate can be approximated by the real rate of return on long-term government debt (i.e., yield on Treasury notes minus annual rate of change in the Consumer Price Index), which has averaged about 3 percent on a pre-tax basis for the past 30 years.

Table V-15 shows the consumer NPV results for each TSL DOE considered for both product classes of microwave ovens, using both a 7-percent and a 3-percent discount rate. In each case, the impacts cover the lifetime of products purchased in 2016–2045. See chapter 10 of the final rule TSD for more detailed NPV results.

[35] OMB Circular A-4, section E (Sept. 17, 2003). Available at: http://www.whitehouse.gov/omb/circulars_a004_a-4. (Last accessed December 2012.)

Table V-15 Cumulative Net Present Value of Consumer Benefits for Microwave Oven Standby Mode and Off Mode for Units Sold in 2016–2045

TSL	Net Present Value (Billions 2011$)					
	Microwave-Only Ovens and Countertop Convection Microwave Ovens		Built-In and Over-the-Range Convection Microwave Ovens		Total*	
	7% Discount Rate	3% Discount Rate	7% Discount Rate	3% Discount Rate	7% Discount Rate	3% Discount Rate
1	1.13	2.32	0.01	0.02	1.14	2.34
2	1.61	3.31	0.02	0.05	1.63	3.36
3	1.51	3.34	0.02	0.04	1.53	3.38
4	2.00	4.56	0.04	0.09	2.04	4.65

* The total values may differ from the sum of the product class sub-totals due to the rounding to two decimal places.

The NPV results presented in Table V-15 are based on the default product price trend. As discussed in section IV.E.3 of this rulemaking, DOE developed several sensitivity cases with alternative forecasts of future prices of microwave ovens. The impact of these alternative forecasts on the NPV results is presented in appendix 10-C of the final rule TSD.

The NPV results based on the afore-mentioned 9-year analytical period are presented in Table V-16. The impacts are counted over the lifetime of products purchased in 2016–2024. As mentioned previously, this information is presented for informational purposes only and is not indicative of any change in DOE's analytical methodology or decision criteria.

Table V-16 Cumulative Net Present Value of Consumer Benefits for Microwave Oven Standby Mode and Off Mode for Units Sold in 2016–2024

TSL	Net Present Value (Billions 2011$)					
	Microwave-Only Ovens and Countertop Convection Microwave Ovens		Built-In and Over-the-Range Convection Microwave Ovens		Total*	
	7% Discount Rate	3% Discount Rate	7% Discount Rate	3% Discount Rate	7% Discount Rate	3% Discount Rate
1	0.55	0.84	0.00	0.01	0.56	0.85
2	0.79	1.20	0.01	0.02	0.80	1.22
3	0.73	1.19	0.01	0.01	0.74	1.20
4	0.96	1.61	0.02	0.03	0.98	1.64

* The total values may differ from the sum of the product class sub-totals due to the rounding to two decimal places.

c. Indirect Impacts on Employment

DOE develops estimates of the indirect employment impacts of proposed standards on the economy in general. As discussed above, DOE expects energy conservation standards for microwave ovens to reduce energy bills for consumers of those products, and the resulting net savings to be redirected to other forms of economic activity. Those shifts in spending and economic activity could affect the demand for labor. As described in section IV.I of this rulemaking, to estimate those effects, DOE used an input/output model of the U.S. economy. Chapter 13 of the final rule TSD presents the estimated net indirect employment impacts in the near term for the TSLs for both product classes of microwave ovens that DOE considered in this rulemaking. The results suggest that today's standards are likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment.

4. Impact on Utility or Performance of Product

For the reasons stated in section III.D.1.d of this rulemaking, DOE believes that for purposes of 42 U.S.C. 6295(o)(2)(B)(i)(IV), the standby power level considered in this rulemaking does not reduce the utility or performance of the microwave oven products under consideration in this rulemaking.

5. Impact of Any Lessening of Competition

DOE has considered any lessening of competition that is likely to result from today's standards. The Attorney General determines the impact, if any, of any lessening of competition likely to result from a proposed standard, and transmits such determination to the Secretary of Energy, together with an analysis of the nature and extent of such impact. (42 U.S.C. 6295(o)(2)(B)(i)(V) and (B)(ii)) To assist the Attorney General in making such a determination, DOE provided the Department of Justice (DOJ) with copies of the proposed rule and the TSD for review. In a letter to DOE dated May 9, 2012, DOJ provided the following opinion: "[T]he proposed energy conservation standards for microwave oven standby power are unlikely to have a significant adverse impact on competition." DOE considered DOJ's comments on the proposed rule in preparing the final rule.

