DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE–2017–BT–STD–0023]

RIN 1904–AE00

Energy Conservation Program: Energy Conservation Standards for Microwave Ovens

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

ACTION: Final rule.

SUMMARY: The Energy Policy and Conservation Act, as amended (''EPCA''), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including microwave ovens. EPCA also requires the U.S. Department of Energy (''DOE'') to periodically determine whether more stringent standards would be technologically feasible and economically justified, and whether they would result in significant energy savings. In this final rule, DOE is adopting amended energy conservation standards for microwave ovens. It has determined that the amended energy conservation standards for these products would result in significant conservation of energy and are technologically feasible and economically justified.

DATES: The effective date of this rule is August 21, 2023. Compliance with the amended standards established for microwave ovens in this final rule is required on and after June 22, 2026.

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

The docket web page can be found at *www.regulations.gov/docket/EERE-2017-BT-STD-0023.* The docket web page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

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SUPPLEMENTARY INFORMATION:

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I. Synopsis of the Final Rule

The Energy Policy and Conservation Act, Public Law 94–163, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part B of EPCA [2] established the Energy Conservation Program for Consumer Products Other Than Automobiles. (42 U.S.C. 6291–6309) These products include microwave ovens, the subject of this rulemaking.

Pursuant to EPCA, any new or amended energy conservation standard must 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)) EPCA also provides that not later than 6 years after issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m))

In accordance with these and other statutory provisions discussed in this document, DOE is adopting amended energy conservation standards for microwave ovens. The adopted standards, which are expressed in watts (''W''), are shown in Table I.1. These standards apply to all products listed in Table I.1 and manufactured in, or imported into, the United States starting on June 22, 2026.

TABLE I.1—ENERGY CONSERVATION STANDARDS FOR MICROWAVE OVENS (COMPLIANCE STARTING JUNE 22, 2026)

Product class	Maximum allowable average standby power, (watts)
PC 1: Microwave-Only Ovens and Countertop Convection Microwave Ovens.	0.6 W
PC 2: Built-In and Over-the-Range Convection Microwave Ovens.	1.0 W

A. Benefits and Costs to Consumers

Table I.2 summarizes DOE's evaluation of the economic impacts of the adopted standards on consumers of microwave ovens, as measured by the average life-cycle cost (''LCC'') savings and the simple payback period (''PBP'').[3] The average LCC savings are positive for all product classes, and the PBP is less than the average lifetime of microwave ovens, which is estimated to be 10.78 years (see section IV.F of this document).

TABLE I.2—IMPACTS OF ADOPTED ENERGY CONSERVATION STANDARDS ON CONSUMERS OF MICROWAVE OVENS

Product class	Average LCC savings (2021$)	Simple payback period (years)
PC 1: Microwave-Only Ovens and Countertop Convection Microwave Ovens	0.99	1.3
PC 2: Built-In and Over-the-Range Convection Microwave Ovens	0.83	0.8

DOE's analysis of the impacts of the adopted standards on consumers is described in section IV.F of this document.

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 (2023–2055). Using a real discount rate of 8.5 percent, DOE estimates that the INPV for manufacturers of microwave ovens in the case without amended standards is $1,426 million in 2021 dollars. Under the adopted standards, DOE estimates the change in INPV to range from −$37.2 million, which represents a change of −2.6 percent, to no change in INPV. In order to bring products into compliance with amended standards, it is estimated that industry will incur total conversion costs of $46.1 million.

DOE's analysis of the impacts of the adopted standards on manufacturers is described in sections IV.J and V.B.2 of this document.

C. National Benefits and Costs [4]

DOE's analyses indicate that the adopted energy conservation standards for microwave ovens would save a significant amount of energy. Relative to the case without amended standards, the lifetime energy savings for microwave ovens purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2026–2055), amount to 0.06 quadrillion British thermal units (''Btu''), or quads.[5] This represents a savings of 19 percent relative to the energy use of these products in the case without amended standards (referred to as the ''no-new-standards case'').

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

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

[3] The average LCC savings refer to consumers that are affected by a standard and are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of new or amended standards (*see* section [IV.F.9] of this document). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (*see* section IV.C of this document).

[4] All monetary values in this document are expressed in 2021 dollars. and, where appropriate, are discounted to 2023 unless explicitly stated otherwise.

[5] The quantity refers to full-fuel-cycle (FFC) energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.1 of this document.

The cumulative net present value (''NPV'') of total consumer benefits of the standards for microwave ovens ranges from $0.16 (at a 7-percent discount rate) to $0.35 (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased product costs for microwave ovens purchased in 2026–2055.

In addition, the adopted standards for microwave ovens are projected to yield significant environmental benefits. DOE estimates that the standards will result in cumulative emission reductions (over the same period as for energy savings) of 1.87 million metric tons (''Mt'') [6] of carbon dioxide (''CO_2''), 0.85 thousand tons of sulfur dioxide (''SO_2''), 2.88 thousand tons of nitrogen oxides (''NO_X''), 12.64 thousand tons of methane (''CH_4''), 0.02 thousand tons of nitrous oxide (''N_2O''), and 0.005 tons of mercury (''Hg'').[7] The estimated cumulative reduction in CO_2 emissions through 2030 amounts to 0.10 Mt, which is equivalent to the emissions resulting from the annual electricity use of more than 19 thousand homes.

DOE estimates the value of climate benefits from a reduction in greenhouse gases (GHG) using four different estimates of the social cost of CO_2 (''SC–CO_2''), the social cost of methane (''SC–CH_4''), and the social cost of nitrous oxide (''SC–N_2O''). Together these represent the social cost of GHG (SC–GHG). DOE used interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (IWG).[8] The derivation of these values is discussed in section IV.L of this document. For presentational purposes, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are estimated to be $0.10 billion. DOE does not have a single central SC–GHG point estimate and DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates.[9]

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions, using benefit-per-ton estimates from the scientific literature, as discussed in section IV.L of this document. DOE estimated the present value of the health benefits would be $0.07 billion using a 7-percent discount rate, and $0.17 billion using a 3-percent discount rate.[10] DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects, such as health benefits, from reductions in direct $PM_{2.5}$ emissions.

Table I.3 summarizes the monetized benefits and costs expected to result from the amended standards for microwave ovens. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

TABLE I.3—SUMMARY OF MONETIZED BENEFITS AND COSTS OF ADOPTED ENERGY CONSERVATION STANDARDS FOR MICROWAVE OVENS

	Billion $2021
3% discount rate	
Consumer Operating Cost Savings	0.43
Climate Benefits *	0.10
Health Benefits **	0.17
Total Benefits †	0.70
Consumer Incremental Product Costs ‡	0.08
Net Benefits	0.62
7% discount rate	
Consumer Operating Cost Savings	0.21
Climate Benefits * (3% discount rate)	0.10
Health Benefits **	0.07
Total Benefits†	0.38
Consumer Incremental Product Costs ‡	0.05
Net Benefits	0.34

Note: This table presents the costs and benefits associated with microwave ovens shipped in 2026 − 2055. These results include benefits to consumers which accrue after 2055 from the products shipped in 2026–2055.

[6] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.

[7] DOE calculated emissions reductions relative to the no-new-standards-case, which reflects key assumptions in the *Annual Energy Outlook 2022* (''*AEO2022*''). *AEO2022* represents current Federal and State legislation and final implementation of regulations as of the time of its preparation. *See* section IV.K of this document for further discussion of *AEO2022* assumptions that effect air pollutant emissions.

[8] *See* Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide. Interim Estimates Under Executive Order 13990, Washington, DC, February 2021 (''February 2021 SC–GHG TSD''*). www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.*

[9] On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

[10] DOE estimates the economic value of these emissions reductions resulting from the considered TSLs for the purpose of complying with the requirements of Executive Order 12866.

* Climate benefits are calculated using four different estimates of the social cost of carbon ($SC–CO_2$), methane ($SC–CH_4$), and nitrous oxide ($SC–N_2O$) (model average at 2.5-percent, 3-percent, and 5-percent discount rates; 95th percentile at 3-percent discount rate) (*see* section IV.L of this document). Together these represent the global SC–GHG. For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC–GHG point estimate. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects, such as health benefits, from reductions in direct $PM_{2.5}$ emissions. *See* section IV.L of this document for more details.

† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate.

‡ Costs include incremental equipment costs as well as installation costs.

The benefits and costs of the proposed standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are (1) the reduced consumer operating costs, minus (2) the increase in product purchase prices and installation costs, plus (3) the value of climate and health benefits of emission reductions, all annualized.[11]

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of microwave ovens shipped in 2026–2055. The benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated based on the lifetime of microwave ovens shipped in 2026–2055. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate. Estimates of SC–GHG values are presented for all four discount rates in section V.B.8 of this document.

Table I.4 presents the total estimated monetized benefits and costs associated with the standards adopted in this rule, expressed in terms of annualized values. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NO_X and SO_2 emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is $4.3 million per year in increased equipment costs, while the estimated annual benefits are $19.5 million in reduced equipment operating costs, $5.2 million in climate benefits, and $6.9 million in health benefits. In this case, the net benefit would amount to $27.3 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the amended standards is $4.3 million per year in increased equipment costs, while the estimated annual benefits are $23.5 million in reduced operating costs, $5.2 million in climate benefits, and $9.2 million in health benefits. In this case, the net benefit would amount to $33.5 million per year.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS FOR MICROWAVE OVENS

	Million 2021 $/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	23.5	22.2	25.0
Climate Benefits *	5.2	5.1	5.4
Health Benefits **	9.2	9.0	9.4
Total Benefits †	37.9	36.3	39.8
Consumer Incremental Product Costs ‡	4.3	4.3	4.2
Net Benefits	33.5	31.9	35.6
7% discount rate			
Consumer Operating Cost Savings	19.5	18.6	20.5
Climate Benefits * (3% discount rate)	5.2	5.1	5.4
Health Benefits **	6.9	6.7	7.1
Total Benefits †	31.6	30.4	32.9
Consumer Incremental Product Costs ‡	4.3	4.3	4.2

[11] To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2022, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.,* 2020 or 2030), and then discounted the present value from each year to 2022. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

TABLE I.4—ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS FOR MICROWAVE OVENS—Continued

	Million 2021 $/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
Net Benefits	27.3	26.1	28.7

Note: This table presents the costs and benefits associated with microwave ovens shipped in 2026–2055. These results include benefits to consumers which accrue after 2055 from the products shipped in 2026–2055. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2022* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.1 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC–GHG (*see* section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. *See* section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate.

‡ Costs include incremental equipment costs as well as installation costs.

DOE's analysis of the national impacts of the adopted standards is described in sections IV.H, IV.K, and IV.L of this document.

D. Conclusion

DOE concludes that the standards adopted in this final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified, and would result in the significant conservation of energy. Specifically, with regards to technological feasibility, products achieving these standard levels are already commercially available for all product classes covered by this proposal. As for economic justification, DOE's analysis shows that the benefits of the standards exceed, to a great extent, the burdens of the standards.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the standards for microwave ovens is $4.3 million per year in increased product costs, while the estimated annual benefits are $19.5 million in reduced product operating costs, $5.2 million in climate benefits, and $6.9 million in health benefits. The net benefit amounts to $27.3 million per year.

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.[12] For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national energy savings of 0.06 quads in FFC energy use and emissions, the equivalent of the primary annual energy use of 1.6 million homes. In addition, the standards are projected to reduce CO_2 emissions by 1.87 Mt. Based on these findings, DOE has determined the energy savings from the standard levels adopted in this final rule are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these conclusions is contained in the remainder of this document and the accompanying final rule technical support document (''TSD'').

II. Introduction

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

A. Authority

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part B of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles. These products include microwave ovens, the subject of this document. (42 U.S.C. 6292(a)(10)) EPCA prescribed energy conservation standards for these products, and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(h)(2)(A)–(B)) EPCA further provides that, not later than 6 years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination that standards for the product do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6295(m)(1))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation

[12] Procedures, Interpretations, and Policies for Consideration in New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Commercial/Industrial Equipment, 86 FR 70892, 70901 (Dec. 13, 2021).

standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

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

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. 6295(o)(3)(A) and 42 U.S.C. 6295(r)) 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. (42 U.S.C. 6295(s)) The DOE test procedures for microwave ovens appear at title 10 of the Code of Federal Regulations (''CFR'') § 430.23(i) and 10 CFR part 430, subpart B, appendix I (''appendix I'').

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including microwave ovens. Any new or amended standard for a covered product must be designed to achieve the maximum improvement in energy efficiency that the Secretary of Energy determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A) and 42 U.S.C. 6295(o)(3)(B)) 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 standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed 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 statutory 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 standard;

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

(4) Any lessening of the utility or the performance of the covered products likely to result from 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 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))

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. (42 U.S.C. 6295(o)(2)(B)(iii))

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 in 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))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. DOE must specify a different standard level for a type or class of products that has 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))

Finally, pursuant to the amendments contained in the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110–140, any final rule for new or amended energy conservation standards promulgated after July 1, 2010, is 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 a single 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))

B. Background

1. Current Standards

In a final rule published on June 17, 2013 (''June 2013 Final Rule''), DOE prescribed the current energy conservation standards for microwave ovens manufactured on and after June 17, 2016. 78 FR 36316. These standards are set forth in DOE's regulations at 10 CFR 430.32(j)(3) and are repeated in Table II.1.

TABLE II.1—FEDERAL ENERGY CONSERVATION STANDARDS FOR MICROWAVE OVENS

Product class	Maximum allowable average standby power
Microwave-Only Ovens and Countertop Convection Microwave Ovens.	1.0 W.
Built-In and Over-the-Range Convection Microwave Ovens.	2.2 W.

2. History of Standards Rulemaking for Microwave Ovens

EPCA prescribed an energy conservation standard for kitchen ranges and ovens, and directed DOE to conduct two cycles of rulemakings to determine whether to amend standards for these products. (42 U.S.C. 6295(h)(2)(A)–(B)) DOE completed the first of these rulemaking cycles by publishing a final rule on September 8, 1998, that codified the prescriptive design standard for gas cooking products established in EPCA, but found that no standards were justified for electric cooking products, including microwave ovens, at that time. 63 FR 48038, 48053–48054. DOE completed the second rulemaking cycle and published a final rule on April 8, 2009, in which it determined, among other things, that standards for microwave oven active mode energy use were not economically justified. 74 FR 16040.

DOE published the June 2013 Final Rule, adopting energy conservation standards for microwave ovens. 78 FR 36316. In the June 2013 Final Rule, DOE maintained its prior determination that active mode standards are not warranted for microwave ovens and prescribed energy conservation standards that address the standby and off mode energy use of microwave ovens. 78 FR 36316, 36317.

In support of the present review of the microwave oven energy conservation standards, DOE published an early assessment request for information on August 13, 2019, which identified various issues on which DOE sought comment to inform its determination of whether the standards need to be amended. 84 FR 39980.

DOE subsequently published a notice of proposed determination (''NOPD'') on August 12, 2021, in which DOE initially determined that current standards for microwave ovens do not need to be amended. 86 FR 44298. (''August 2021 NOPD'') In the August 2021 NOPD, DOE tentatively determined that there are technology options that would improve the efficiency of microwave ovens. 86 FR 44298, 44310. Based on the analysis conducted for the August 2021 NOPD, DOE estimated that amended standards for microwave oven standby power at the maximum technologically feasible (''max-tech'') level would result in 0.1 quads of energy saved over a 30-year period (representing an estimated 8 percent reduction in site energy use of microwave ovens). 86 FR 44298, 44310.

In evaluating the significance of the estimated energy savings for the August 2021 NOPD, DOE applied a two-part numeric threshold test that was then applicable under section 6(b) of appendix A to 10 CFR part 430 subpart C (Jan. 1, 2021 edition). Specifically, the threshold required that an energy conservation standard result in a 0.30 quads reduction in site energy use over a 30-year analysis period or a 10-percent reduction in site energy use over that same period. See 85 FR 8626, 8670 (Feb. 14, 2020). In the August 2021 NOPD, DOE stated that the estimated site energy savings at the max-tech level was under the 0.3-quads/10-percent threshold and tentatively determined that amended energy conservation standards for microwave oven standby power would not result in significant conservation of energy. 86 FR 44298, 44310. DOE also noted that the two-part numeric threshold was under reconsideration. 86 FR 44298, 44302.

On December 13, 2021, DOE published in the **Federal Register** a final rule that amended appendix A to 10 CFR part 430 subpart C (''appendix A''). 86 FR 70892 (''December 2021 Final Rule''). The December 20201 Final Rule, in part, removed the numeric threshold in section 6(b) of appendix A for determining when the significant energy savings criterion is met, reverting to DOE's prior practice of making such determinations on a case-by-case basis. 86 FR 70892.

After the publication of the NOPD, DOE conducted investigative testing and manufacturer discussions, and updated the engineering analysis to be used in a subsequently published supplemental notice of proposed rulemaking (''SNOPR'') on August 24, 2022. 87 FR 52282. (''August 2022 SNOPR'') In the August 2022 SNOPR, DOE revised the efficiency levels, manufacturer selling price (''MSP'')-efficiency relationships, and LCC and PBP analyses to evaluate the economic impacts of potential energy conservation standards for microwave ovens on individual consumers. The amended energy conservation standards for microwave ovens proposed in the August 2022 SNOPR are shown in Table II.2. DOE requested comment on these proposed standards and associated analyses and results.

TABLE II.2—AUGUST 2022 SNOPR PROPOSED ENERGY CONSERVATION STANDARDS FOR MICROWAVE OVENS

Product class	Maximum allowable average standby power (watts)
PC 1: Microwave-Only Ovens and Countertop Convection Microwave Ovens.	0.6 W.
PC 2: Built-In and Over-the-Range Convection Microwave Ovens.	1.0 W.

DOE held a public meeting on October 11, 2022, to solicit feedback from stakeholders concerning the August 2022 SNOPR, and received 5 comments in response to the August 2022 SNOPR from the interested parties listed in Table II.3.

TABLE II.3—AUGUST 2022 SNOPR WRITTEN COMMENTS

Commenter(s)	Abbreviation	Comment number in the docket	Commenter type
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, National Consumer Law Center, Natural Resources Defense Council, Northwest Energy Efficiency Alliance.	The Joint Commenters.	31	Efficiency Organizations.
Association of Home Appliance Manufacturers	AHAM	28	Trade Association.
Center for Climate and Energy Solutions, Institute for Policy Integrity at New York University School of Law, Natural Resources Defense Council, Sierra Club, Union of Concerned Scientists, Institute for Policy Integrity.	C2ES	29	Efficiency Organizations.

TABLE II.3—AUGUST 2022 SNOPR WRITTEN COMMENTS—Continued

Commenter(s)	Abbreviation	Comment number in the docket	Commenter type
Whirlpool Corporation	Whirlpool	30	Manufacturer.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[13] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the October 11, 2022 webinar, DOE cites the written comments throughout this final rule. Any oral comments provided during the webinar that are not substantively addressed by written comments are summarized and cited separately throughout this final rule.

III. General Discussion

DOE developed this final rule after considering oral and written comments, data, and information from interested parties that represent a variety of interests. The following discussion addresses issues raised by these commenters.

A. Scope of Coverage

This final rule covers those consumer products that meet the definition of ''microwave oven'' as codified at 10 CFR 430.2, which defines ''microwave oven'' as a category of cooking products which is a household cooking appliance consisting of a compartment designed to cook or heat food by means of microwave energy, including microwave ovens with or without thermal elements designed for surface browning of food and convection microwave ovens. This includes any microwave oven(s) component of a combined cooking product. Any product meeting the definition of microwave oven is included in DOE's scope of coverage.

For this final rule, DOE considered the two product classes of microwave ovens prescribed in the current energy conservation standards: (1) Microwave-Only Ovens and Countertop Convection Microwave Ovens, and (2) Built-In and Over-the-Range Convection Microwave Ovens.

For these two classes of microwave ovens, DOE's current test procedure measures the energy consumption in standby mode and off mode only. Consequently, DOE's current energy conservation standards for microwave ovens are also expressed in terms of standby mode and off mode power. There are currently no active mode energy conservation standards; nor is there a prescribed test procedure for measuring the active mode energy use or efficiency (*e.g.,* cooking efficiency) of microwave ovens.

The Joint Commenters commented that adopting a standard for active mode energy consumption could achieve ''significantly greater'' savings than proposed standby power standards, and that DOE should develop a test procedure and standards for active mode power consumption. (Joint Commenters, No. 31 at p. 2) DOE previously rejected developing an active mode test procedure in the microwave oven test procedure final rule published on March 30, 2022, (''March 2022 TP Final Rule'') due to undue burden on manufacturers and the lack of an available test procedure that accounts for the efficiency improvements of inverter microwave ovens. 87 FR 18261. As there is no test procedure for measuring the active mode efficiency of a microwave oven, and since development of such a test procedure is out of the scope of this document, DOE is not currently proposing to adopt an active mode energy usage standard.

See section IV.2 of this document for discussion of the product classes analyzed in this final rule.

B. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6293) Manufacturers of covered products must use these test procedures to certify to DOE that their product complies with energy conservation standards and to quantify the efficiency of their product. DOE will finalize a test procedure establishing methodologies used to evaluate proposed energy conservation standards prior to publication of a NOPR proposing new or amended energy conservation standards. Section 8(d)(1) of appendix A. As discussed, DOE amended the test procedure for microwave ovens, set forth in appendix I, in the March 2022 TP Final Rule. DOE's current energy conservation standards for microwave ovens are expressed in terms of watts of standby power. (*See* 10 CFR 430.23(j)(3).)

C. Technological Feasibility

1. General

In each energy conservation 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. Sections 6(b)(3)(i) and 7(b)(1) of appendix A.

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, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety and (4) unique-pathway proprietary technologies. Sections 6(b)(3)(ii) through (v) and sections 7(b)(2) through (5) of appendix A. Section IV.B of this document 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 standards considered in this rulemaking. For further details on the screening analysis for this rulemaking, see chapter 4 of the final rule TSD.

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

[13] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for microwave ovens. (Docket No. EERE–2017–BT–STD–0023, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE determined the maximum technologically feasible (''max-tech'') improvements in energy efficiency for microwave ovens, using the design parameters for the most efficient products available on the market or in working prototypes. The max-tech levels that DOE determined for this rulemaking are described in section IV.C of this document and in chapter 5 of the final rule TSD.

D. Energy Savings

1. Determination of Savings

For each trial standard level (''TSL''), DOE projected energy savings from application of the TSL to microwave ovens purchased in the 30-year period that begins in the year of compliance with the amended standards (2026–2055).[14] The savings are measured over the entire lifetime of products purchased in the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of amended energy conservation standards.

DOE used its national impact analysis (''NIA'') spreadsheet models to estimate national energy savings (''NES'') from potential amended standards for microwave ovens. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports national energy savings in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.[15] DOE's approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

2. Significance of Savings

To adopt any new or amended standards for a covered product, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 6295(o)(3)(B))

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking. For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than products with relatively constant demand. In evaluating the significance of energy savings, DOE considers differences in primary energy and FFC effects for different covered products and equipment when determining whether energy savings are significant. Primary energy and FFC effects include the energy consumed in electricity production (depending on load shape), in distribution and transmission, and in extracting, processing, and transporting primary fuels (*i.e.,* coal, natural gas, petroleum fuels), and thus present a more complete picture of the impacts of energy conservation standards.

Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis. As stated, the standard levels adopted in this final rule are projected to result in national FFC energy savings of 0.06 quads, the equivalent of the electricity use of 1.6 million homes in one year. DOE has determined the energy savings from the standard levels adopted in this final rule are ''significant'' within the meaning of 42 U.S.C. 6295(o)(3)(B).

E. Economic Justification

1. Specific Criteria

As noted previously, 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)(I)–(VII)) 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 potential amended standards on manufacturers, DOE conducts a Manufacturer Impact Analysis (''MIA''), as discussed in section IV.J of this document. DOE 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 (1) INPV, which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) 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 individual consumers, measures of economic impact include the changes in LCC and payback period (''PBP'') associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national net present value of the consumer costs and benefits expected to result from particular standards. DOE also evaluates the impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a standard.

b. Savings in Operating Costs Compared To Increase in Price (LCC and PBP)

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product that are likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analysis.

The LCC is the sum of the purchase price of a product (including its

[14] Each TSL is composed of specific efficiency levels for each product class. The TSLs considered for this rule are described in section V.A of this document. DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

[15] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).

installation) and the operating cost (including energy, maintenance, and repair expenditures) discounted over the lifetime of the product. The LCC analysis requires a variety of inputs, such as product prices, product energy consumption, energy prices, maintenance and repair costs, product lifetime, and discount rates appropriate for consumers. 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.

The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

For its LCC and PBP analysis, DOE assumes that consumers will purchase the covered products in the first year of compliance with new or amended standards. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. DOE's LCC and PBP analysis is discussed in further detail in section IV.F of this document.

c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting 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.E of this document, DOE uses the NIA spreadsheet models to project national energy savings.

d. Lessening of Utility or Performance of Products

In establishing product classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered products. (42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards adopted in this document would 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 the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a standard. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the 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 proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6295(o)(2)(B)(ii)) To assist the Department of Justice (''DOJ'') in making such a determination, DOE transmitted copies of the August 2022 SNOPR and the SNOPR TSD to the Attorney General for review, with a request that the DOJ provide its determination on this issue. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for microwave ovens are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

f. Need for National Energy Conservation

DOE also considers the need for national energy and water conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from the adopted 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, as discussed in section IV.M of this document.

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The adopted standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases (''GHGs'') associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document; the estimated emissions impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described previously, DOE could consider such information under ''other factors.''

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 effects that proposed 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.F of this document.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to microwave ovens. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the standards considered in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation

standards. The national impacts analysis uses a second spreadsheet set that provides shipments projections and calculates national energy savings and net present value of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model (''GRIM''), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: *www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/48.* Additionally, DOE used output from the latest version of the Energy Information Administration's (''EIA's'') *Annual Energy Outlook* (''*AEO*'') for the emissions and utility impact analyses.

1. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the products concerned, including the purpose of the products, the industry structure, manufacturers, market characteristics, and technologies used in the products. This activity includes both quantitative and qualitative assessments, based primarily on publicly-available information. The subjects addressed in the market and technology assessment for this rulemaking include (1) a determination of the scope of the rulemaking and product classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) shipments information, (5) market and industry trends, and (6) technologies or design options that could improve the energy efficiency of microwave ovens. The key findings of DOE's market assessment are summarized in the following sections. See chapter 3 of the final rule TSD for further discussion of the market and technology assessment.

AHAM commented that it disagrees with DOE addressing European efficiency programs as a part of its analysis for the August 2022 SNOPR. AHAM stated that DOE is improperly making direct comparisons to the European market and should not look to Europe or any other jurisdiction for guidance without first understanding the differences between products in those markets and those in the United States. (AHAM, No. 28 at p. 10) In response to AHAM's comment, DOE notes that its analysis of foreign regulatory programs is only to reduce additional manufacturer burden in complying with conflicting standards. DOE did not find any conflicting foreign regulatory programs, nor did it develop trial standards levels based on any foreign regulations. In the case of this rulemaking, foreign regulations had no bearing on DOE's analysis.

2. Product Classes

When evaluating and establishing energy conservation standards, DOE may establish separate standards for a group of covered products (*i.e.,* establish a separate product class) if DOE determines that separate standards are justified based on the type of energy used, or if DOE determines that a product's capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6295(q)) In making a determination whether a performance-related feature justifies a different standard, DOE must consider such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

Any product meeting the definition of a microwave oven, as codified in 10 CFR 430.2, is included in DOE's scope of coverage. ''Microwave oven'' is defined as a category of cooking products which is a household cooking appliance consisting of a compartment designed to cook or heat food by means of microwave energy, including microwave ovens with or without thermal elements designed for surface browning of food and convection microwave ovens. This includes any microwave oven(s) component of a combined cooking product.

For this proposal, DOE considered the two product classes of microwave ovens prescribed in the current energy conservation standards: (1) Microwave-Only Ovens and Countertop Convection Microwave Ovens, and (2) Built-In and Over-the-Range Convection Microwave Ovens.

For these two classes of microwave ovens, DOE's current test procedure measures the energy consumption in standby mode and off mode only. Consequently, DOE's current energy conservation standards for microwave ovens are also expressed in terms of standby mode and off mode power. There are currently no active mode energy conservation standards nor a prescribed test procedure for measuring the active mode energy use or efficiency (*e.g.,* cooking efficiency) of microwave ovens.

In response to the August 2022 SNOPR, AHAM and Whirlpool requested that DOE consider changing microwave oven product classes to align with the three general chassis designs: countertop, built-in, and over-the-range. AHAM commented that the feature sets, design requirements, consumer use patterns, and standby powers are more correlated to chassis type than the presence of convection functionality. (AHAM, No. 28 at p. 12) AHAM further stated that, on a shipment-weighted average basis, countertop models consume 0.6 W of standby power, followed by over-the-range models, and built-in models consuming 0.81 W and 1.65 W of standby power, respectively. (AHAM, No. 28 at p. 13) Whirlpool added that task lights, exhaust fans, and environmental sensors are some of the unique features of many over-the-range microwave ovens. (Whirlpool, No. 30 at p. 6).

In the June 2013 Final Rule, DOE discussed its rationale for establishing the current product class structure. In that rulemaking, DOE acknowledged 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 warrant a separate product class for over-the-range microwave-only ovens from countertop microwave ovens. 78 FR 36328. For this rulemaking, DOE's teardown and analyses of the Compliance Certification Database (''CCD [16]'') showed that microwave ovens have a wide variety of features independent of chassis type. DOE found various sensors, display types, and connectivity features in over-the-range, built-in and countertop microwave ovens. As such, DOE determines that performance-related features are fully reflected by the current product class structure. Additionally, AHAM claims via its shipment-weighted average standby power consumption data that the only meaningful differentiation for product classes is installation configuration. AHAM however did not provide shipments data with sufficient granularity to contradict DOE's previous data and conclusions (*i.e.,* to justify eliminating product class differentiation on the basis of convection features and instead defining product classes solely by installation configuration). As a result, DOE is unable to rely on AHAM's data to revise the product classes. Further, DOE is not aware of, nor did AHAM provide, any data demonstrating that consumer utility varies by chassis type and has impacts on energy use that would justify establishing separate product classes. As a result, DOE is

[16] Available at *www.regulations.doe.gov/certification-data.*

opting to maintain its current product class structure.

3. Technology Options

In the preliminary market analysis and technology assessment for the August 2022 SNOPR, DOE identified four technology options initially determined to improve the efficiency of microwave ovens, as measured by the DOE test procedure:

TABLE IV.1—MICROWAVE OVEN TECHNOLOGY OPTIONS

Mode	Technology option
Standby	Lower-power display technologies.
Standby	Cooking sensors with no standby power requirement.
Standby	More efficient power supply and control board options.
Standby	Automatic power-down of most power-consuming components, including the clock display.

In support of the analysis for its August 2022 SNOPR, DOE purchased and tested 33 microwave ovens representing the two proposed product classes, and the results confirmed that microwave oven models currently on the market can achieve standby power consumption values in-between the very low levels enabled by automatic power-down microwave ovens and the proposed levels (*i.e.,* 0.6 W for Product Class 1 and 1.0 W for Product Class 2). 87 FR 52283. Further, DOE's testing suggested that microwave ovens are frequently rated conservatively, such that their certified standby power level is higher than actual values obtained when tested in accordance with appendix I. Therefore, DOE was unable to accurately assess the relationship between specific standby power levels and utilized technology options based on data from the CCD. Instead, DOE used the measured standby power levels of microwave oven models in its test sample as a proxy to determine the representative distribution of standby power levels among microwave ovens on the market, as shown in Table *IV.2.* Details of the methodology and results from DOE's investigative testing are included in chapter 3 and chapter 5 of the SNOPR TSD as well as the final rule TSD.[17]

[17] The final rule TSD as well as the SNOPR TSD are available on the docket, *www.regulations.gov/document/EERE-2017-BT-STD-0023-0022.*

TABLE IV.2—ESTIMATED MARKET DISTRIBUTION OF MICROWAVE OVENS

Standby power (W)	Market share (%)
Microwave-Only Ovens and Countertop Convection Microwave Ovens	
1	15
0.8	45
0.6	29
0.4	11
Built-in and Over-the-Range Convection Microwave Ovens	
2.2	0
1.5	36
1	59
0.5	5

AHAM commented that it disagreed with DOE's use of tested values rather than CCD reported values in the August 2022 SNOPR, a practice it says undermines the practice of conservatively reporting standby power to allow some ''buffer'' to ensure consumers are getting what they are promised. (AHAM, No. 28 at p. 9) AHAM further commented that conservative rating ensures compliance with applicable standards by providing a safety factor to account for unavoidable variation in the manufacturing process. DOE notes that its tested values were often much lower than the reported values in the CCD, with differences as great as 1.43 W (approximately 65 percent) for Product Class 2 microwave ovens and 0.6192 W (approximately 61 percent) for Product Class 1 microwave ovens. DOE determines these current ratings to be significantly more conservative than is necessary, considering electronics manufacturing processes are sufficiently advanced. Furthermore, DOE did not see any variation in standby power greater than 0.1 W in the duplicate test units.

AHAM additionally commented that the products that use significantly less power than rated undermine the need for new standards, as there is little to gain. (AHAM, No. 28 at p. 9)

DOE reiterates that its analysis uses an efficiency distribution based on tested values that shows the existing market to be more efficient compared to that based on overly conservative rated values. As discussed further in section V.C.1 of this document, DOE's analysis demonstrates that despite the use of a more efficient distribution in its analysis as a starting point, the benefits of the standard exceed, to a great extent, the burdens at TSL 2 and an amended standard set at this level for microwave ovens would be economically justified. Additionally, AHAM's comment underscores the importance of testing units rather than relying solely on data from the CCD.