6. Need of the Nation to Conserve Energy

Improving the energy consumption of microwave oven standby mode and off mode, where economically justified, would likely improve the security of the Nation's energy system by reducing overall demand for energy. Reduced electricity demand may also improve the reliability of the electricity system. As a measure of this reduced demand, chapter 14 in the final rule TSD presents the estimated reduction in national generating capacity for the TSLs that DOE considered in this rulemaking.

Energy savings from more stringent microwave oven standby mode and off mode standards would also produce environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with electricity production. Table V-17 provides DOE's estimate of cumulative CO_2 and NO_X emissions reductions that would result from the TSLs considered in this rulemaking. DOE reports estimated annual changes in emissions attributable to each TSL in chapter 15 of the final rule TSD.

Table V-17 Cumulative Emissions Reductions under Microwave Oven Standby Mode and Off Mode Trial Standard Levels for Units Sold in 2016–2045

TSL	CO2 (Mt)	SO_2 (1,000 tons)	NO_X (1,000 tons)	Hg (tons)
1	19.13	13.63	16.40	0.048
2	27.63	19.70	23.69	0.069
3	38.11	27.14	32.67	0.095
4	58.55	41.72	50.20	0.146

Mt = million metric tons. Values for other emissions reductions refer to short tons.

DOE also estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_X that DOE estimated for each of the TSLs considered for microwave oven standby mode and off mode. In order to make this calculation similar to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in 2016–2045.

As discussed in section IV.L.1 of this rulemaking, DOE used four sets of values for the SCC developed by an interagency process. For each of the four cases, DOE calculated a present value of the stream of annual values using the same discount rate as was used in the studies upon which the dollar-per-ton values are based. Table V-18 presents the global values of CO_2 emissions reductions at each TSL. DOE calculated domestic values as a range from 7 percent to 23 percent of the global values, and these results are presented in chapter 16 of the final rule TSD.

Table V-18 Estimates of Present Value of CO_2 Emissions Reductions Under Microwave Oven Standby Mode and Off Mode Trial Standard Levels for Products Sold in 2016–2045

TSL	SCC Case			
	5% discount rate, average*	**3% discount rate, average***	**2.5% discount rate, average***	**3% discount rate, 95th percentile***
	(Million 2011$)			
1	$128	$592	$942	$1,815
2	$185	$855	$1,360	$2,621
3	$255	$1,179	$1,876	$3,615
4	$392	$1,812	$2,882	$5,554

***** Columns are labeled by the discount rate used to calculate the SCC and whether it is an average value or drawn from a different part of the distribution. The values in 2016 (in 2011$) are $12.6/ton, $41.1/ton, $63.2/ton, and $119/ton. The values increase over time.

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the world economy continues to evolve rapidly. Thus, any value placed on reducing CO_2 emissions is subject to change. DOE, together with other Federal agencies, will continue to review various methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. However, consistent with DOE's legal obligations, and taking into account the uncertainty involved with this particular issue, DOE has included in this rule the most recent values resulting from the interagency review process.

DOE also estimated a range for the cumulative monetary value of the economic benefits associated with NO_X emissions reductions anticipated to result from new standby mode and off mode standards for microwave ovens. The dollar-per-ton values that DOE used are discussed in section IV.L.2 of this rulemaking. Table V-19 presents the cumulative present values for each TSL calculated using 7-percent and 3-percent discount rates.

Table V-19 Estimates of Present Value of NO_X Emissions Reductions Under Microwave Oven Standby Mode and Off Mode Trial Standard Levels for Products Sold in 2016–2045

TSL	3% discount rate (Million 2011$)	7% discount rate (Million 2011$)
1	$22.3	$11.0
2	$32.3	$15.8
3	$44.5	$21.8
4	$68.4	$33.6

The NPV of the monetized benefits associated with emissions reductions can be viewed as a complement to the NPV of the consumer savings calculated for each TSL considered in this rulemaking. Table V-20 and Table V-21 present the NPV values that result from adding the estimates of the potential economic benefits resulting from reduced CO_2 and NO_X emissions in each of four valuation scenarios to the NPV of consumer savings calculated for each TSL considered in this rulemaking, at both a 7-percent and 3-percent discount rate. The CO_2 values used in the columns of each table correspond to the four scenarios for the valuation of CO_2 emission reductions presented in section IV.L of this rulemaking.

Table V-20 Results of Adding Net Present Value of Consumer Savings (at 7-Percent Discount Rate) to Net Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions for Microwave Oven Standby Mode and Off Mode

TSL	Consumer NPV at 7% Discount Rate added with:			
	SCC Value of \$12.6/t CO_2* and Low Value for NO_X** (Billion 2011\$)	SCC Value of \$41.1/t CO_2* and Medium Value for NO_X** (Billion 2011\$)	SCC Value of \$63.2/t CO_2* and Medium Value for NO_X** (Billion 2011\$)	SCC Value of \$119/t CO_2* and High Value for NO_X** (Billion 2011\$)
1	1.26	1.73	2.08	2.96
2	1.80	2.48	2.99	4.26
3	1.77	2.71	3.41	5.17
4	2.40	3.85	4.92	7.62

* These label values represent the global SCC in 2016, in 2011\$. The present values have been calculated with scenario-consistent discount rates.
** Low Value corresponds to \$455 per ton of NO_X emissions. Medium Value corresponds to \$2,567 per ton of NO_X emissions. High Value corresponds to \$4,679 per ton of NO_X emissions.

Table V-21 Results of Adding Net Present Value of Consumer Savings (at 3-Percent Discount Rate) to Net Present Value of Monetized Benefits from CO_2 and NO_X Emissions Reductions for Microwave Oven Standby Mode and Off Mode

TSL	Consumer NPV at 3% Discount Rate added with:			
	SCC Value of \$12.6/t CO_2* and Low Value for NO_X** (Billion 2011\$)	SCC Value of \$41.1/t CO_2* and Medium Value for NO_X** (Billion 2011\$)	SCC Value of \$63.2/t CO_2* and Medium Value for NO_X** (Billion 2011\$)	SCC Value of \$119/t CO_2* and High Value for NO_X** (Billion 2011\$)
1	2.45	2.93	3.28	4.17
2	3.50	4.20	4.70	5.99
3	3.60	4.56	5.26	7.03
4	4.97	6.44	7.51	10.24

* These label values represent the global SCC in 2016, in 2011\$. The present values have been calculated with scenario-consistent discount rates.
** Low Value corresponds to \$455 per ton of NO_X emissions. Medium Value corresponds to \$2,567 per ton of NO_X emissions. High Value corresponds to \$4,679 per ton of NO_X emissions.

Although adding the value of consumer savings to the values of emission reductions provides a valuable perspective, two issues should be considered. First, the national operating cost savings are domestic U.S. consumer monetary savings that occur as a result of market transactions, while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and the SCC are performed with different methods that use quite different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2016–2045. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one ton of CO_2 in each year. These impacts continue well beyond 2100.

7. Other Factors

The Secretary of Energy, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) DOE has not considered other factors in development of the standards in this final rule.

C. Conclusion

When considering proposed standards, the new or amended energy conservation standard that DOE adopts for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6295(o)(2)(B)(i)) The new or amended standard must also "result in significant conservation of energy." (42 U.S.C. 6295(o)(3)(B))

The Department considered the impacts of standards at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader in understanding the benefits and/or burdens of each TSL, Table V-22 summarizes the quantitative analytical results for each TSL, based on the assumptions and methodology discussed herein. In addition to the quantitative results presented in the table, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers, such as low-income households and seniors, who may be disproportionately affected by a national standard. Section V.B.1.b of this rulemaking presents the estimated impacts of each TSL for these subgroups.

Table V-22 Summary of Results for Trial Standard Levels for Microwave Oven Standby Mode and Off Mode Energy Use

Category	TSL 1	TSL 2	TSL 3	TSL 4
National Energy Savings (quads)	0.24	0.35	0.48	0.73
NPV of Consumer Benefits (Billion 2011$)				
3% discount rate	2.34	3.36	3.38	4.65
7% discount rate	1.14	1.63	1.53	2.04
Manufacturer Impacts				
Industry NPV (Million 2011$)	(15.1) to (17.3)	(24.6) to (28.5)	(40.0) to (96.6)	(76.1) to (184.6)
Industry NPV (% change)	(1.1) to (1.2)	(1.8) to (2.1)	(2.9) to (7.0)	(5.5) to (13.3)
Cumulative Emissions Reduction				
CO_2 (Mt)	19.13	27.63	38.11	58.55
SO_2 (thousand tons)	13.63	19.70	27.14	41.72
NO_x (thousand tons)	16.40	23.69	32.67	50.20
Hg (tons)	0.048	0.069	0.095	0.146
Value of Emissions Reductions CO_2 (Million 2011$)*	128 to 1815	185 to 2621	255 to 3615	392 to 5554
NO_X – 3% discount rate (Million 2011$)	22.3	32.3	44.5	68.4
NO_X – 7% discount rate (Million 2011$)	11.0	15.8	21.8	33.6
Consumer Mean LCC Savings (2011$)				
Product Class 1	8	11	11	15
Product Class 2	7	16	12	30
Consumer Median PBP (years)				
Product Class 1	0.2	0.3	3.5	3.5
Product Class 2	0.1	0.1	3.3	2.0
Distribution of Consumer LCC Impacts				
Product Class 1				
Net Cost	0	0	12	5
No Impact	54	19	0	0
Net Benefit	46	81	88	95
Product Class 2				
Net Cost	0	0	0	0
No Impact	0	0	0	0
Net Benefit	100	100	100	100

Parentheses indicate negative (-) values. For NPVs, a negative value means a decrease in NPV.
* Range of the economic value of CO_2 reductions is based on estimates of the global benefit of reduced CO_2 emissions.