As part of the analysis for the August 2022 SNOPR, DOE subsequently tore down all 33 microwave ovens, but was unable to isolate a unique set of technology options associated with each standby power level. As such, DOE concluded that models demonstrating lower standby power consumption than the current energy conservation standards are not implementing specific technology options; rather, they are incorporating a comprehensive, system-level control board redesign that prioritizes standby power performance from the ground up. Examples of possible redesign strategies include (1) the replacement of microcontrollers with modern ones that demonstrate significantly lower quiescent current consumption and (2) firmware that emphasizes the shutting down of any subassemblies that are not in use while idle. DOE estimated that while these improvements would not contribute to the incremental manufacturer production cost (''MPC'') of a control board, the redesign would result in significant conversion costs for manufacturers as they attempt to bring their microwave oven models into compliance with any proposed standards. *See* section IV.J.2.a of this document.

In the August 2022 SNOPR, DOE requested feedback on its tentative conclusion that reducing the standby power consumption of a microwave oven would require a whole-board redesign, and that manufacturers would incur a one-time conversion cost without any additional MPC. AHAM and Whirlpool agreed with DOE's assessment that standby power reduction is a system-level redesign challenge, and that standby power often cannot be reduced with simple component changes. (AHAM, No. 28 at p. 5; Whirlpool, No. 30 at p. 6) AHAM and Whirlpool disagreed with DOE's conclusion that redesign would not impact overall MPC of a given product. Whirlpool commented that the new classes of microprocessors, display backlight circuits, display deep sleep technologies, and power switches may be necessary to reach higher efficiencies, and that this will add to the MPC for more efficient microwave ovens. (Whirlpool, No. 30 at p. 7) AHAM commented that changes to the control board may require manufacturers to evaluate and replace or remove components affected by the control board (*e.g.,* displays, sensors,

and clock) to reach amended standard levels. (AHAM, No. 28 at p. 5)

In response to AHAM and Whirlpool's comments, DOE notes that the analysis of the 33 microwave ovens noted above included product teardowns and establishing costed bill of materials. DOE examined the datasheets for components used in each design but was unable to establish a strong relationship between the use of better components and a microwave oven's overall standby performance. DOE found that while standby performance could be improved by opting for a better component, such as in the case of microcontrollers with deep sleep states, the cost differentials were often zero or negative. In all situations, DOE found that overall circuit design rather than component selection itself had a greater impact on standby performance cost. In the absence of additional cost data showing a clear MPC-efficiency relationship, DOE maintains its conclusion that any system-level redesign would not contribute to an incremental MPC increase.

B. Screening Analysis

DOE uses the following five screening criteria to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking:

(1) *Technological feasibility.* Technologies that are not incorporated in commercial products or in working prototypes will not be considered further.

(2) *Practicability to manufacture, install, and service.* If it is determined that mass production and reliable installation and servicing of a technology in commercial products could not be achieved on the scale necessary to serve the relevant market at the time of the projected compliance date of the standard, then that technology will not be considered further.

(3) *Impacts on product utility or product availability.* If it is determined that a technology would have a significant adverse impact on the utility of the product for significant subgroups of consumers or would result in the unavailability of any covered product type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

(4) *Adverse impacts on health or safety.* If it is determined that a technology would have significant adverse impacts on health or safety, it will not be considered further.

(5) *Unique-Pathway Proprietary Technologies.* If a design option utilizes proprietary technology that represents a unique pathway to achieving a given efficiency level, that technology will not be considered further due to the potential for monopolistic concerns.

Sections 6(b)(3) and 7(b) of appendix A.

In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed five criteria, it will be excluded from further consideration in the engineering analysis. The reasons for eliminating any technology are discussed in the following sections.

The subsequent sections include DOE's evaluation of each technology option against the screening analysis criteria, and whether DOE determined that a technology option should be excluded (''screened out'') based on the screening criteria.

1. Screened-Out Technologies

DOE considers whether a technology option will adversely impact consumer utility and product availability. To that end, DOE has previously stated it is uncertain the extent to which consumers value the function of a continuous display clock, but that loss of such function may result in significant loss of consumer utility. 78 FR 36316, 36362. Consistent with this prior concern, DOE has screened out ''automatic power-down'' as a technology option due to its impact on consumer utility in this final rule.

2. Remaining Technologies

Through a review of each technology, DOE concludes that all of the other identified technologies listed in section IV.B.2 of this document meet all five screening criteria to be examined further as design options in DOE's final rule analysis. In summary, DOE did not screen out the following technology options:

(1) Lower-power display technologies;

(2) Cooking sensors with no standby power requirement; and

(3) More efficient power supply and control board options.

DOE determines that these technology options are technologically feasible because they are being used or have previously been used in commercially-available products or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (*i.e.,* practicable to manufacture, install, and service and do not result in adverse impacts on consumer utility, product availability, health, or safety). For additional details, see chapter 4 of the final rule TSD.

AHAM and Whirlpool asserted that DOE's revised standards will cause an unacceptable loss of product functionality, and that future features will not be able to be added to microwave ovens due to feature power draw and DOE's practice of undermining conservative ratings. (AHAM, No. 28 at pp. 3–4, 8; Whirlpool, No. 30 at p. 5) AHAM provided a confidential list of various features that it states would be impossible to implement at DOE's updated standards. (AHAM, No. 28 at p. 4) AHAM additionally commented that manufacturers will also be unable to incorporate indoor air quality (''IAQ'') sensors, which may be required by future state building codes and could be impossible to implement due to EPCA's backsliding provision. (*Id.* at pp. 3, 13) AHAM and Whirlpool commented that other sensors may also need to be removed as well, driving consumers to use less efficient methods of cooking, and Whirlpool added that it was not aware of any humidity sensors that do not impact standby power. (AHAM, No. 28 at p. 4; Whirlpool, No. 30 at pp. 4, 7) Finally, AHAM stated that updated microwave oven standby power standards could lead to a loss of connectivity features in microwave ovens. (AHAM, No 28 at p. 3)

The Joint Commenters commented that they were able to find many Product Class 1 [18] units from various manufacturers with reported powers below 0.6 W that incorporated sensor technologies. (Joint Commenters, No. 31 at p. 3)

In response to these comments, DOE concludes that IAQ monitoring sensors (smoke and carbon monoxide(''CO'')) are technologically mature enough to be implemented without any significant impact to microwave oven standby power budgets due to the prevalence and maturity of low-power smoke and carbon monoxide detectors required by most state building codes.[19] DOE researched additional sensors that might be applicable for use in microwave ovens, and found low-power options for IAQ, such as the Bosch BME688, with an average current consumption of 0.1 milliamps (''mA'') at 3.6 volts (''V'') in low power mode, and the Renesas ZMOD4410 with an average power consumption of 0.16 milliwatts in ultra-low power mode. Similarly, DOE found

[18] Product Class 1 comprises microwave-only ovens and countertop convection microwave ovens.

[19] DOE found that the First Alert BRK PRC710 and Kidde P3010CU combination smoke and CO detectors include sealed batteries meant to last 10 years.

flame detection sensors, such as the Kemet QFS series, with an average current draw of 3.5 microamps (''μA'') at 3.6 V and PM sensors, such as the Sensirion SPS30, with an idle current draw of 330 μA and a sleep current draw of 50 μA.

Regarding AHAM's comment that updated standards impact connectivity features, DOE notes that section 2.1.1 of appendix I instructs that if a microwave oven can communicate through a network (*e.g.,* Bluetooth® or internet connection), the network function is disabled for the duration of standby mode and off mode testing, if it is possible to disable it by means provided in the manufacturer's user manual. Furthermore, DOE's testing did not find any correlation between presence of connected features and standby power consumption. Similarly, DOE did not find any standby power impact from humidity sensors in the microwave ovens tested and torn down. An additional review of available humidity sensors showed multiple models without a listed electrical warm-up time, as well as sensors with power requirements less than 0.005 W (*e.g.* review of datasheets for humidity sensors from component manufacturers such as Reneas, Amphenol, and Texas Instrument shows typical supply currents in the range of 1 to 200 μA).

With regards to loss of features and functionality, DOE notes that many of the features discussed confidentially by AHAM were already present in the microwave ovens torn down by DOE and therefore were captured by DOE in its analysis. DOE also determines that those features discussed by AHAM that were not seen in DOE's teardown analysis would not impact standby power, as the microwave oven would not be in standby mode while those features are activated. Instead, the features would be disconnected, turned off, or put into a quiescent state [20] in order to place the microwave oven in standby mode for testing. As such, DOE determines that amending standards would neither impact the types of sensors that can be used in microwave oven designs nor adversely impact consumer utility.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of microwave ovens. There are two elements to consider in the engineering analysis; the selection of efficiency levels to analyze (*i.e.,* the ''efficiency analysis'') and the determination of product cost at each efficiency level (*i.e.,* the ''cost analysis''). In determining the performance of higher-efficiency microwave ovens, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each product class, DOE estimates the baseline cost, as well as the incremental cost for the product/equipment at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency ''curves'' that are used in downstream analyses (*i.e.,* the LCC and PBP analyses and the NIA).

1. Efficiency Analysis

DOE typically uses one of two approaches to develop energy efficiency levels for the engineering analysis: (1) relying on observed efficiency levels in the market (*i.e.,* the efficiency-level approach), or (2) determining the incremental efficiency improvements associated with incorporating specific design options to a baseline model (*i.e.,* the design-option approach). Using the efficiency-level approach, the efficiency levels established for the analysis are determined based on the market distribution of existing products (in other words, based on the range of efficiencies and efficiency level ''clusters'' that already exist on the market). Using the design option approach, the efficiency levels established for the analysis are determined through detailed engineering calculations and/or computer simulations of the efficiency improvements from implementing specific design options that have been identified in the technology assessment. DOE may also rely on a combination of these two approaches. For example, the efficiency-level approach (based on actual products on the market) may be extended using the design option approach to ''gap fill'' levels (to bridge large gaps between other identified efficiency levels) and/or to extrapolate to the ''max-tech'' level (particularly in cases where the ''max-tech'' level exceeds the maximum efficiency level currently available on the market).

In this rulemaking, DOE applied the efficiency-level approach. As discussed, DOE was unable to use the design-option approach because it did not identify specific design options associated with each standby power level.

a. Baseline Efficiency/Energy Use

For each product class, DOE generally selects a baseline model as a reference point against which to measure changes resulting from energy conservation standards. The baseline model in each product class represents the characteristics of a product typical of that class (*e.g.,* capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market.

For microwave-only ovens and countertop convection microwave ovens (''Product Class 1''), the baseline standby power level is equal to the current standard of 1.0 W. For the built-in and over-the-range convection microwave ovens product class (''Product Class 2''), the baseline standby power consumption used for the analysis is equal to the current standard of 2.2 W. This maximum allowable average standby power consumption for Product Class 2 is higher than that allowed for Product Class 1 microwave ovens because, in the June 2013 Final Rule, DOE concluded that built-in and over-the-range convection microwave ovens require a larger power supply to support additional features, such as an exhaust fan, additional relays, and additional lights, and that the larger power supply contributes to a higher standby power consumption. 78 FR 36316, 36328. Nonetheless, DOE expects that certain available design options for reducing standby power consumption for Product Class 2 microwave ovens would be similar to those for Product Class 1 microwave ovens.

b. Higher Efficiency Levels

Using the efficiency-level approach, the higher efficiency levels established for the analysis are determined based on the market distribution of existing products (in other words, based on the range of efficiencies and efficiency level ''clusters'' that already exist on the market). As noted in section IV.A.2 of this document, DOE's testing suggests that microwave ovens are frequently rated conservatively, such that their certified standby power level is higher than actual values obtained when tested in accordance with appendix I. DOE therefore used the measured standby power levels of microwave oven models in its test sample as a proxy to determine the representative distribution of standby power levels among microwave ovens currently on the market, as shown in Table IV.2.

According to this efficiency distribution, 85 percent of Product Class 1 microwave ovens achieve a standby power consumption lower than the

[20] In electronics design, Quiescent state or Quiescent mode is defined as a state of inactivity or dormancy, with attributes of very low current draw.

current standard of 1.0 W, with 45 percent of the market estimated to be achieving 0.8 W, 29 percent achieving 0.6 W, and 11 percent achieving 0.4 W, all without the use of automatic power-down. For Product Class 1, therefore, DOE analyzed three efficiency levels (''ELs'') above the baseline, which correspond to these three standby power levels, as shown in Table IV.3.

The test results also showed that all of the Product Class 2 test units achieved a standby power consumption in the range of 0.5 W to 1.5 W, lower than the current standard of 2.2 W. As such, DOE analyzed higher efficiency levels for this product class at standby power values evenly distributed within that range: EL 1 at 1.5 W, EL 2 at 1.0 W, and EL 3 (max-tech) at 0.5 W. DOE estimates that there are currently no built-in and over-the-range convection microwave ovens in the market at the baseline standby power consumption of 2.2 W.

In summary, DOE analyzed the following efficiency levels for this rule:

TABLE IV.3—ANALYZED EFFICIENCY LEVELS FOR MICROWAVE-ONLY OVENS AND COUNTERTOP CONVECTION MICROWAVE OVENS

Efficiency level	Standby power (W)
Baseline	1.00
1	0.8
2	0.6
3 (Max-Tech)	0.4

TABLE IV.4—ANALYZED EFFICIENCY LEVELS FOR BUILT-IN AND OVER-THE-RANGE CONVECTION MICROWAVE OVENS

Efficiency level	Standby power (W)
Baseline	2.2
1	1.5
2	1.0
3 (Max-Tech)	0.5

The Joint Commenters requested that DOE analyze an additional efficiency level above max-tech, citing a number of microwave ovens in the CCD with reported standby powers of less than 0.3 W. The Joint Commenters further stated that many of these microwave ovens do not utilize the screened-out automatic power-down technology option, making this a viable efficiency level for manufacturers.

With regard to the Joint Commenters request, DOE's review of the market has shown that the majority of the microwave ovens at or below 0.3 W utilize other screened-out technology options (no clock, no display, and automatic power-down) to achieve a low standby power, and that an EL above max-tech would require designing microwave ovens with a significant impact to consumer utility. Also, as discussed further in section V.C of this document, DOE has determined that there is uncertainty as to whether or not a standard at max-tech would stifle innovation and risk impacting customer utility. Accordingly, DOE has elected not to analyze an efficiency level above the max-tech discussed in the August 2022 SNOPR.

AHAM and Whirlpool commented that electromagnetic interference (''EMI'') filtration boards draw a significant amount of power that DOE's analysis did not take into account. (AHAM, No. 28 at p. 6; Whirlpool, No. 30, at pp. 2–3) Furthermore, AHAM stated that EMI filters that draw less power than those currently in use may not be as effective at filtering out conducted electromagnetic fields (''EMF''). Whirlpool stated that effective filter designs can account for up to 0.3 W of standby power in a microwave oven. (Whirlpool, No. 30 at p. 4) AHAM commented that a survey of the current market found filter board power contributions of 0.17 W for countertop microwave ovens, 0.22 W for over-the-range microwave ovens, and 0.08 W for built-in microwave ovens (AHAM, No. 28 at p. 6).

As detailed in chapter 5 of the final rule TSD, DOE conducted a number of additional standby power tests on a sample of nine microwave ovens from both product classes after removing their input power filtration boards. Tested units included inverter microwave ovens, which tend to have more expensive and complex filtration boards, and units with different sensors and WiFi functionality.

DOE found that the sampled power filtration boards, on average, account for only 0.012 W of power during standby testing, calculated as the difference between the standby power with the filter installed and the standby power without the filter installed. This average measured value of 0.012 W is approximately 25 times less than Whirlpool's estimate (0.3 W) and about 10 times less than the shipment-weighted average of AHAM's reported values (0.173 W) using shipment weights provided by Whirlpool in its comments. (Whirlpool, No. 30 at p. 6) DOE conducted a single-tailed T-test to determine whether AHAM's reported mean differs in a statistically significant way from the measured mean. The resulting p-value rejected the null hypothesis (*i.e.,* the difference is indeed statistically significant and not due to sampling artifices). Whirlpool commented that DOE's tested models may not utilize the highest levels of filtering. (Whirlpool, No. 30 at p. 4) Since neither AHAM nor Whirlpool provided any further information identifying brands and models used to arrive at these values, DOE cannot verify the comments that EMI filtration boards take up a significant amount of a microwave's standby power budget, nor that DOE's tests were not representative of the market.

DOE performed additional teardown analysis of power filter boards from tested microwave ovens. All boards were passive filtration boards that utilize (1) a selection of capacitors and a common mode choke for mains power filtration; (2) a safety capacitor bleed resistor used to discharge capacitors that might otherwise shock a user when unplugging the unit from the wall; and (3) In some cases, a metal oxide varistor likely for voltage transient suppression. The primary standby power draw of this circuit is the always-connected bleeder resistor, which can be further eliminated with minimal impact to EMI filtration quality by using any number of automatic safety capacitor discharge circuits. However, this approach to reducing standby power with an automatic safety capacitor discharge circuit would only be relevant and meaningful if the power consumption of EMI filters with regular bleed resistors were significant. As discussed previously, DOE's testing showed power consumption of EMI filters to be a fraction of what AHAM and Whirlpool commented. The use of automatic capacitor discharge circuits would therefore not be meaningful and/or necessary.

Additionally, AHAM commented that microwave ovens account for 40.51 percent of consumer-reported nuisance trips when connected to a mains line with an arc-fault circuit interrupter (''AFCI'') circuit breaker. (AHAM, No. 28 at p. 8) AHAM stated that manufacturers traditionally outfit microwave ovens with EMI filters designed to only meet emissions limits established by the Federal Communications Commission (''FCC'') in 47 CFR part 15 and 47 CFR part 18 (referred to as ''Part 15'' and ''Part 18''), and that actual limits for avoiding accidental ''nuisance'' tripping are much more stringent and require EMI filters that consume more power. (AHAM, No. 28 at pp. 6–8) With increasing use of AFCIs in homes, Whirlpool commented that DOE must account for the additional power draw

of AFCI-compliant EMI filters when amending standards or risk losing other features that provide consumer utility. (Whirlpool, No. 30 at p. 4)

DOE researched guidance for appliance manufacturers on ensuring compatibility with AFCI outlets. As part of its efforts to promote the use of AFCIs, the National Electrical Manufacturer's Association (''NEMA'') has published guidelines [21] for appliance manufacturers that wish to design appliances that are compatible with AFCI outlets. These guidelines were developed by the Molded Case Circuit Breaker Product Group of the Low Voltage Distribution Equipment Section of NEMA. At the time of publication, this group included ABB Control, Inc.; Eaton Corporation; General Electric; Siemens Industry, Inc.; and Schneider Electric USA, all manufacturers of AFCIs. Although it is unclear how many of these members participated in the development of NEMA's guidance, DOE has not found contradicting guidance from any AFCI manufacturers.

NEMA's white paper describes the emission limits recommendations for appliance manufacturers. Specifically, NEMA recommends that manufacturers meet Part 15 requirements for Class B devices, even if appliances are not subject to these regulations. DOE notes that the Part 15 requirements for conducted emissions of Class B devices are the same as the Part 18 requirements for consumer devices other than induction cooking ranges and ultrasonic equipment. Thus, if manufacturers are designing microwave ovens to meet Part 18 requirements as AHAM states, they are following the leading industry guidance for avoiding AFCI nuisance tripping.

Although AHAM commented that AFCIs are being improperly tripped by normal microwave use, DOE recognizes that there are many potential sources of arcing in a microwave oven that may be difficult for consumers to recognize, potentially leading to an over-reporting of nuisance tripping. Unwanted arcing can occur during cooking if there are materials that reflect microwaves; the microwave is improperly loaded (ran empty or nearly empty); or there is a stalled stirrer blade or non-rotating antenna, which may not be visible to the consumer, resulting in reflected microwaves. In all three of these cases, the AFCI is performing its function correctly by detecting arcs and preventing further power draw, though consumers may not be aware that these arcs are occurring. Microwave ovens also rely on a number of relays to control various functionality. Relays, if not properly implemented, can also be prone to producing excessive arcing that may trip AFCIs. Thus, AFCIs can correctly trip from detected arcs that may be invisible to consumers.

In sum, DOE does not find that future EMI filter board designs would substantively alter the standby power levels that microwave ovens can achieve and concludes, therefore, that EMI filtration board power draw will not prohibit future innovation in microwave ovens. Further, DOE determined that microwave ovens are already meeting the leading guidance for avoiding nuisance tripping and will continue to do so as long as manufacturers design according to mandatory FCC standards.

2. Cost Analysis

The cost analysis portion of the engineering analysis is conducted using one or a combination of cost approaches. The selection of cost approach depends on a suite of factors, including the availability and reliability of public information, characteristics of the regulated product, and the availability and timeliness of purchasing the microwave oven on the market. The cost approaches are summarized as follows:

- *Physical teardowns:* Under this approach, DOE physically dismantles a commercially available product, component-by-component, to develop a detailed bill of materials for the product.
- *Catalog teardowns:* In lieu of physically deconstructing a product, DOE identifies each component using parts diagrams (available from manufacturer websites or appliance repair websites, for example) to develop the bill of materials for the product.
- *Price surveys:* If neither a physical nor catalog teardown is feasible (for example, for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable) or cost-prohibitive and otherwise impractical (*e.g.,* large commercial boilers), DOE conducts price surveys using publicly available pricing data published on major online retailer websites and/or by soliciting prices from distributors and other commercial channels.

For microwave ovens, DOE attempted to estimate the MPC of attaining each efficiency level using the physical teardowns approach described previously. As stated in section IV.A.2 of this document, DOE tore down all 33 microwave ovens in its test sample but was unable to isolate a unique set of technology options associated with each standby power level. As such, DOE concludes that models demonstrating lower standby power consumption than the current energy conservation standards are not implementing specific technology options, but rather incorporate a comprehensive system-level control board design that prioritizes standby power performance from the ground up. Examples of possible design strategies include the replacement of microcontrollers and switch mode controllers with modern ones that demonstrate significantly lower quiescent current consumption at no additional cost compared to those found in inefficient systems and firmware that emphasizes the shutting down of all subassemblies that are not in use while idle. DOE estimates that, while these improvements would not contribute to an increase in the MPC of a control board (*i.e.,* incremental MPC of $0), the redesign would result in conversion costs for manufacturers as they bring their microwave oven models into compliance with any proposed standards. *See* section IV.J.2.a of this document. To account for manufacturers' non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting MSP is the price at which the manufacturer distributes a unit into commerce. DOE developed an average manufacturer markup by examining the annual Securities and Exchange Commission (''SEC'') 10–K reports filed by publicly-traded manufacturers primarily engaged in household cooking appliance manufacturing and whose combined product range includes microwave ovens.

3. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data (or ''curves'') in the form of MPC (in dollars) versus standby power consumption (in W). For the reasons discussed in sections IV.A.2 and IV.C.2 of this document, DOE estimated an incremental MPC of $0 at all higher efficiency levels, compared to the baseline MPC, for both of the product classes, as shown in Table IV.5 and Table IV.6 of this document. *See* chapter 5 of the final rule TSD for additional detail on the engineering analysis.

[21] National Electrical Manufacturer's Association. *Recommendations on AFCI/Home Electrical Product Compatibility.* 2011. Rosslyn, VA.

TABLE IV.5—ANALYZED EFFICIENCY LEVELS AND INCREMENTAL MANUFACTURER PRODUCTION COSTS FOR MICROWAVE-ONLY OVENS AND COUNTERTOP CONVECTION MICROWAVE OVENS

Efficiency level	Standby power (W)	Incremental MPC (2021$)
Baseline	1.00	.....
1	0.8	0.0
2	0.6	0.0
3	0.4	0.0

TABLE IV.6—ANALYZED EFFICIENCY LEVELS AND INCREMENTAL MANUFACTURER PRODUCTION COSTS FOR BUILT-IN AND OVER-THE-RANGE CONVECTION MICROWAVE OVENS

Efficiency level	Standby power (W)	Incremental MPC (2021$)
Baseline	2.20	.....
1	1.5	$0.0
2	1.00	$0.0
3	0.5	$0.0

D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.,* retailer markups, distributor markups, contractor markups) in the distribution chain and sales taxes to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis. At each step in the distribution channel, companies mark up the price of the product to cover business costs and profit margin.

For microwave ovens, DOE further developed baseline and incremental markups for each link in the distribution chain (after the product leaves the manufacturer). Baseline markups are applied to the price of products with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.[22]

DOE relied on economic data from the U.S. Census Bureau to estimate average baseline and incremental markups. Specifically, DOE used the 2017 Annual Retail Trade Survey for the ''electronics and appliance stores'' sector to develop retailer markups.[23]

Chapter 6 of the final rule TSD provides details on DOE's development of markups for microwave ovens.

E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of microwave ovens at different efficiencies in representative U.S. single-family homes, multi-family residences, and mobile homes, and to assess the energy savings potential of increased microwave ovens efficiency. The energy use analysis estimates the range of energy use of microwave ovens in the field (*i.e.,* as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

For this final rule, DOE used the same methodology as that described in section IV.D of the August 2022 SNOPR. In the June 2013 Final Rule, DOE determined the average hours of operation for microwave ovens to be 44.9 hours per year.[24] [25] To calibrate the average annual operating hours, DOE primarily used data from the EIA's 2020 *Residential Energy Consumption Survey* (''*RECS*'').[26] *RECS 2020* provides information on the frequency of microwave oven usage per week for each household. DOE calculated the *RECS* microwave oven usage factor for each household in the sample by dividing the weighted-average usage based on the entire *RECS* samples. DOE then multiplied the usage factor by the annual operating hours (*i.e.,* 44.9 hours) for each household in the *RECS.* DOE subtracted field microwave ovens operating hours from the total number of hours in a year and multiplied that difference by the standby mode power usage at each efficiency level to determine annual standby mode and off mode energy consumption.

Chapter 7 of the final rule TSD provides details on DOE's energy use analysis for microwave ovens.

F. Life-Cycle Cost and Payback Period Analysis

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for microwave ovens. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

- The LCC is the total consumer expense of an appliance or product over the life of that product, consisting of

[22] Because the projected price of standards-compliant products is typically higher than the price of baseline products, using the same markup for the incremental cost and the baseline cost would result in higher per-unit operating profit. While such an outcome is possible, DOE maintains that in markets that are reasonably competitive, it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

[23] US Census Bureau, Annual Retail Trade Survey. 2017. *www.census.gov/programs-surveys/arts.html.*

[24] Uniform Test Method for Measuring the Energy Consumption of Cooking Products. 10 CFR part 430, subpart B, appendix I, *www.law.cornell.edu/cfr/text/10/appendix-I_to_subpart_B_of_part_430.*

[25] Williams, *et al.* 2012. Surveys of Microwave Ovens in U.S. Homes. LBNL–5947E *www.osti.gov/biblio/1172657.*

[26] U.S. Department of Energy-Energy Information Administration, Residential Energy Consumption Survey, 2020 Public Use Microdata Files, 2015. Washington, DC. Available online at: *www.eia.doe.gov/emeu/recs/recspubuse20/pubuse20.html.*

total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the product.

• The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient product through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of microwave ovens in the absence of new or amended energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline product.

For each considered efficiency level in each product class, DOE calculated the LCC and PBP for a nationally representative set of housing units. As stated previously, DOE developed household samples from the *RECS 2020*. For each sample household, DOE determined the energy consumption for the microwave ovens and the appropriate energy price. By developing a representative sample of households, the analysis captured the variability in energy consumption and energy prices associated with the use of microwave ovens.

Inputs to the calculation of total installed cost include the cost of the product—which includes MPCs, manufacturer markups, retailer and distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, product lifetimes, and discount rates. DOE created distributions of values for product lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC relies on a Monte Carlo simulation to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations randomly sample input values from the probability distributions and microwave ovens user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.[27] The model calculated the LCC for products at each efficiency level for 10,000 housing units per simulation run. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given consumer, product efficiency is chosen based on its probability. If the chosen product efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC calculation reveals that a consumer is not impacted by the standard level. By accounting for consumers who already purchase more-efficient products, DOE avoids overstating the potential benefits from increasing product efficiency. DOE calculated the LCC and PBP for consumers of microwave ovens as if each were to purchase a new product in the first year of required compliance with new or amended standards. Amended standards apply to microwave ovens manufactured 3 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(g)(10)(B)) Therefore, DOE used 2026 as the first year of compliance with any amended standards for microwave ovens.

Table IV.5 summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the final rule TSD and its appendices.

TABLE IV.5—SUMMARY OF INPUTS AND METHODS FOR THE LCC AND PBP ANALYSIS *

Inputs	Source/method
Product Cost ..	Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate. Used historical data to derive a price scaling index to project product costs.
Installation Costs.	Assumed no change with efficiency level.
Annual Energy Use.	The total annual energy use multiplied by the hours per year. Average number of hours based on field data. Variability: Based on the RECS 2020.
Energy Prices	Electricity: Based on EEI 2021. Variability: Regional energy prices determined for nine regions.
Energy Price Trends.	Based on *AEO2022* price projections.
Repair and Maintenance Costs.	Assumed no change with efficiency level.
Product Lifetime.	Average: 10.78 years.
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered appliances, or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Compliance Date.	2026.

* Not used for PBP calculation. References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the final rule TSD.

1. Product Cost

To calculate consumer product costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described previously (along with sales taxes). DOE used different markups for baseline products and higher-efficiency products, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency products.

Economic literature and historical data suggest that the real costs of many products may trend downward over time according to ''learning'' or ''experience'' curves. An experience curve analysis implicitly includes factors such as efficiencies in labor, capital investment, automation, materials prices, distribution, and economies of scale at an industry-wide level. To derive the learning rate parameter for microwave ovens, DOE obtained historical Producer Price Index (''PPI'') data for microwave ovens from the Bureau of Labor Statistics (''BLS''). A PPI for ''Household Cooking Appliance Manufacturing: Electric (Including Microwave) Household Ranges, Ovens, Surface Cooking Units,

[27] Crystal Ball™ is a commercially-available software tool to facilitate the creation of these types of models by generating probability distributions and summarizing results within Excel, available at *www.oracle.com/technetwork/middleware/crystalball/overview/index.html* (last accessed December 13, 2022).

and Equipment'' was available for the time period between 1972 and 2020.[28] Inflation-adjusted price indices were calculated by dividing the PPI series by the gross domestic product index from the Bureau of Economic Analysis for the same years. Using data from 1972–2020, the estimated learning rate (defined as the fractional reduction in price expected from each doubling of cumulative production) is 10.7 percent.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. DOE used data from 2022 to estimate the baseline installation cost for microwave ovens. DOE found no evidence that installation costs would be impacted with increased efficiency levels.

3. Annual Energy Consumption

For each sampled household, DOE determined the energy consumption for a microwave oven at different efficiency levels using the approach described previously in section IV.E of this document.

4. Energy Prices

Because marginal electricity price more accurately captures the incremental savings associated with a change in energy use from higher efficiency, it provides a better representation of incremental change in consumer costs than average electricity prices. Therefore, DOE applied average electricity prices for the energy use of the product purchased in the no-new-standards case, and marginal electricity prices for the incremental change in energy use associated with the other efficiency levels considered.

DOE derived electricity prices in 2022 using data from Edison Electric Institute (''EEI'') Typical Bills and Average Rates reports.[29] Based upon comprehensive, industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the residential sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2018).[30] For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).[31]

DOE's methodology allows electricity prices to vary by sector, region, and season. In the analysis, variability in electricity prices is chosen to be consistent with the way the consumer economic and energy use characteristics are defined in the LCC analysis. For microwave ovens, DOE derived electricity prices in 2022 using data from EEI. DOE used the EEI data to define a marginal price as the ratio of the change in the bill to the change in energy consumption. *See* chapter 8 of the final rule TSD for details.

To estimate energy prices in future years, DOE multiplied the 2020 energy prices by the projection of annual average price changes for each of the nine census divisions from the Reference case in *AEO2022,* which has an end year of 2050.[32] To estimate price trends after 2050, the 2046–2050 average was used for all subsequent years.

5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing product components that have failed in an appliance; maintenance costs are associated with maintaining the operation of the product. Typically, small incremental increases in product efficiency entail no, or only minor, changes in repair and maintenance costs compared to baseline efficiency products. In this final rule analysis, DOE included no changes in maintenance or repair costs for microwave ovens that exceed baseline efficiency.

6. Product Lifetime

For microwave ovens, DOE developed a distribution of lifetimes from which specific values are assigned to the appliances in the samples. DOE conducted an analysis of actual lifetime in the field using a combination of historical shipments data, the stock of the considered appliances in the *American Housing Survey,* and responses in *RECS* on the age of the appliances in the homes. The data allowed DOE to estimate a survival function, which provides an average appliance lifetime. This analysis yielded a lifetime probability distribution with an average lifetime for microwave ovens of approximately 10.78 years. *See* chapter 8 of the final rule TSD for further details.

7. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to households to estimate the present value of future operating cost savings. DOE estimated a distribution of discount rates for microwave ovens based on the opportunity cost of consumer funds.

DOE applies weighted average discount rates calculated from consumer debt and asset data, rather than marginal or implicit discount rates.[33] The LCC analysis estimates net present value over the lifetime of the product, so the appropriate discount rate will reflect the general opportunity cost of household funds, taking this time scale into account. Given the long time horizon modeled in the LCC, the application of a marginal interest rate associated with an initial source of funds is inaccurate. Regardless of the method of purchase, consumers are expected to continue to rebalance their debt and asset holdings over the LCC analysis period, based on the restrictions consumers face in their debt payment requirements and the relative size of the interest rates available on debts and assets. DOE estimates the aggregate impact of this rebalancing using the historical distribution of debts and assets.