In addition to the quantitative results, DOE also considered harmonization of microwave oven standby mode and off mode standards with international standby power programs such as Korea's e-standby program,[36] Australia's standby program,[37] and Japan's Top Runner Program.[38] Those programs seek to establish standby power ratings through the International Energy Agency's (IEA) 1-Watt Program, which seeks to lower standby power below 1 W for microwave ovens.[39] Korea published a mandatory standby power standard of 1 W that became effective in 2010 and Australia will publish mandatory standby power standards of 1 W by 2013. In accordance with Japan's Top Runner Program, Japanese appliance manufacturers made a voluntary declaration to reduce standby power of microwave ovens that lack a timer to as close to zero as possible and that of microwave ovens that have a timer to 1 W or lower.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. This undervaluation suggests that regulation that promotes energy efficiency can produce significant net private gains (as well as producing social gains by, for example, reducing pollution). There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of

---

[36] Refer to: http://www.kemco.or.kr/new_eng/pg02/pg02100300.asp. (Last accessed December 2012.)
[37] Refer to: http://www.energyrating.gov.au/products-themes/standby-power/about/. (Last accessed December 2012.)
[38] Refer to: http://www.eccj.or.jp/top_runner/pdf/tr_microwaveoven.pdf. (Last accessed December 2012.)
[39] IEA Energy Information Centre. Standby Power Use and the IEA "1-Watt Plan." Available at: http://greenshorenstein.info/pdf/Standby%20Power%20Fact%20Sheet%20-%20IEA%20-%20April%202007.pdf. (Last accessed December 2012.)

sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (that is, renter versus owner; builder vs. purchaser). Other literature indicates that with less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher than expected rate between current consumption and uncertain future energy cost savings.

In its current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchasing decisions are included in two ways. First, if consumers forego a purchase of a product in the standards case, this decreases sales for product manufacturers and the cost to manufacturers is included in the MIA. Second, DOE accounts for energy savings attributable only to products actually used by consumers in the standards case; if a regulatory option decreases the number of products used by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides detailed estimates of shipments and changes in the volume of product purchases in chapter 9 of the final rule TSD. DOE's current analysis does not explicitly control for heterogeneity in consumer preferences, preferences across subcategories of products or specific features, or consumer price sensitivity variation according to household income.[40]

---

[40] P.C. Reiss and M.W. White. Household Electricity Demand, Revisited. Review of Economic Studies (2005) 72, 853–883.

While DOE is not prepared at present to provide a fuller quantifiable framework for estimating the benefits and costs of changes in consumer purchase decisions due to an energy conservation standard, DOE is committed to developing a framework that can support empirical quantitative tools for improved assessment of the consumer welfare impacts of appliance standards. DOE has posted a paper that discusses the issue of consumer welfare impacts of appliance energy efficiency standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[41]

1. Benefits and Burdens of TSLs Considered for Microwave Oven Standby Mode and Off Mode Energy Use

First, DOE considered TSL 4, the max-tech level for microwave oven standby mode and off mode energy use. TSL 4 likely would save 0.73 quads of energy through 2045, an amount DOE considers significant. Under TSL 4, the estimated NPV of consumer benefit is $2.04 billion, using a discount rate of 7 percent, and $4.65 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 58.55 Mt of CO_2, 41.72 thousand tons of SO_2, 50.20 thousand tons of NO_X, and 0.146 tons of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 4 ranges from $392 million to $5,554 million.

[41] Alan Sanstad, Notes on the Economics of Household Energy Consumption and Technology Choice. Lawrence Berkeley National Laboratory. 2010. Available online at: www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf. (Last accessed December 2012.)

DOE projects that at TSL 4 for microwave-only ovens and countertop convection microwave ovens (Product Class 1), the average microwave oven consumer would experience a savings in LCC of $15. DOE also estimates 95 percent of consumers who purchase these microwave ovens would realize some LCC savings. The median payback period at TSL 4 is projected to be 3.5 years, substantially shorter than the lifetime of the product. DOE projects that at TSL 4 for built-in and over-the-range convection microwave ovens (Product Class 2), the average microwave oven consumer would experience a savings in LCC of $30, and all consumers who purchase these microwave ovens would realize some LCC savings. The median payback period at TSL 4 is projected to be 2.0 years, substantially shorter than the lifetime of the product.

Although DOE estimates that all microwave oven consumers would benefit economically from TSL 4, the reduction in standby power consumption at TSL 4 would result in the loss of certain functions that provide utility to consumers, specifically the continuous clock display. Because it is uncertain how greatly consumers value this function, DOE is concerned that TSL 4 may result in significant loss of consumer utility.