To establish residential discount rates for the LCC analysis, DOE identified all relevant household debt or asset classes in order to approximate a consumer's opportunity cost of funds related to appliance energy cost savings. It estimated the average percentage shares of the various types of debt and equity by household income group using data from the Federal Reserve Board's triennial Survey of Consumer

[28] U.S. Bureau of Labor Statistics, PPI Industry Data, Major household appliance manufacturers, Product series ID: PCU 33522033522011. Data series available at: *www.bls.gov/ppi/.*

[29] Edison Electric Institute. Typical Bills and Average Rates Report. 2020. Winter 2020, Summer 2020: Washington, DC

[30] Coughlin, K. and B. Beraki.2018. Residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL–2001169. *ees.lbl.gov/publications/residential-electricity-prices-review.*

[31] Coughlin, K. and B. Beraki. 2019. Non-residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL–2001203. *ees.lbl.gov/publications/non-residential-electricity-prices.*

[32] U.S. Department of Energy—Energy Information Administration. *Annual Energy Outlook 2018 with Projections to 2050.* Washington, DC. Available at *www.eia.gov/forecasts/aeo/* (last accessed December 13, 2022).

[33] The implicit discount rate is inferred from a consumer purchase decision between two otherwise identical goods with different first cost and operating cost. It is the interest rate that equates the increment of first cost to the difference in net present value of lifetime operating cost, incorporating the influence of several factors: transaction costs; risk premiums and response to uncertainty; time preferences; and interest rates at which a consumer is able to borrow or lend. The implicit discount rate is not appropriate for the LCC analysis because it reflects a range of factors that influence consumer purchase decisions, rather than the opportunity cost of the funds that are used in purchases.

Finances [34] (''SCF'') starting in 1995 and ending in 2019. Using the SCF and other sources, DOE developed a distribution of rates for each type of debt and asset by income group to represent the rates that may apply in the year in which amended 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 and income groups, weighted by the shares of each type, is 4.3 percent.

See chapter 8 of the final rule TSD for further details on the development of consumer discount rates.

8. Energy Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of product efficiencies under the no-new-standards case (*i.e.,* the case without amended or new energy conservation standards).

To estimate the energy efficiency distribution of microwave ovens for 2026, DOE used data from the engineering analysis. The estimated market shares for the no-new-standards case for microwave ovens are shown in Table IV.6. *See* chapter 8 of the final rule TSD for further information on the derivation of the efficiency distributions.

TABLE IV.6—NO-NEW-STANDARDS CASE EFFICIENCY DISTRIBUTION FOR MICROWAVE OVENS IN 2026

TSL	Product class 1: microwave-only and countertop convection microwave ovens		Product class 2: built-in and over-the-range convection microwave ovens	
	Standby power (W)	Market share (%)	Standby power (W)	Market share (%)
Baseline	1.00	15	2.20	0
1	0.8	45	1.5	36
2	0.6	29	1.0	59
3	0.4	11	0.5	5

In response to the August 2023 SNOPR, AHAM stated that the CCD is not an accurate determination of efficiency distributions. (AHAM, No. 28 at p. 10) DOE agrees that shipment-weighted efficiency distributions would be preferable to shares based on model counts, but such data were not available for microwave ovens, and there is no firm basis to make an adjustment to the model count market shares. DOE's approach may well overstate the market share of higher-efficiency products in the absence of new standards, but this would mean that the energy and economic benefits estimated by DOE for new standards are minimum amounts. The justification for the adopted standards would be even stronger if DOE were able to use actual shipment data for the model counts.

The LCC Monte Carlo simulations draw from the efficiency distributions and randomly assign an efficiency to the microwave oven purchased by each sample household in the no-new-standards case. The resulting percent shares within the sample match the market shares in the efficiency distributions.

9. Payback Period Analysis

The payback period is the amount of time (expressed in years) it takes the consumer to recover the additional installed cost of more-efficient products, compared to baseline products, through energy cost savings. Payback periods that exceed the life of the product mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the product and the change in the first-year annual operating expenditures relative to the baseline. DOE refers to this as a ''simple PBP'' because it does not consider changes over time in operating cost savings. The PBP calculation uses the same inputs as the LCC analysis when deriving first-year operating costs.

As noted previously, EPCA 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 first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the amended standards would be required.

G. Shipments Analysis

DOE uses projections of annual product shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.[35] The shipments model takes an accounting approach, tracking market shares of each product class and the vintage of units in the stock. Stock accounting uses product shipments as inputs to estimate the age distribution of in-service product stocks for all years. The age distribution of in-service product stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

Total shipments for microwave ovens are developed by considering the demand from replacements for units in stock that fail and the demand from new installations in newly constructed homes. DOE calculated shipments due to replacements using the retirement function developed for the LCC analysis and historical data from AHAM. DOE calculated shipments due to new installations using estimates from the microwave oven saturation rate in new homes in *RECS 2020* and projections of new housing starts from *AEO2022. See*

[34] U.S. Board of Governors of the Federal Reserve System. Survey of Consumer Finances. 1995, 1998, 2001, 2004, 2007, 2010, 2013, 2016, and 2019. Available at *www.Federalreserve.gov/econresdata/scf/scfindex.htm* (last accessed December 13, 2022).

[35] DOE uses data on manufacturer shipments as a proxy for national sales, as aggregate data on sales are lacking. In general, one would expect a close correspondence between shipments and sales.

chapter 9 of the final rule TSD for details.

For this final rule analysis, DOE used data from a market research report and estimated the market share for built-in and over-the-range convection microwave ovens at 4 percent.[36]

DOE considers the impacts on shipments from changes in product purchase price and operating cost associated with higher energy efficiency levels using a price elasticity and an efficiency elasticity. DOE employs a 0.2-percent efficiency elasticity rate and a price elasticity of −0.45 in its shipments model.[37] The market impact is defined as the difference between the product of price elasticity of demand and the change in price due to a standard level, and the product of the efficiency elasticity and the change in operating costs due to a standard level.

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[38] (''Consumer'' in this context refers to consumers of the product being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of microwave ovens sold from 2026 through 2055.

DOE evaluates the impacts of new or amended standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each product class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each product class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.,* the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of products with efficiencies greater than the standard.

DOE uses a spreadsheet model to calculate the energy savings and the national consumer costs and savings from each TSL. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV.7 summarizes the inputs and methods DOE used for the NIA analysis for the final rule. Discussion of these inputs and methods follows the table. *See* chapter 10 of the final rule TSD for further details.

TABLE IV.7—SUMMARY OF INPUTS AND METHODS FOR THE NATIONAL IMPACT ANALYSIS

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2026.
Efficiency Trends	Standards cases: ''Roll up'' equipment to meet potential efficiency level.
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual values do not change with efficiency level.
Energy Price Trends	*AEO2022* projections (to 2050) and extrapolation thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on *AEO2022.*
Discount Rate	Three and seven percent.
Present Year	2023.

1. Product Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.8 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered product classes for the year of anticipated compliance with an amended or new standard. To project the trend in efficiency absent amended standards for microwave ovens over the entire shipments projection period, DOE used the shipments-weighted standby power (''SWSP'') as a starting point. DOE assumed that the shipment-weighted efficiency would not increase annually for the microwave oven product classes. The approach is further described in chapter 10 of the final rule TSD.

For the standards cases, DOE used a ''roll-up'' scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2026). In this scenario, the market shares of products in the no-new-standards case that do not meet the standard under consideration would ''roll up'' to meet the new standard level, and the market share of products above the standard would remain unchanged.

2. National Energy Savings

The national energy savings analysis involves a comparison of national energy consumption of the considered products between each TSL and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.,* the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2022.*

[36] Euromonitor International. 2021. *Air treatment products in the U.S.* December.

[37] Fujita, K. (2015) Estimating Price Elasticity using Market-Level Appliance Data. Lawrence Berkeley National Laboratory, LBNL–188289.

[38] The NIA accounts for impacts in the 50 states.

Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency products is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the product due to the increase in efficiency. DOE did not find any data on the rebound effect specific to microwave ovens; therefore, no rebound was applied.

In 2011, in response to the recommendations of a committee on ''Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards'' appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and greenhouse gas and other emissions in the national impact analyses and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (Aug. 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System (''NEMS'') is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (Aug. 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector [39] that EIA uses to prepare its *Annual Energy Outlook.* The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the final rule TSD.

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are (1) total annual installed cost, (2) total annual operating costs (energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-new-standards case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of each product shipped during the projection period.

As discussed in section IV.F.1 of this document, DOE developed microwave oven price trends based on historical PPI data. DOE applied the same trends to project prices for each product class at each considered efficiency level. By 2055, which is the end date of the projection period, the average microwave oven price is projected to drop 11 percent relative to 2021. DOE's projection of product prices is described in appendix 10C of the final rule TSD.

To evaluate the effect of uncertainty regarding the price trend estimates, DOE investigated the impact of different product price projections on the consumer NPV for the considered TSLs for microwave ovens. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a high price decline case based on ''electric household cooking products'' PPI series from 1993 to 2021 and (2) a low price decline case based on the same PPI series from 1972 to 1992. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the final rule TSD.

The energy cost savings are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average residential energy price changes in the Reference case from *AEO2022,* which has an end year of 2050. To estimate price trends after 2050, the 2046–2050 average was used for all years. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2022* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. NIA results based on these cases are presented in appendix 10C of the final rule TSD.

In considering the consumer welfare gained due to the direct rebound effect, DOE accounted for change in consumer surplus attributed to additional cooling from the purchase of a more efficient unit. Overall consumer welfare is generally understood to be enhanced from rebound. The net consumer impact of the rebound effect is included in the calculation of operating cost savings in the consumer NPV results. *See* appendix 10F of the final rule TSD for details on DOE's treatment of the monetary valuation of the rebound effect.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget (''OMB'') to Federal agencies on the development of regulatory analysis.[40] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the ''social rate of time preference,'' which is the rate at which society discounts future consumption flows to their present value.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. For this final rule, DOE analyzed the impacts of the considered standard levels on two subgroups: (1) low-income households and (2) senior-only households. The analysis used subsets of the *RECS 2020* sample composed of households that meet the criteria for the considered subgroups. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. Chapter 11 of the final rule TSD describes the consumer subgroup analysis.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of amended energy conservation standards on manufacturers of microwave ovens and to estimate the potential impacts of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects and includes analyses of projected

[39] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2009,* DOE/EIA–0581(2009), October 2009. Available at *www.eia.gov/forecasts/aeo/index.cfm* (last accessed December 13, 2022).

[40] United States Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. Section E. Available at *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed December 13, 2022).

industry cash flows, the INPV, investments in research and development (''R&D'') and manufacturing capital, and domestic manufacturing employment. Additionally, the MIA seeks to determine how amended energy conservation standards might affect manufacturing employment, capacity, and competition, as well as how standards contribute to overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the Government Regulatory Impact Model (''GRIM''), an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, product shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant products. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more-stringent energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases (TSLs). To capture the uncertainty relating to manufacturer pricing strategies following amended standards, the GRIM estimates a range of possible impacts under different markup scenarios.

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative impact of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the final rule TSD.

DOE prepared a profile of the microwave oven manufacturing industry based on the market and technology assessment, current information from DOE's CCD, and information from the June 2013 Final Rule. (78 FR 36316) This included a top-down analysis of microwave oven manufacturers that DOE used to derive preliminary financial inputs for the GRIM (*e.g.,* revenues; materials, labor, overhead, and depreciation expenses; SG&A expenses; and R&D expenses).

Additionally, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of amended energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standard and extending over a 30-year period following the compliance date of the standard. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) creating a need for increased investment, (2) raising production costs per unit, and (3) altering revenue due to higher per-unit prices and changes in sales volumes.

DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers, niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed in section VI.B of this document, ''Review under the Regulatory Flexibility Act'' and in chapter 12 of the final rule TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to amended standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from amended energy conservation standards. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2023 (the base year of the analysis) and continuing to 2055. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of microwave ovens, DOE used a real discount rate of 8.5 percent, which was the same real discount rate used in the June 2013 Final Rule and that was verified during manufacturer interviews for that rulemakings analysis.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the amended energy conservation standards on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available data, results of the engineering analysis, and information used in the June 2013 Final Rule. The GRIM results are presented in section V.B.2 of this document. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Manufacturer Production Costs

Manufacturing more efficient products is typically more expensive than manufacturing baseline products due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered products can affect the revenues, gross margins, and cash flow of the industry. As previously stated in the engineering analysis in section IV.C.3 of this document, DOE estimated an incremental MPC of $0 at all efficiency levels, compared to the baseline MPC. DOE did not make any changes to the MPCs from the August 2022 SNOPR.

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2023 (the base year) to 2055 (the end year of the analysis period). *See* chapter 9 of the final rule TSD for additional details. DOE slightly updated the shipments analysis from the August 2022 SNOPR.

c. Product and Capital Conversion Costs

Amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and product designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) product

conversion costs and (2) capital conversion costs. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with amended energy conservation standards. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new compliant product designs can be fabricated and assembled.

DOE used a bottom-up cost estimate to arrive at a total industry conversion cost at each efficiency level for both product classes. First, DOE estimated the investments manufacturers are likely to incur in redesigning a single microwave oven control board to be able to meet the analyzed energy conservation standards. These per-board conversion costs were based on manufacturer interviews and include both per-board capital conversion costs (*e.g.,* investments in machinery and tooling) as well as product conversion costs (*e.g.,* investments in R&D and testing). Based on manufacturer feedback, DOE assigned a smaller level of investment necessary to achieve lower efficiency levels and a larger level of investment to achieve higher efficiency levels.

Next, based on engineering teardowns and market research, DOE estimated the total number of unique control boards used across all covered microwave ovens. DOE used the percentage of unique microwave oven models for each product class that were certified in DOE's publicly available CCD to estimate the number of unique control boards for each product class. Then DOE used the efficiency distribution from the shipments analysis to estimate the number, for each product class, of unique control boards specific to each efficiency level. Once DOE estimated the number of unique control boards, DOE used the per-board redesign costs specific to achieve each analyzed efficiency level in order to arrive at the total industry conversion costs.

DOE did not make any changes to the capital and product conversion costs estimates used in the August 2022 SNOPR. In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the amended standards. The conversion cost figures used in the GRIM can be found in section V.B.2 of this document. *See* chapter 12 of the final rule TSD for additional information on the estimated capital and product conversion costs.

d. Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.,* labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.,* SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied non-production cost markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these markups in the standards case yields different sets of impacts on manufacturers. As in the August 2022 SNOPR, DOE used a manufacturer markup of 1.298 for both product classes in the no-new-standards case. (87 FR 52282, 52296)

For the MIA, DOE modeled two standards-case markup scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards: (1) a conversion cost recovery scenario; and (2) a constant price scenario. These scenarios lead to different manufacturer markup values at each TSL that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the conversion cost recovery scenario, DOE modeled a scenario in which manufacturers increase their manufacturer markups in response to amended energy conservation standards. Because DOE's engineering analysis assumed there were no increases in the MPCs at higher efficiency levels compared to the baseline MPCs, and that microwave oven manufacturers would incur conversion costs to redesign non-compliant models, DOE modeled a manufacturer markup scenario in which microwave oven manufacturers attempt to recover these investments through an increase in their manufacturer markup. Therefore, in the standards cases, the manufacturer markup of models that would need to be re-designed is a value larger than the 1.298 manufacturer markup used in the no-new-standards case. DOE calibrated these manufacturer markups for each product class at each efficiency level to cause manufacturer INPV in the standards cases to be equal to the INPV in the no-new-standards case. Because manufacturer markups used in this scenario are calculated using the shipments analysis as inputs and the shipments analysis was updated from the August 2022 SNOPR to this final rule analysis, the calibrated manufacturer markups used in the conversion cost recovery scenario for this final rule analysis are slightly different than those values that were calculated in the August 2022 SNOPR. However, the methodology used to calculate these manufacturer markup values are the same as those used in the August 2022 SNOPR.

The conversion cost recovery scenario represents the upper-bound of manufacturer profitability, as microwave oven manufacturers are no worse off, as measured by INPV, with energy conservation standards than in the no-new-standards case (*i.e.,* if DOE did not amend energy conservation standards).

Under the constant price scenario, DOE applied the same manufacturer markup, 1.298, for all efficiency levels in the no-new-standards case and the standards cases. Because DOE's engineering analysis assumed there were no increases in the MPCs at higher efficiency levels and that microwave oven manufacturers would incur conversion costs to redesign non-compliant models, microwave oven manufacturers do not earn any additional revenue in the standards cases than in the no-new-standards case, despite incurring conversion costs to redesign non-compliant microwave oven models. The constant price scenario represents the lower-bound of manufacturer profitability, as microwave oven manufacturers incur conversion costs but do not receive any additional revenue from these redesign efforts. The manufacturer markups in the constant price scenario are the same as those used in the August 2022 SNOPR.

A comparison of industry financial impacts under the two markup scenarios is presented in section V.B.2.a of this document.

3. Discussion of MIA Comments

AHAM commented on the August 2022 SNOPR that DOE correctly decided to incorporate conversion costs into the LCC analysis as part of the August 2022 SNOPR. However, AHAM stated that DOE should amortize these conversion costs over a 6-year period instead of amortizing these conversion costs over a 30-year period, which is what was done in the August 2022 SNOPR. (AHAM, No. 28 at p. 11)

In the SNOPR analysis, DOE used the GRIM to calculate a higher manufacturer markup in the standards cases that results in an equivalent manufacturer INPV in the standards cases compared to the no-new-standards case. The conversion cost recovery scenario is the manufacturer markup scenario incorporated into all downstream analyses, including the LCC analysis, in the standards cases. In this scenario, manufacturers make investments, both

in machinery and tooling (capital conversion costs) and in redesign and testing (product conversion costs), prior to the compliance date of energy conservation standards. After compliance with energy conservation standards manufacturers increase their manufacturer markup, thereby increasing revenue and free cash flow for the remainder of the 30-year analysis period. Amortizing these conversion costs over a 6-year period would create a scenario where manufacturer INPV increases in all analyzed TSLs in the standards cases compared to the no-new-standards case. DOE maintains that amortizing these conversion costs over the 30-year analysis period reflects an accurate upper-bound to industry profitability in the standards cases as manufacturers do not lose INPV in the conversion cost recovery scenario in the standards cases compared to the no-new-standards case.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of CO_2, NO_X, SO_2, and Hg. The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, CH_4 and N_2O, as well as the reductions in emissions of other gases due to ''upstream'' activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion.

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO,* including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the final rule TSD. The analysis presented in this final rule uses projections from *AEO2022.* Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the Environmental Protection Agency (EPA).[41]

FFC upstream emissions, which include emissions from fuel combustion during extraction, processing, and transportation of fuels, and ''fugitive'' emissions (direct leakage to the atmosphere) of CH_4 and CO_2, are estimated based on the methodology described in chapter 15 of the final rule TSD.

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. For power sector emissions, specific emissions intensity factors are calculated by sector and end use. Total emissions reductions are estimated using the energy savings calculated in the national impact analysis.

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO,* which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2022* generally represents current legislation and environmental regulations, including recent government actions, that were in place at the time of preparation of *AEO2022,* including the emissions control programs discussed in the following paragraphs.[42]

SO_2 emissions from affected electric generating units (''EGUs'') are subject to nationwide and regional emissions cap-and-trade 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 (''DC''). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule (''CSAPR''). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015 and has been subsequently updated.[43] *AEO2022* incorporates implementation of CSAPR, including the Revised CSAPR Update issued in April 2021. 86 FR 23054. Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, for States subject to SO_2 emissions limits under CSAPR, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

Beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards (''MATS'') for power plants. 77 FR 9304 (Feb. 16, 2012). In the MATS final 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 are being reduced as a result of the control technologies installed on coal-fired power plants to comply with the MATS requirements for acid gas. Because of the emissions reductions under the MATS, 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 another regulated EGU. Therefore, energy conservation standards that decrease electricity generation will generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2022.*

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such cases, NO_X emissions would remain near the limit even if electricity generation goes down. A different case could possibly result, depending on the configuration of the power sector in the different regions and the need for allowances, such that NO_X emissions might not remain at the limit in the case of lower electricity demand. In this case, energy conservation standards might

[41] Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed December 13, 2022).

[42] For further information, *see* the Assumptions to *AEO2022* report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (last accessed December 13, 2022).

[43] CSAPR requires States to address annual emissions of SO_2 and NO_X, precursors to the formation of fine particulate matter (''$PM_{2.5}$'') pollution, in order to address the interstate transport of pollution with respect to the 1997 and 2006 $PM_{2.5}$ National Ambient Air Quality Standards (''NAAQS''). CSAPR also requires certain States to address the ozone season (May-September) emissions of NO_X, a precursor to the formation of ozone pollution, in order to address the interstate transport of ozone pollution with respect to the 1997 ozone NAAQS. 76 FR 48208 (Aug. 8, 2011). EPA subsequently issued a supplemental rule that included an additional five States in the CSAPR ozone season program; 76 FR 80760 (Dec. 27, 2011) (Supplemental Rule). In 2021, EPA issued the Revised CSAPR Update for the 2008 Ozone NAAQs (Revised CSAPR Update) promulgating EGU NO_X ozone season emission budgets for 12 states. 86 FR 23054, 23059 (Apr. 30, 2021).

reduce NO_X emissions in covered States. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in States covered by CSAPR. Standards would be expected to reduce NO_X emissions in the States not covered by CSAPR. DOE used *AEO2022* data to derive NO_X emissions factors for the group of States not covered by CSAPR.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would be expected to slightly reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO2022,* which incorporates the MATS.

L. Monetizing Emissions Impacts

As part of the development of this final rule, for the purpose of complying with the requirements of Executive Order 12866, DOE considered the estimated monetary benefits from the reduced emissions of CO_2, CH_4, N_2O, NO_X, and SO_2 that are expected to result from each of the TSLs considered. In order to make this calculation analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of products shipped in the projection period for each TSL. This section summarizes the basis for the values used for monetizing the emissions benefits and presents the values considered in this final rule.

On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law. DOE requests comment on how to address the climate benefits and other non-monetized effects of the proposal.

AHAM commented that DOE should not use the social cost of carbon and other monetization of emissions reductions benefits in its analysis of the factors EPCA requires DOE to balance to determine the appropriate standard. AHAM commented that while it may be acceptable for DOE to continue its current practice of examining the social cost of carbon and monetization of other emissions reductions benefits as informational so long as the underlying interagency analysis is transparent and vigorous, the monetization analysis should not impact the TSLs DOE selects as a new or amended standard. (AHAM, No. 28 at p. 13)

As stated in section III.F.1.f of this document, DOE maintains that environmental and public health benefits associated with the more efficient use of energy, including those connected to global climate change, are important to take into account when considering the need for national energy conservation, which is one of the factors that EPCA requires DOE to evaluate in determining whether a potential energy conservation standard is economically justified. *See* 42 U.S.C. 6295(o)(2)(B)(i)(VI). In addition, Executive Order 13563, which was re-affirmed on January 21, 2021, stated that each agency must, among other things: ''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).'' For these reasons, DOE includes monetized emissions reductions in its evaluation of potential standard levels. As previously stated, however, DOE would reach the same conclusion presented in this final rulemaking in the absence of the social cost of greenhouse gases.

1. Monetization of Greenhouse Gas Emissions

DOE estimates the monetized benefits of the reductions in emissions of CO_2, CH_4, and N_2O by using a measure of the social cost of each pollutant (*e.g.,* SC–CO_2). These estimates represent the monetary value of the net harm to society associated with a marginal increase in emissions of these pollutants in a given year, or the benefit of avoiding that increase. These estimates are intended to include (but are not limited to) climate-change-related changes in net agricultural productivity, human health, property damages from increased flood risk, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services.

DOE exercises its own judgment in presenting monetized climate benefits as recommended by applicable Executive orders, and DOE would reach the same conclusion presented in this final rulemaking in the absence of the social cost of greenhouse gases. That is, the social costs of greenhouse gases, whether measured using the February 2021 interim estimates presented by the Interagency Working Group on the Social Cost of Greenhouse Gases (IWG) or by another means, did not affect the rule ultimately proposed by DOE.

DOE estimated the global social benefits of CO_2, CH_4, and N_2O reductions (*i.e.,* SC–GHGs) using the estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, published in February 2021 by the IWG. The SC–GHGs is the monetary value of the net harm to society associated with a marginal increase in emissions in a given year, or the benefit of avoiding that increase. In principle, SC–GHGs includes the value of all climate change impacts, including (but not limited to) changes in net agricultural productivity, human health effects, property damage from increased flood risk and natural disasters, disruption of energy systems, risk of conflict, environmental migration, and the value of ecosystem services. The SC–GHGs therefore reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC–GHGs is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO_2, N_2O, and CH_4 emissions. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees that the interim SC–GHG estimates represent the most appropriate estimate of the SC–GHG until revised estimates have been developed reflecting the latest, peer-reviewed science.

The SC–GHGs estimates presented here were developed over many years using a transparent process, peer-reviewed methodologies, the best science available at the time of that process, and with input from the public. Specifically, in 2009, the IWG, which included DOE and other executive branch agencies and offices, was established to ensure that agencies were using the best available science and to promote consistency in the social cost of carbon (SC–CO_2) values used across agencies. The IWG published SC–CO_2 estimates in 2010 that were developed from an ensemble of three widely cited

integrated assessment models (IAMs) that estimate global climate damages using highly aggregated representations of climate processes and the global economy combined into a single modeling framework. The three IAMs were run using a common set of input assumptions in each model for future population, economic, and CO_2 emissions growth, as well as equilibrium climate sensitivity—a measure of the globally averaged temperature response to increased atmospheric CO_2 concentrations. These estimates were updated in 2013 based on new versions of each IAM. In August 2016, the IWG published estimates of the social cost of methane (SC–CH_4) and nitrous oxide (SC–N_2O) using methodologies that are consistent with the methodology underlying the SC–CO_2 estimates. The modeling approach that extends the IWG SC–CO_2 methodology to non-CO_2 GHGs has undergone multiple stages of peer review. The SC–CH_4 and SC–N_2O estimates were developed by Marten *et al.*[44] and underwent a standard double-blind peer review process prior to journal publication. In 2015, as part of the response to public comments received to a 2013 solicitation for comments on the SC–CO_2 estimates, the IWG announced a National Academies of Sciences, Engineering, and Medicine review of the SC–CO_2 estimates to offer advice on how to approach future updates to ensure that the estimates continue to reflect the best available science and methodologies. In January 2017, the National Academies released their final report, *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide,* and recommended specific criteria for future updates to the SC–CO_2 estimates, a modeling framework to satisfy the specified criteria, and both near-term updates and longer-term research needs pertaining to various components of the estimation process.[45] Shortly thereafter, in March 2017, President Trump issued Executive Order 13783, which disbanded the IWG, withdrew the previous TSDs, and directed agencies to ensure SC–CO_2 estimates used in regulatory analyses are consistent with the guidance contained in OMB's Circular A–4, ''including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates'' (E.O. 13783, Section 5(c)). Benefit-cost analyses following E.O. 13783 used SC–GHG estimates that attempted to focus on the U.S.-specific share of climate change damages as estimated by the models and were calculated using two discount rates recommended by Circular A–4, 3 percent and 7 percent. All other methodological decisions and model versions used in SC–GHG calculations remained the same as those used by the IWG in 2010 and 2013, respectively.

On January 20, 2021, President Biden issued Executive Order 13990, which re-established the IWG and directed it to ensure that the U.S. Government's estimates of the social cost of carbon and other greenhouse gases reflect the best available science and the recommendations of the National Academies (2017). The IWG was tasked with first reviewing the SC–GHG estimates currently used in Federal analyses and publishing interim estimates within 30 days of the E.O. that reflect the full impact of GHG emissions, including by taking global damages into account. The interim SC–GHG estimates published in February 2021 are used here to estimate the climate benefits for this proposed rulemaking. The E.O. instructs the IWG to undertake a fuller update of the SC–GHG estimates by January 2022 that takes into consideration the advice of the National Academies (2017) and other recent scientific literature. The February 2021 SC–GHG TSD provides a complete discussion of the IWG's initial review conducted under E.O.13990. In particular, the IWG found that the SC–GHG estimates used under E.O. 13783 fail to reflect the full impact of GHG emissions in multiple ways.

First, the IWG found that the SC–GHG estimates used under E.O. 13783 fail to fully capture many climate impacts that affect the welfare of U.S. citizens and residents, and those impacts are better reflected by global measures of the SC–GHG. Examples of omitted effects from the E.O. 13783 estimates include: (1) direct effects on U.S. citizens, assets, and investments located abroad; (2) supply chains;(3) U.S. military assets and interests abroad; (4) tourism; and (5) spillover pathways, such as economic and political destabilization and global migration, that can lead to adverse impacts on U.S. national security, public health, and humanitarian concerns. In addition, assessing the benefits of U.S. GHG mitigation activities requires consideration of how those actions may affect mitigation activities by other countries, as those international mitigation actions will provide a benefit to U.S. citizens and residents by mitigating climate impacts that affect U.S. citizens and residents. A wide range of scientific and economic experts have emphasized the issue of reciprocity as support for considering global damages of GHG emissions. If the United States does not consider impacts on other countries, it is difficult to convince other countries to consider the impacts of their emissions on the United States The only way to achieve an efficient allocation of resources for emissions reduction on a global basis—and so benefit the U.S. and its citizens—is for all countries to base their policies on global estimates of damages. As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with this assessment and, therefore, in this proposed rule, DOE centers attention on a global measure of SC–GHG. This approach is the same as that taken in DOE regulatory analyses from 2012 through 2016. A robust estimate of climate damages that accrue only to U.S. citizens and residents does not currently exist in the literature. As explained in the February 2021 SC–GHG TSD, existing estimates are both incomplete and underestimate total damages that accrue to the citizens and residents of the U.S. because they do not fully capture the regional interactions and spillovers discussed above, nor do they include all of the important physical, ecological, and economic impacts of climate change recognized in the literature. As noted in the February 2021 SC–GHG TSD, the IWG will continue to review developments in the literature, including more robust methodologies for estimating a U.S.-specific SC–GHG value and exploring ways to better inform the public of the full range of carbon impacts. As a member of the IWG, DOE will continue to follow developments in the literature pertaining to this issue.

Second, the IWG found that the use of the social rate of return on capital (7 percent under current OMB Circular A–4 guidance) to discount the future benefits of reducing GHG emissions inappropriately underestimates the impacts of climate change for the purposes of estimating the SC–GHG. Consistent with the findings of the National Academies (2017) and the economic literature, the IWG continued to conclude that the consumption rate of interest is the theoretically appropriate discount rate in an intergenerational

[44] Marten, A. L., E. A. Kopits, C. W. Griffiths, S. C. Newbold, and A. Wolverton. Incremental CH_4 and N_2O mitigation benefits consistent with the US Government's SC–CO_2 estimates. *Climate Policy.* 2015. 15(2): pp. 272–298.

[45] National Academies of Sciences, Engineering, and Medicine. *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide.* 2017. The National Academies Press: Washington, DC.

context [46] and recommended that discount rate uncertainty and relevant aspects of intergenerational ethical considerations be accounted for in selecting future discount rates.

Furthermore, the damage estimates developed for use in the SC–GHG are estimated in consumption-equivalent terms, and so an application of OMB Circular A–4's guidance for regulatory analysis would then use the consumption discount rate to calculate the SC–GHG. DOE agrees with this assessment and will continue to follow developments in the literature pertaining to this issue. DOE also notes that while OMB Circular A–4, as published in 2003, recommends using 3 percent and 7 percent discount rates as ''default'' values, Circular A–4 also reminds agencies that ''different regulations may call for different emphases in the analysis, depending on the nature and complexity of the regulatory issues and the sensitivity of the benefit and cost estimates to the key assumptions.'' On discounting, Circular A–4 recognizes that ''special ethical considerations arise when comparing benefits and costs across generations,'' and Circular A–4 acknowledges that analyses may appropriately ''discount future costs and consumption benefits. . .at a lower rate than for intragenerational analysis.'' In the 2015 Response to Comments on the Social Cost of Carbon for Regulatory Impact Analysis, OMB, DOE, and the other IWG members recognized that ''Circular A–4 is a living document'' and ''the use of 7 percent is not considered appropriate for intergenerational discounting. There is wide support for this view in the academic literature, and it is recognized in Circular A–4 itself.'' Thus, DOE concludes that a 7-percent discount rate is not appropriate to apply to value the social cost of greenhouse gases presented in this analysis.

To calculate the present and annualized values of climate benefits, DOE uses the same discount rate as the rate used to discount the value of damages from future GHG emissions, for internal consistency. That approach to discounting follows the same approach that the February 2021 SC–GHG TSD recommends ''to ensure internal consistency—*i.e.,* future damages from climate change using the SC–GHG at 2.5 percent should be discounted to the base year of the analysis using the same 2.5 percent rate.'' DOE has also consulted the National Academies' 2017 recommendations on how SC–GHG estimates can ''be combined in RIAs with other cost and benefits estimates that may use different discount rates.'' The National Academies reviewed several options, including ''presenting all discount rate combinations of other costs and benefits with [SC–GHG] estimates.''