For manufacturers of microwave ovens, DOE estimated a decrease in INPV that ranges from $76.1 million to $184.6 million. DOE recognizes that TSL 4 poses the risk of large negative impacts if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached, as DOE expects, TSL 4 could result in a net loss of 13.3 percent in INPV to microwave oven manufacturers.

After carefully considering the analysis and weighing the benefits and burdens of TSL 4, DOE has reached the following initial conclusion: At TSL 4, the benefits of energy savings, NPV of consumer benefit, positive consumer LCC impacts, and emissions reductions would be outweighed by the potential burden on consumers from loss of product utility and the large product conversion costs that could result in a reduction in INPV for manufacturers.

DOE then considered TSL 3. Primary energy savings are estimated to be 0.48 quads of energy through 2045, which DOE considers significant. Under TSL 3, the estimated NPV of consumer benefit is $1.53 billion, using a discount rate of 7 percent, and $3.38 billion, using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 38.11 Mt of CO_2, 27.14 thousand tons of SO_2, 32.67 thousand tons of NO_X, and 0.095 tons of Hg. The estimated monetary value of the CO_2 emissions reductions at TSL 3 ranges from $255 million to $3,615 million.

For microwave-only ovens and countertop convection microwave ovens, DOE projects that at TSL 3 the average consumer would experience a savings in LCC of $11, and 88 percent of consumers who purchase these microwave ovens would realize some

LCC savings. At TSL 3 the median payback period is projected to be 3.5 years, substantially shorter than the lifetime of the product. In addition, DOE estimates that the reduction in standby power consumption under TSL 3 (to no greater than 1.0 W) would not impact consumer utility. The continuous clock display that would be lost under TSL 4 would be retained at TSL 3.

For built-in and over-the-range convection microwave ovens, DOE projects that at TSL 3 the average consumer would experience a savings in LCC of $12, and all consumers who purchase these microwave ovens would realize some LCC savings. At TSL 3, the median payback period is projected to be 3.3 years, significantly shorter than the lifetime of the product.

For manufacturers of microwave ovens, DOE estimated that the projected decrease in INPV under TSL 3 would range from $40.0 million to $96.6 million. DOE recognizes the risk of large negative impacts at TSL 3 if manufacturers' expectations about reduced profit margins are realized. In particular, if the high end of the range of impacts is reached, as DOE expects, TSL 3 could result in a net loss of 7.0 percent in INPV to microwave oven manufacturers.

After considering the analysis and weighing the benefits and the burdens of TSL 3, the Secretary concludes that TSL 3 will offer the maximum improvement in efficiency that is technologically feasible and economically justified, and will result in the significant conservation of energy. Therefore, DOE adopts the energy conservation standards for microwave oven standby mode and off mode at TSL 3. The amended energy conservation standards, which are maximum allowable standby power consumption, are shown in Table V-23.

Table V-23 Amended Energy Conservation Standards for Microwave Oven Standby and Off Mode

Product Classes	Effective June 17, 2016
Microwave-Only Ovens and Countertop Convection Microwave Ovens	Maximum Standby Power = 1.0 watt
Built-In and Over-the-Range Convection Microwave Ovens	Maximum Standby Power = 2.2 watts

2. Summary of Benefits and Costs (Annualized) of the Standards

The benefits and costs of today's proposed standards can also be expressed in terms of annualized values. The annualized monetary values are the sum of (1) the annualized national economic value, expressed in 2011$, of the benefits from operating products that meet the proposed standards (consisting primarily of operating cost savings from using less energy, minus increases in equipment purchase costs, which is another way of representing consumer NPV), and (2) the monetary value of the benefits of emission reductions, including CO_2 emission reductions.[42] The value of the CO_2 reductions is calculated using a range of values per metric ton of CO_2 developed by a recent interagency process. The monetary costs and benefits of cumulative emissions

[42] 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 2011, the year used for discounting the NPV of total consumer costs and savings, for the time-series of costs and benefits using discount rates of 3 and 7 percent for all costs and benefits except for the value of CO_2 reductions. For the latter, DOE used a range of discount rates, as shown in Table V-24. From the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in 2011 that yields the same present value. 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.

reductions are reported in 2011$ to permit comparisons with the other costs and benefits in the same dollar units.

Although combining the values of operating savings and CO_2 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 while the value of CO_2 reductions is based on a global value. Second, the assessments of operating cost savings and SCC are performed with different methods that use different time frames for analysis. The national operating cost savings is measured for the lifetime of products shipped in 2016–2045. The SCC values, on the other hand, reflect the present value of future climate-related impacts resulting from the emission of one ton of CO_2 in each year. These impacts continue well beyond 2100.