As a member of the IWG involved in the development of the February 2021 SC–GHG TSD, DOE agrees with the above assessment and will continue to follow developments in the literature pertaining to this issue. While the IWG is working to assess how best to incorporate the latest peer-reviewed science to develop an updated set of SC–GHG estimates, it set the interim estimates to be the most recent estimates developed by the IWG prior to the group being disbanded in 2017. The estimates rely on the same models and harmonized inputs and are calculated using a range of discount rates. As explained in the February 2021 SC–GHG TSD, the IWG has recommended that agencies revert to the same set of four values drawn from the SC–GHG distributions based on three discount rates as were used in regulatory analyses between 2010 and 2016 and were subject to public comment. For each discount rate, the IWG combined the distributions across models and socioeconomic emissions scenarios (applying equal weight to each) and then selected a set of four values recommended for use in benefit-cost analyses: an average value resulting from the model runs for each of three discount rates (2.5 percent, 3 percent, and 5 percent), plus a fourth value, selected as the 95th percentile of estimates based on a 3-percent discount rate. The fourth value was included to provide information on potentially higher-than-expected economic impacts from climate change. DOE agrees with the update explained in the February 2021 SC–GHG TSD, which reflects the immediate need to have an operational SC–GHG—for use in regulatory benefit-cost analyses and other applications—that was developed using a transparent process, peer-reviewed methodologies, and the science available at the time of that process. Those estimates were subject to public comment in the context of dozens of proposed rulemakings as well as in a dedicated public comment period in 2013.

A number of limitations and uncertainties are associated with the SC–GHG estimates. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.[47] Second, the IAMs used to produce these interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature; furthermore, the science underlying their ''damage functions''—*i.e.,* the core parts of the IAMs that map global mean temperature changes and other physical impacts of climate change into economic (both market and nonmarket) damages—lags behind the most recent research. For example, limitations include the incomplete treatment of catastrophic and non-catastrophic impacts in the integrated assessment models, their incomplete treatment of adaptation and technological change, the incomplete way in which inter-regional and intersectoral linkages are modeled, uncertainty in the extrapolation of damages due to high temperatures, and the inadequate representation of the relationship between the discount rate and uncertainty in economic growth over long time horizons. Likewise, the socioeconomic and emissions scenarios used as inputs to the models do not reflect new information from the last decade of scenario generation or the full range of projections. The modeling limitations do not all work in the same direction in terms of their influence on the SC–CO_2 estimates. However, as discussed in the February 2021 SC–GHG

[46] Interagency Working Group on Social Cost of Carbon. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. 2010. United States Government. Available at *www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf* (last accessed April 15, 2022). Interagency Working Group on Social Cost of Carbon. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. 2013 Available at *www.federalregister.gov/documents/2013/11/26/2013-28242/technical-support-document-technical-update-of-the-social-cost-of-carbon-for-regulatory-impact* (last accessed April 15, 2022). Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Technical Support Document: Technical Update on the Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866. August 2016. Available at *www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf* (last accessed January 18, 2022). Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. August 2016. Available at *www.epa.gov/sites/default/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf* (last accessed January 18, 2022).

[47] Interagency Working Group on Social Cost of Greenhouse Gases (IWG). 2021. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. February. United States Government. Available at *www.whitehouse.gov/briefing-room/blog/2021/02/26/a-return-to-science-evidence-based-estimates-of-the-benefits-of-reducing-climate-pollution/.*

TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC–GHG estimates used in this final rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

DOE's derivations of the SC–CO_2, SC–N_2O, and SC–CH_4 values used for this rule are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these GHGs are presented in section V.B.6 of this document.

The C2ES commented that DOE appropriately applies the social cost estimates developed by the IWG to its analysis of emissions reduction benefits generated by the proposed rule. The C2ES commented that DOE should expand upon its rationale for adopting a global damages valuation and for the range of discount rates it applies to climate effects, as there are additional legal, economic, and policy reasons for such methodological decisions that can further bolster DOE's support for these choices. C2ES added that DOE should consider conducting a sensitivity analysis using a sound domestic-only social cost estimate as a backstop, and should explicitly conclude that the rule is cost-benefit justified even using a domestic-only valuation that may still undercount climate benefits. The C2ES urged DOE to consider providing an additional sensitivity analysis using discount rates lower than 2.5 percent for climate impacts. (C2ES, No. 29 at p. 2)

DOE maintains that the reasons for using global measures of the SC–GHG previously discussed are sufficient for the purposes of this rulemaking. DOE notes that further discussion of this topic is contained in the February 2021 SC–GHG TSD, and DOE agrees with the assessment therein. Regarding conducting sensitivity analysis using a domestic-only social cost estimate, DOE agrees with the assessment in the February 2021 SC–GHG TSD that the only currently available quantitative characterization of domestic damages from GHG emissions is both incomplete and an underestimate of the share of total damages that accrue to the citizens and residents of the United States. Therefore, it would be of questionable value to conduct the suggested sensitivity analysis at this time. DOE considered performing sensitivity analysis using discount rates lower than 2.5 percent for climate impacts, as suggested by the IWG, but it concluded that such analysis would not add meaningful information in the context of this rulemaking.

a. Social Cost of Carbon

The SC–CO_2 values used for this final rule were based on the values developed for the IWG's February 2021 TSD. Table IV.8 shows the updated sets of SC–CO_2 estimates from the IWG's TSD in 5-year increments from 2020 to 2050. The full set of annual values that DOE used is presented in appendix 14–A of the final rule TSD. For purposes of capturing the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–CO_2 values, as recommended by the IWG.[48]

TABLE IV.8.—ANNUAL SC–CO_2 VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2020$ per Metric Ton CO_2]

Year	Discount rate and statistic			
	5% Average	3% Average	2.5% Average	3% 95th percentile
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

For 2051 to 2070, DOE used SC–CO_2 estimates published by EPA, adjusted to 2020$.[49] These estimates are based on methods, assumptions, and parameters identical to the 2020–2050 estimates published by the IWG (which were based on EPA modeling). DOE expects additional climate benefits to accrue for any longer-life furnaces after 2070, but a lack of available SC–CO_2 estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

DOE multiplied the CO_2 emissions reduction estimated for each year by the SC–CO_2 value for that year in each of the four cases. DOE adjusted the values to 2021$ using the implicit price deflator for gross domestic product (''GDP'') from the Bureau of Economic Analysis. 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 SC–CO_2 values in each case.

b. Social Cost of Methane and Nitrous Oxide

The SC–CH_4 and SC–N_2O values used for this final rule were based on the values developed for the February 2021 SC–GHG TSD. Table IV.9 shows the updated sets of SC–CH_4 and SC- N_2O estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the final rule TSD. To capture the uncertainties involved in regulatory impact analysis, DOE has determined it is appropriate to include all four sets of SC–CH_4 and SC- N_2O values, as recommended by the IWG. DOE derived values after 2050 using the approach described above for the SC–CO_2.

[48] For example, the February 2021 SC–GHG TSD discusses how the understanding of discounting approaches suggests that discount rates appropriate for intergenerational analysis in the context of climate change may be lower than 3 percent.

[49] *See* EPA, Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis, Washington, DC, December 2021. Available at *nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf* (last accessed January 13, 2023). (last accessed January 20, 2023).

TABLE IV.9.—ANNUAL SC–CH_4 AND SC–N_2O VALUES FROM 2021 INTERAGENCY UPDATE, 2020–2050

[2020$ per metric ton]

Year	SC–CH_4				SC–N_2O			
	Discount rate and statistic				Discount rate and statistic			
	5% Average	3% Average	2.5% Average	3% 95th percentile	5% Average	3% Average	2.5% Average	3% 95th percentile
2020 ..	670	1,500	2,000	3,900	5,800	18,000	27,000	48,000
2025 ..	800	1,700	2,200	4,500	6,800	21,000	30,000	54,000
2030 ..	940	2,000	2,500	5,200	7,800	23,000	33,000	60,000
2035 ..	1,100	2,200	2,800	6,000	9,000	25,000	36,000	67,000
2040 ..	1,300	2,500	3,100	6,700	10,000	28,000	39,000	74,000
2045 ..	1,500	2,800	3,500	7,500	12,000	30,000	42,000	81,000
2050 ..	1,700	3,100	3,800	8,200	13,000	33,000	45,000	88,000

2. Monetization of Other Emissions Impacts

For the final rule, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.[50] DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025 and 2030, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 range; for years beyond 2040 the values are held constant. DOE combined the EPA benefit per ton estimates with regional information on electricity consumption and emissions to define weighted-average national values for NO_X and SO_2 as a function of sector (see. appendix 14B of the final rule TSD).

DOE multiplied the site emissions reduction (in tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate.

M. Utility Impact Analysis

The utility impact analysis estimates the changes in installed electrical capacity and generation projected to result for each considered TSL. The analysis is based on published output from the NEMS associated with *AEO2022.* NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption and emissions in the *AEO2022* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the final rule TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity, and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of potential new or amended energy conservation standards.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts from new or amended energy conservation standards include both 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 are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. 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 consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the products to which the new standards apply and other goods and services, 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 BLS. 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.[51] There are many reasons for these differences, including wage 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, the BLS data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this final rule using an input/output model of the U.S. economy called Impact of Sector Energy

[50] Estimating the Benefit per Ton of Reducing $PM_{2.5}$ Precursors from 21 Sectors. Available at *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors.*

[51] *See* U.S. Department of Commerce–Bureau of Economic Analysis. *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (''RIMS II'').* 1997. U.S. Government Printing Office: Washington, DC. Available at *https://www.bea.gov/sites/default/files/methodologies/RIMSII_User_Guide.pdf* (last accessed January 20, 2023).

Technologies version 4 (''ImSET'').[52] 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 that the uncertainties involved in projecting employment impacts especially change in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may over-estimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes, where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the final rule TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for microwave ovens. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for microwave ovens, and the standards levels that DOE is adopting in this final rule. Additional details regarding DOE's analyses are contained in the final rule TSD supporting this document.

A. Trial Standard Levels

In general, DOE typically evaluates potential amended standards for products and equipment by grouping individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider manufacturer cost interactions between the product classes, to the extent that there are such interactions, and market cross elasticity from consumer purchasing decisions that may change when different standard levels are set.

In the analysis conducted for this final rule, DOE analyzed the benefits and burdens of three TSLs for microwave ovens. DOE developed TSLs that combine efficiency levels for each analyzed product class. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the final rule TSD.

Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for microwave ovens. TSL 3 represents the maximum technologically feasible (''max-tech'') energy efficiency for all product classes. TSL 2 and TSL 1 represent interim energy efficiency levels between the current standard level and the max-tech energy efficiency level.

TABLE V.1—TRIAL STANDARD LEVELS FOR MICROWAVE OVENS

Product class	TSL 1	TSL 2	TSL 3
	Maximum allowable average standby power (W)		
PC 1: Microwave-Only and Countertop Convection	0.8	0.6	0.4
PC 2: Built-In and Over-the-Range Convection	1.5	1.0	0.5

DOE constructed the TSLs for this final rule to include efficiency levels representative of efficiency levels with similar characteristics (*i.e.,* using similar technologies and/or efficiencies, and having roughly comparable equipment availability). The use of representative efficiency levels provided for greater distinction between the TSLs. While representative efficiency levels were included in the TSLs, DOE considered all efficiency levels as part of its analysis.[53]

The Joint Commenters requested DOE to consider an additional TSL that evaluates Product Class 1 at a level more stringent than what DOE proposed in the August 2022 SNOPR. Specifically, the Joint Commenters requested that DOE evaluate a modified TSL with Product Class 1 at 0.4W and Product Class 2 at 1.0W, noting that this approach would alleviate DOE's concerns of net cost to consumers while roughly doubling the national energy savings relative to the proposed levels. (Joint Commenters, No. 31 at p. 2)

As discussed in section V.B.2.c of this document, DOE assumes manufacturers will meet amended energy conservation standards for microwave ovens by re-designing the control boards of non-compliant models. DOE estimates that approximately 89 percent of Product Class 1 shipments will need to be redesigned to meet the efficiency levels of the modified TSL suggested by the Joint Commenters. This represents a need to redesign models accounting for approximately 10.5 million units with manufacturers expressing concern that a redesign effort of this extent may not be possible in a three-year time period. Manufacturers would most likely stop offering lower-volume non-compliant models to consumers, choosing instead to focus their resources on remodeling the highest-volume selling models first. Due to the potential impact on consumer choice, DOE did not evaluate the additional TSL suggested by the Joint Commenters in this rulemaking.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on microwave oven consumers by looking at the effects that potential amended standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed in the following sections.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency products affect consumers in two ways: (1) purchase price increases and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.,* product price plus installation costs) and operating costs (*i.e.,* annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime

[52] Livingston, O. V., S. R. Bender, M. J. Scott, and R. W. Schultz. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide.* 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL–24563.

[53] Efficiency levels that were analyzed for this NOPR are discussed in section IV.C.4 of this document. Results by efficiency level are presented in final rule TSD chapters 8, 10, and 12.

and a discount rate. Chapter 8 of the final rule TSD provides detailed information on the LCC and PBP analyses.

Table V.2 through Table V.5 show the LCC and PBP results for the TSLs considered for each product class. In the first of each pair of tables, the simple payback is measured relative to the baseline product. In the second table, the impacts are measured relative to the efficiency distribution in the in the no-new-standards case in the compliance year (see section IV.F.8 of this document). Because some consumers purchase products with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline product and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase a product with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

TABLE V.2—AVERAGE LCC AND PBP RESULTS FOR PC 1: MICROWAVE-ONLY OVENS AND COUNTERTOP CONVECTION MICROWAVE OVENS

TSL	EL	Standby power (W)	Average costs (2021$)				Simple payback (years)	Average lifetime (years)
			Installed cost	First year's operating cost	Lifetime operating cost	LCC		
	0	.....	$254.16	$1.26	$11.38	$265.54	.....	10.78
1	1	0.8	254.24	1.02	9.20	263.44	0.3	10.78
2	2	0.6	254.80	0.78	7.02	261.81	1.3	10.78
3	3	0.4	255.57	0.54	4.83	260.40	2.0	10.78

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product.

TABLE V.3—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PC 1: MICROWAVE-ONLY OVENS AND COUNTERTOP CONVECTION MICROWAVE OVENS

TSL	Efficiency level	Life-cycle cost savings	
		Average LCC savings * (2021$)	Percent of consumers that experience net cost
1	1	$0.25	0
2	2	0.99	5
3	3	2.16	12

* The savings represent the average LCC for affected consumers.

TABLE V.4—AVERAGE LCC AND PBP RESULTS FOR PC 2: BUILT-IN AND OVER-THE-RANGE CONVECTION MICROWAVE OVENS

TSL	EL	Standby power (W)	Average costs (2021$)				Simple payback (years)	Average lifetime (years)
			Installed cost	First year's operating cost	Lifetime operating cost	LCC		
	0	.....	$546.11	$2.74	$24.75	$570.86	.....	10.78
1	1	1.5	546.11	1.89	17.11	563.22	0.0	10.78
2	2	1.0	547.28	1.29	11.65	558.93	0.8	10.78
3	3	0.5	551.36	0.69	6.19	557.55	2.6	10.78

Note: The results for each TSL are calculated assuming that all consumers use products at that efficiency level. The simple PBP is measured relative to the baseline product.

TABLE V.5—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PC 2: BUILT-IN AND OVER-THE-RANGE CONVECTION MICROWAVE OVENS

TSL	EL	Life-cycle cost savings	
		Average LCC savings * (2021$)	Percent of consumers that experience net cost
1	1	$0.00	0
2	2	0.83	7

TABLE V.5—AVERAGE LCC SAVINGS RELATIVE TO THE NO-NEW-STANDARDS CASE FOR PC 2: BUILT-IN AND OVER-THE-RANGE CONVECTION MICROWAVE OVENS—Continued

TSL	EL	Life-cycle cost savings	
		Average LCC savings * (2021$)	Percent of consumers that experience net cost
3	3	1.95	42

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on low-income households and senior-only households. Table V.6 and Table V.7 compare the average LCC savings and PBP at each efficiency level for the consumer subgroups with similar metrics for the entire consumer sample for both product classes. In most cases, the average LCC savings and PBP for low-income households and senior-only households at the considered efficiency levels are not substantially different from the average for all households. Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroups.

TABLE V.6—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; PC 1: MICROWAVE-ONLY OVENS AND COUNTERTOP CONVECTION MICROWAVE OVENS

TSL	EL	Average life-cycle cost savings * (2021$)			Simple payback period (years)			Net cost (%)		
		Low-income ‡	Senior-only §	Nation	Low-income	Senior-only	Nation	Low-income	Senior-only	Nation
1	1	$0.25	$0.25	$0.25	0.3	0.3	0.3	0	0	0
2	2	0.99	0.97	0.99	1.3	1.3	1.3	6	5	5
3	3	2.13	2.12	2.16	2.0	2.0	2.0	13	12	12

* The savings represent the average LCC for affected consumers.
‡ Low-income households represent 12.5 percent of all households for this product class.
§ Senior-only households represent 24.7 percent of all households for this product class.