Table V-24 shows the annualized values for the proposed standards for microwave oven standby mode and off mode energy use. The results for the primary estimate are as follows. Using a 7-percent discount rate for benefits and costs other than CO_2 reductions, for which DOE used a 3-percent discount rate along with the SCC series corresponding to a value of $41.1/ton in 2011, the cost of the standards proposed in today's rule is $58.4 million per year in increased product costs, while the annualized benefits are $174 million in reduced product operating costs, $58.4 million in CO_2 reductions, and $1.64 million in reduced NO_X emissions. In this case, the net benefit amounts to $175 million per year. Using a 3-percent discount rate for all benefits and costs and the SCC series corresponding to a value of $41.1/ton in 2011, the cost of the standards proposed in today's rule is $66.4 million per year in increased product costs, while the annualized benefits are $234 million in reduced operating costs, $58.4 million in CO_2 reductions, and $2.20 million in reduced NO_X emissions. In this case, the net benefit amounts to $228 million per year. The monetary value of the CO_2 emissions reductions using the previous (2010) SCC estimates, and the net benefits using those estimates, is presented for information purposes in Table V.24.

Table V-24 Annualized Benefits and Costs of Amended Standards (TSL 3) for Microwave Ovens Sold in 2016–2045

	Discount Rate	Primary Estimate*	Low Net Benefits Estimate	High Net Benefits Estimate
		(Million 2011$/year)		
Benefits				
Operating Cost Savings	7%	174	162	191
	3%	234	215	261
Using 2013 Social Cost of Carbon Values				
CO_2 Reduction ($12.6/t case)**	5%	15.8	14.7	17.4
CO_2 Reduction ($41.1/t case)**	3%	58.4	54.1	64.5
CO_2 Reduction ($63.2/t case)**	2.5%	87.4	80.9	96.7
CO_2 Reduction ($119/t case)**	3%	179	166	198
Total Benefits†	7% plus CO_2 range	191 to 354	178 to 329	210 to 391
	7%	234	218	258
	3%	294	271	328
	3% plus CO_2 range	252 to 415	232 to 383	281 to 462
Using 2010 Social Cost of Carbon Values				
CO_2 Reduction ($6.2/t case)***	5%	9.29	8.62	17.4
CO_2 Reduction ($25.6/t case)***	3%	36.7	34.0	40.6
CO_2 Reduction ($41.1/t case)***	2.5%	57.9	53.6	64.1
CO_2 Reduction ($78.4/t case)***	3%	111.8	103.5	123.6
NO_X Reduction at $2,567/ton**	7%	1.64	1.54	1.79
	3%	2.20	2.05	2.42
Total Benefits†	7% plus CO_2 range	185 to 287	172 to 267	203 to 317
	7%	212	198	234
	3%	273	251	304
	3% plus CO_2 range	245 to 348	226 to 321	274 to 388
Costs				
Incremental Installed Costs	7%	58.4	59.6	57.5
	3%	66.4	67.8	64.3
Net Benefits (using 2013 SCC values)				
Total†	7% plus	133 to 296	119 to 270	153 to 334

	Discount Rate	Primary Estimate*	Low Net Benefits Estimate	High Net Benefits Estimate
		(Million 2011$/year)		
	CO_2 range			
	7%	175	158	200
	3%	228	203	264
	3% plus CO_2 range	185 to 349	164 to 315	217 to 398
Net Benefits (using 2010 SCC values)				
Total††	7% plus CO_2 range	126 to 229	113 to 208	146 to 259
	7%	154	138	176
	3%	206	183	240
	3% plus CO_2 range	179 to 281	158 to 253	210 to 323

* This table presents the annualized costs and benefits associated with microwave ovens shipped in 2016–2045. These results include benefits to consumers which accrue after 2016 from the microwave ovens purchased from 2016–2045. Costs incurred by manufacturers, some of which may be incurred prior to 2016 in preparation for the rule, are not directly included, but are indirectly included as part of incremental equipment costs. The Primary, Low Benefits, and High Benefits Estimates utilize projections of energy prices and housing starts from the AEO 2012 Reference case, Low Estimate, and High Estimate, respectively. In addition, incremental product costs reflect a medium decline rate for product prices in the Primary Estimate, constant product price in the Low Benefits Estimate, and a high decline rate for product prices in the High Benefits Estimate. The methods used to derive projected price trends are explained in section IV.E.1 of this rulemaking.

** The CO_2 values represent global monetized values of the SCC, in 2011$, in 2016 under several scenarios. The values of $12.6, $41.1, and $63.2 per metric ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $119/t represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series increase over time. The value for NO_X (in 2011$) is the average of the low and high values used in DOE's analysis.

*** The CO_2 values represent global monetized values of the SCC, in 2011$, in 2016 under several scenarios. The values of $6.2, $25.6, and $41.1 per metric ton are the averages of SCC distributions calculated using 5%, 3%, and 2.5% discount rates, respectively. The value of $78.4/t represents the 95th percentile of the SCC distribution calculated using a 3% discount rate. The SCC time series increase over time. The value for NO_X (in 2011$) 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 series corresponding to SCC value of $41.1/t in 2016. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 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 CO_2 values.

†† Total Benefits for both the 3-percent and 7-percent cases are derived using the series corresponding to SCC value of $25.6/t in 2016. In the rows labeled "7% plus CO_2 range" and "3% plus CO_2 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 CO_2 values.

VI. Additional Technical Corrections to 10 CFR 430.32

In the February 2012 SNOPR, DOE also proposed the following technical corrections to the language contained in 10 CFR 430.32. DOE noted that 10 CFR 430.32, "Energy and water conservation standards and their effective dates" contains dates required for compliance with energy and water conservation standards rather than the effective dates of such standards. As a result, DOE proposed in the February 2012 SNOPR to revise the title of 10 CFR 430.32 to read "Energy and water conservation standards and their compliance dates." DOE also noted that the current energy conservation standards for cooking products found at 10 CFR 430.32(j)(1)–(2) should be revised to more accurately reflect the date required for compliance with energy conservation standards. DOE proposed to revise the language in 10 CFR 430.32(j)(1)–(2) to state that products manufactured on or after the compliance date must meet the required energy conservation standard. 77 FR 8526, 8569 (Feb. 14, 2012).

AHAM and GE supported the proposed amendment to the title of 10 CFR 430.32 to clarify that these are compliance dates rather than effective dates, and the proposed revision to 10 CFR 430.32(j)(1)–(2) to state that products manufactured on or after the compliance date must meet the required energy conservation standards. AHAM and GE further requested that DOE clarify that products manufactured before the compliance date may continue to be sold after the compliance date. (AHAM, No. 16 at p. 4; GE, No. 19 at p. 1) DOE also received a comment from a private citizen requesting that DOE clarify the compliance date for new microwave oven standby power standards. (Private Citizen, No. 10 at p. 7)

For clarity, DOE revises in today's final rule the title of 10 CFR 430.32 and amends 10 CFR 430.32(j)(1)–(2) as proposed in the February 2012 SNOPR. In the new energy conservation standards that will be codified at 10 CFR 430.32(j)(3), DOE specifies the maximum standby power consumption for microwave ovens manufactured on or after June 17, 2016. These new standards do not apply to any microwave oven manufactured before that compliance date.

VII. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Section 1(b)(1) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993), requires each agency to identify the problem that it intends to address, including, where applicable, the failures of private markets or public institutions that warrant new agency action, as well as to assess the significance of that problem. The problems that today's standards address are as follows:

(1) There is a lack of consumer information and/or information processing capability about energy efficiency opportunities in the home appliance market.

(2) There is asymmetric information (one party to a transaction has more and better information than the other) and/or high transactions costs (costs of gathering information and effecting exchanges of goods and services).

(3) There are external benefits resulting from improved energy efficiency of microwave ovens that are not captured by the users of such equipment. These benefits include externalities related to environmental protection and energy security that are not reflected in energy prices, such as reduced emissions of greenhouse gases.

In addition, DOE has determined that today's regulatory action is an "economically significant regulatory action" under section 3(f)(1) of Executive Order 12866. Accordingly, section 6(a)(3) of the Executive Order requires that DOE prepare a regulatory impact analysis (RIA) on today's rule and that the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget (OMB) review this rule. DOE presented to OIRA for review the draft rule and other documents prepared for this rulemaking, including the RIA, and has included these documents in the rulemaking record. The assessments prepared pursuant to Executive Order 12866 can be found in the technical support document for this rulemaking.

DOE has also reviewed this regulation pursuant to Executive Order 13563, issued on January 18, 2011 (76 FR 3281 (Jan. 21, 2011)). EO 13563 is supplemental to and explicitly reaffirms the principles, structures, and definitions governing regulatory review established in Executive Order 12866. To the extent permitted by law, agencies are required by Executive Order 13563 to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.

DOE emphasizes as well that Executive Order 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, DOE determines that today's final rule is consistent with these principles, including the requirement that, to the extent permitted by law, benefits justify costs and that net benefits are maximized.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq.) requires preparation of a regulatory flexibility analysis (RFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (Aug. 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (www.gc.doe.gov).

For manufacturers of microwave ovens, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. 65 FR 30836, 30848 (May 15, 2000), as amended at 65 FR 53533, 53544 (Sept. 5, 2000) and codified at 13 CFR part 121.The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at http://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf. Microwave oven manufacturing is classified under NAICS 335221, "Household Cooking Appliance Manufacturing." The SBA sets a threshold of 750 employees or less for an entity to be considered as a small business for this category.

DOE surveyed the AHAM member directory to identify manufacturers of microwave ovens. In addition, DOE asked interested parties and AHAM representatives within the microwave oven industry if they were aware of any small business manufacturers. DOE consulted publicly available data, purchased company reports from sources such as Dun & Bradstreet, and contacted manufacturers, where needed, to determine if they meet the SBA's definition of a small business manufacturing facility and have their manufacturing facilities located within the United States. Based on this analysis, DOE determined that the microwave oven industry consists of seven manufacturers that have a market share greater than 3 percent. Most are large, foreign companies that import microwave ovens into the United States. There are U.S. facilities that partly assemble microwave ovens, but none of these are small businesses. DOE estimates that there is one small business which manufactures a product which combines a microwave oven with other appliance functionality. However, because DOE is not amending energy conservation standards at this time for the microwave oven portion of such combined products, DOE certifies that today's final rule would not have a significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE will transmit the certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act

Manufacturers of microwave ovens must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedure for microwave ovens, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including microwave ovens. (76 FR 12422 (Mar. 7, 2011). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910-1400. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act (NEPA) of 1969, DOE has determined that the rule fits within the category of actions included in Categorical Exclusion (CX) B5.1 and otherwise meets the requirements for application of a CX. See 10 CFR Part 1021, App. B, B5.1(b); 1021.410(b) and Appendix B, B(1)–(5). The rule fits within the category of actions because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, and for which none of the exceptions identified in CX B5.1(b) apply. Therefore, DOE has made a CX determination for this rulemaking, and DOE does not need to prepare an Environmental

Assessment or Environmental Impact Statement for this rule. DOE's CX determination for this rule is available at http://cxnepa.energy.gov/.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism." 64 FR 43255 (Aug. 10, 1999) imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For an amended regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section

202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at www.gc.doe.gov.

DOE has concluded that this final rule would likely require expenditures of $100 million or more on the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by microwave oven manufacturers in the years between the final rule and the compliance date for the new standards, and (2) incremental additional expenditures by consumers to purchase higher-efficiency microwave ovens, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the final rule. 2 U.S.C. 1532(c). The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The

SUPPLEMENTARY INFORMATION section of the notice of final rulemaking and the “Regulatory Impact Analysis” section of the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, the Department is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. 2 U.S.C. 1535(a). DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(h), today’s final rule would establish energy conservation standards for microwave ovens that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified. A full discussion of the alternatives considered by DOE is presented in the “Regulatory Impact Analysis” section of the TSD for today’s final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights" 53 FR 8859 (Mar. 18, 1988), that this regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use" 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that today's regulatory action, which sets forth energy conservation standards for microwave oven standby mode and off mode, is not a significant energy action because the amended standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on the final rule.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions. 70 FR 2667.

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. The "Energy Conservation Standards Rulemaking Peer Review Report" dated February 2007 has been disseminated and is available at the following Web site: www1.eere.energy.gov/buildings/appliance_standards/peer_review.html.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The report will state that it has been determined that the rule is a "major rule" as defined by 5 U.S.C. 804(2).

VIII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of today's final rule.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements**.**

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Reporting and recordkeeping requirements, and Small businesses.

Issued in Washington, DC, on May 31, 2013.

____
David T. Danielson
Assistant Secretary of Energy
Energy Efficiency and Renewable Energy

For the reasons stated in the preamble, DOE amends parts 429 and 430, of Chapter II of title 10 of the Code of Federal Regulations, as set forth below.

PART 429--CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317.

2. In § 429.23 revise paragraph (b)(2) to read as follows:

§ 429.23 Conventional cooking tops, conventional ovens, microwave ovens.

* * * * *

(b) * * *

(2) Pursuant to §429.12(b)(13), a certification report shall include the following public product-specific information: For conventional cooking tops and conventional ovens: the type of pilot light and a declaration that the manufacturer has incorporated the applicable design requirements. For microwave ovens, the average standby power in watts.

PART 430--ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

3. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

4. In § 430.23 add paragraph (i)(3) to read as follows:

§ 430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(i) * * *

(3) The standby power for microwave ovens shall be determined according to 3.2.3 of appendix I to this subpart. The standby power shall be rounded off to the nearest 0.1 watt.

* * * * *

5. In § 430.32 revise the section heading and paragraph (j) to read as follows:

§ 430.32 Energy and water conservation standards and their compliance dates.

* * * * *

(j) Cooking Products (1) Gas cooking products with an electrical supply cord manufactured on or after January 1, 1990, shall not be equipped with a constant burning pilot light.

(2) Gas cooking products without an electrical supply cord manufactured on or after April 9, 2012, shall not be equipped with a constant burning pilot light.

(3) Microwave-only ovens and countertop convection microwave ovens manufactured on or after June 17, 2016 shall have an average standby power not more than 1.0 watt. Built-in and over-the-range convection microwave ovens manufactured on or after June 17, 2016 shall have an average standby power not more than 2.2 watts.

* * * * *

[FR Doc. 2013-13535 Filed 06/14/2013 at 8:45 am; Publication Date: 06/17/2013]