TABLE V.7—COMPARISON OF LCC SAVINGS AND PBP FOR CONSUMER SUBGROUPS AND ALL HOUSEHOLDS; PC 2: BUILT-IN AND OVER-THE-RANGE CONVECTION MICROWAVE OVENS

TSL	EL	Average life-cycle cost savings * (2021$)			Simple payback period (years)			Net cost (%)		
		Low-income ‡	Senior-only §	Nation	Low-income	Senior-only	Nation	Low-income	Senior-only	Nation
1	1	$0.00	$0.00	$0.00	0.0	0.0	0.0	0	0	0
2	2	0.76	0.76	0.83	0.8	0.8	0.8	8	8	7
3	3	1.79	1.79	1.95	2.6	2.6	2.6	43	43	42

* The savings represent the average LCC for affected consumers.
‡ Low-income households represent 12.5 percent of all households for this product class.
§ Senior-only households represent 24.7 percent of all households for this product class.

c. Rebuttable Presumption Payback

As discussed in section III.E.2 of this document, EPCA establishes a rebuttable presumption that 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. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for microwave ovens. In contrast, the PBPs presented in section V.B.1.a of this document were calculated using distributions that reflect the range of energy use in the field.

Table V.8 presents the rebuttable-presumption payback periods for the considered TSLs for microwave ovens. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

TABLE V.8—REBUTTABLE-PRESUMPTION PAYBACK PERIODS

Product class	1	2	3
	(years)		
PC 1: Microwave-Only and Countertop Convection	2.1	2.2	2.2
PC 2: Built-In and Over-the-Range Convection	0.0	2.2	2.7

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of microwave ovens. The next section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from a standard. The following tables summarize the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of microwave ovens, as well as the conversion costs that DOE estimates manufacturers of microwave ovens would incur at each TSL. To evaluate the range of cash-flow impacts on the microwave oven industry, DOE modeled two manufacturer markup scenarios using different assumptions that correspond to the range of anticipated market responses to amended energy conservation standards: (1) the conversion cost recovery scenario and (2) the constant price scenario.

To assess the lowest magnitude of the range of potential impacts, DOE modeled a conversion cost recovery scenario in which manufacturers are able to increase their manufacturer markups in response to amended energy conservation standards. To assess the largest magnitude of the range of potential impacts, DOE modeled a constant price scenario in which manufacturers incur conversion costs but do not receive any additional revenue from these redesign efforts.

As noted in the MIA methodology discussion (*see* section IV.J of this document), in addition to manufacturer markup scenarios, the MPCs, shipments, and conversion cost assumptions also affect INPV results.

The results in Table V.9 and Table V.10 present potential INPV impacts for microwave oven manufacturers. Table V.9 reflects the lowest magnitude of potential impacts (conversion cost recovery scenario), and Table V.10 represents the largest magnitude of potential impacts (constant price scenario). In the following discussion, the INPV results refer to the difference in industry value between the no-new-standards case and each standards case that results from the sum of discounted cash flows from 2023 (the reference year) through 2055 (the end of the analysis period).

TABLE V.9—MANUFACTURER IMPACT ANALYSIS RESULTS—CONVERSION COST RECOVERY SCENARIO

	Units	No-new-standards case	Trial standard level *		
			1	2	3
INPV	*2021$ millions*	1,426	1,426	1,426	1,426
Change in INPV	*2021$ millions*		0.0	0.0	0.0
	%		0.0	0.0	0.0
Product Conversion Costs	*2021$ millions*		2.8	23.6	55.0
Capital Conversion Costs	*2021$ millions*		2.5	22.5	53.3
Total Conversion Costs	*2021$ millions*		5.3	46.1	108.3

* Parentheses indicate negative values. Numbers may not sum exactly due to rounding.

TABLE V.10—MANUFACTURER IMPACT ANALYSIS RESULTS—CONSTANT PRICE SCENARIO

	Units	No-new-standards case	Trial standard level *		
			1	2	3
INPV	*2021$ millions*	1,426	1,422	1,389	1,339
Change in INPV	*2021$ millions*		(4.2)	(37.2)	(87.5)
	%		(0.3)	(2.6)	(6.1)
Product Conversion Costs	*2021$ millions*		2.8	23.6	55.0
Capital Conversion Costs	*2021$ millions*		2.5	22.5	53.3
Total Conversion Costs	*2021$ millions*		5.3	46.1	108.3

* Parentheses indicate negative values. Numbers may not sum exactly due to rounding.

At TSL 1, DOE estimates impacts on INPV will range from −$4.2 million, which represents a change of −0.3 percent, to no change in INPV. At TSL 1, industry free cash flow decreases to $98 million, which represents a decrease of approximately 2.1 percent, compared to the no-new-standards case value of $100 million in 2025, the year leading up to the compliance date.

TSL 1 would set the energy conservation standard for both product classes at EL 1. DOE estimates that 85 percent of Product Class 1 shipments and 100 percent of Product Class 2 shipments would already meet or exceed the efficiency levels required at TSL 1. DOE expects microwave oven manufacturers to incur approximately

$2.8 million in product conversion costs to redesign and re-test non-compliant models and approximately $2.5 million in capital conversion costs to purchase new tooling and equipment necessary to produce these redesigned models.

At TSL 2, DOE estimates that impacts on INPV will range from −$37.2 million, which represents a change of −2.6 percent, to no change in INPV. At TSL 2, industry free cash flow decreases to $82 million, which represents a decrease of approximately 18.4 percent, compared to the no-new-standards case value of $100 million in 2025, the year leading up to the compliance date.

TSL 2 would set the energy conservation standard for both product classes at EL 2. DOE estimates that 40 percent of Product Class 1 shipments and 64 percent of Product Class 2 shipments would already meet or exceed the efficiency levels required at TSL 2. DOE expects microwave oven manufacturers to incur approximately $23.6 million in product conversion costs to redesign and re-test non-compliant models and approximately $22.5 million in capital conversion costs to purchase new tooling and equipment necessary to produce these redesigned models.

At TSL 3, DOE estimates impacts on INPV will range from −$87.5 million, which represents a change of −6.1 percent, to no change in INPV. At TSL 3, industry free cash flow decreases to $57 million, which represents a decrease of approximately 43.3 percent compared to the no-new-standards case value of $100 million in 2025, the year leading up to the compliance date.

TSL 3 would set the energy conservation standard for both product classes at max-tech (EL 3). DOE estimates that 11 percent of Product Class 1 shipments and 5 percent of Product Class 2 shipments would already meet the efficiency levels required at TSL 3. DOE expects microwave oven manufacturers to incur approximately $55.0 million in product conversion costs to redesign and re-test non-compliant models and approximately $53.3 million in capital conversion costs to purchase new tooling and equipment necessary to produce these redesigned models.

b. Direct Impacts on Employment

DOE estimates that over 95 percent of microwave oven manufacturing occurs outside the United States. Furthermore, none of the analyzed efficiency levels require additional labor and would not impact current manufacturing labor practices. Therefore, DOE estimates that there will be no direct impacts on domestic employment at any of the analyzed TSLs.

c. Impacts on Manufacturing Capacity

DOE assumes manufacturers will meet amended energy conservation standards for microwave ovens by re-designing the control boards of non-compliant models. DOE estimates that approximately 89 percent of Product Class 1 shipments and 95 percent of Product Class 2 shipments will need to be redesigned to meet the efficiency levels required at TSL 3. This represents a need to redesign models accounting for approximately 10.5 million Product Class 1 units and 0.4 million Product Class 2 units. Manufacturers have expressed concern that redesigning 90 percent of all microwave oven models in a three-year time period might not be possible.

At TSL 2, DOE estimates that approximately 60 percent of Product Class 1 shipments and 36 percent of Product Class 2 shipments will need to be redesigned to meet the efficiency levels; at TSL 1, DOE estimates that approximately 15 percent of Product Class 1 shipments and no Product Class 2 shipments will need to be redesigned to meet the efficiency levels. Both of the redesign requirements at TSL 1 and TSL 2 are unlikely to cause a significant capacity concern for most microwave oven manufacturers.

d. Impacts on Subgroups of Manufacturers

Small manufacturers, niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average could be affected disproportionately. Using average cost assumptions developed for an industry cash-flow estimate is inadequate to assess differential impacts among manufacturer subgroups.

For the microwave oven industry, DOE identified and evaluated the impact of amended energy conservation standards on one subgroup—small manufacturers. The Small Business Administration (''SBA'') defines a ''small business'' as having 1,500 employees or fewer for the North American Industry Classification System (''NAICS'') code 335220, ''Major Household Appliance Manufacturing.'' [54] For a discussion of the impacts on the small manufacturer subgroup, *see* the regulatory flexibility analysis in section VI.B of this document and chapter 12 of the final rule TSD.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the regulatory actions of other Federal agencies and States that affect the manufacturers of a covered product or equipment. While any one regulation may not impose a significant burden on manufacturers, the combined effects of several existing or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing products. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency.

DOE evaluates product-specific regulations that will take effect approximately 3 years before or after the estimated 2026 compliance date of any amended energy conservation standards for microwave ovens. This information is presented in Table V.11.

[54] Available at *www.sba.gov/document/support-table-size-standards* (last accessed on Jan. 11, 2023).

TABLE V.11—COMPLIANCE DATES AND EXPECTED CONVERSION EXPENSES OF FEDERAL ENERGY CONSERVATION STANDARDS AFFECTING MICROWAVE OVEN MANUFACTURERS

Federal energy conservation standard	Number of mfrs *	Number of manufacturers affected from today's rule **	Approx. standards year	Industry conversion costs (millions$)	Industry conversion costs/product revenue *** (%)
Portable Air Conditioners, 85 FR 1378 (Jan. 10, 2020)	11	2	2025	$320.9 (2015$)	6.7
Room Air Conditioners ‡	8	3	2026	$24.8 (2021$)	0.4
Consumer Clothes Dryers, 87 FR 51734 (Aug. 23, 2022) †	15	9	2027	$149.7 (2020$)	1.8
Consumer Conventional Cooking Products, 88 FR 6818 (Feb. 1, 2023) ††	34	10	2027	$183.4 (2021$)	1.2
Residential Clothes Washers, 88 FR 13520 (Mar. 3, 2023) ††	19	5	2027	$690.8 (2021$)	5.2
Refrigerators, Refrigerator-Freezers, and Freezers, 88 FR 12452 (Feb. 27, 2023) ††	49	12	2027	$1,323.6 (2021$)	3.8
Miscellaneous Refrigeration Products, 88 FR 19382 (Mar. 31, 2023) ††	38	7	2029	$126.9 (2021$)	3.1

* This column presents the total number of manufacturers identified in the energy conservation standard rule contributing to cumulative regulatory burden.

** This column presents the number of manufacturers producing microwave ovens that are also listed as manufacturers in the listed energy conservation standard contributing to cumulative regulatory burden.

*** This column presents industry conversion costs as a percentage of product revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of the final rule to the compliance year of the energy conservation standard. The conversion period typically ranges from 3 to 5 years, depending on the rulemaking.

‡ At the time of issuance of this microwave ovens rulemaking, the rulemaking has been issued and is pending publication in the **Federal Register**. Once published, the room air conditioners final rule will be available at: *www.regulations.gov/docket/EERE-2014-BT-STD-0059*.

†† Indicates a proposed rulemaking. Values could change upon publication of a final rule.

In addition to the rulemakings listed in Table V.11, DOE has other ongoing rulemakings for products that microwave oven manufacturers produce: dishwashers [55] and dehumidifiers.[56]

3. National Impact Analysis

This section presents DOE's estimates of the national energy savings and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended standards.

a. Significance of Energy Savings

To estimate the energy savings attributable to potential amended standards for microwave ovens, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of products purchased in the 30-year period that begins in the year of anticipated compliance with amended standards (2026–2055). Table V.12 presents DOE's projections of the national energy savings for each TSL considered for microwave ovens. The savings were calculated using the approach described in section IV.H.2 of this document.

TABLE V.12—CUMULATIVE NATIONAL ENERGY SAVINGS FOR MICROWAVE OVENS; 30 YEARS OF SHIPMENTS

[2026–2055]

	Trial standard level		
	1	2	3
	(quads)		
Primary energy	0.01	0.05	0.12
FFC energy	0.01	0.06	0.12

OMB Circular A–4 [57] 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

[55] *www.regulations.gov/docket/EERE-2014-BT-STD-0021*.

[56] *www.regulations.gov/docket/EERE-2019-BT-STD-0043*.

[57] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed January 13, 2023).

to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of product shipments. 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.[58] The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to microwave ovens. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.13. The impacts are counted over the lifetime of microwave ovens purchased in 2026–2055.

TABLE V.13—CUMULATIVE NATIONAL ENERGY SAVINGS FOR MICROWAVE OVENS; 9 YEARS OF SHIPMENTS
[2026–2055]

	Trial standard level		
	1	2	3
	(quads)		
Source energy	0.003	0.014	0.034
FFC energy	0.003	0.015	0.035

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for microwave ovens. In accordance with OMB's guidelines on regulatory analysis,[59] DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V.14 shows the consumer NPV results with impacts counted over the lifetime of products purchased in 2026–2055.

TABLE V.14—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR MICROWAVE OVENS; 30 YEARS OF SHIPMENTS
[2026–2055]

Discount rate	Trial standard level		
	1	2	3
	(billion 2021$)		
3 percent	0.080	0.353	0.710
7 percent	0.039	0.164	0.320

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.15. The impacts are counted over the lifetime of products purchased in 2026–2055. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

TABLE V.15—CUMULATIVE NET PRESENT VALUE OF CONSUMER BENEFITS FOR MICROWAVE OVENS; 9 YEARS OF SHIPMENTS
[2026–2055]

Discount rate	Trial standard level		
	1	2	3
	(billion 2021$)		
3 percent	0.030	0.127	0.266
7 percent	0.020	0.079	0.160

[58] 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 products, the compliance period is 5 years rather than 3 years.

[59] U.S. Office of Management and Budget. *Circular A–4: Regulatory Analysis.* September 17, 2003. *obamawhitehouse.archives.gov/omb/circulars_a004_a-4/* (last accessed December 13, 2022).

The previous results reflect the use of a default trend to estimate the change in price for microwave ovens over the analysis period (see section IV.F.1 of this document). DOE also conducted a sensitivity analysis that considered one scenario with a lower rate of price decline than the reference case and one scenario with a higher rate of price decline than the reference case. The results of these alternative cases are presented in appendix 10C of the final rule TSD. In the high-price-decline case, the NPV of consumer benefits is higher than in the default case. In the low-price-decline case, the NPV of consumer benefits is lower than in the default case.

c. Indirect Impacts on Employment

DOE estimates that amended energy conservation standards for microwave ovens will reduce energy expenditures for consumers of those products, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2026–2031), where these uncertainties are reduced.

The results suggest that the adopted 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. Chapter 16 of the final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As discussed in section IV.C.1.b of this document, DOE has concluded that the standards adopted in this final rule will not lessen the utility or performance of the microwave ovens under consideration in this rulemaking. Manufacturers of these products currently offer units that meet or exceed the adopted standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.E.1.e of this document, EPCA 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 in writing to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. To assist the Attorney General in making this determination, DOE provided the Department of Justice (''DOJ'') with copies of the August 2022 SNOPR and the SNOPR TSD for review. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for microwave ovens are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

6. Need of the Nation To Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. Chapter 15 of the final rule TSD presents the estimated impacts on electricity generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from potential energy conservation standards for microwave ovens is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and greenhouse gases. Table V.16 provides DOE's estimate of cumulative emissions reductions expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

TABLE V.16—CUMULATIVE EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055

	Trial standard level		
	1	2	3
Power Sector Emissions			
CO_2 (*million metric tons*)	0.33	1.74	3.92
CH_4 (*thousand tons*)	0.03	0.14	0.31
N_2O (*thousand tons*)	0.00	0.02	0.04
SO_2 (*thousand tons*)	0.16	0.84	1.89
NO_X (*thousand tons*)	0.17	0.88	1.98
Hg (*tons*)	0.00	0.01	0.01
Upstream Emissions			
CO_2 (*million metric tons*)	0.03	0.13	0.30
CH_4 (*thousand tons*)	2.39	12.50	28.14
N_2O (*thousand tons*)	0.00	0.00	0.00
SO_2 (*thousand tons*)	0.00	0.01	0.02
NO_X (*thousand tons*)	0.38	2.00	4.51
Hg (*tons*)	0.00	0.00	0.00
Total FFC Emissions			
CO_2 (*million metric tons*)	0.36	1.87	4.21
CH_4 (*thousand tons*)	2.41	12.64	28.45

TABLE V.16—CUMULATIVE EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055—Continued

	Trial standard level		
	1	2	3
N_2O (*thousand tons*)	0.00	0.02	0.04
SO_2 (*thousand tons*)	0.16	0.85	1.91
NO_X (*thousand tons*)	0.55	2.88	6.49
Hg (*tons*)	0.00	0.01	0.01

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for microwave ovens. Section IV.L of this document discusses the estimated SC–CO_2 values that DOE used. Table V.17 presents the value of CO_2 emissions reduction at each TSL for each of the SC–CO_2 cases. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

TABLE V.17—PRESENT VALUE OF CO_2 EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055

TSL	SC–CO_2 case			
	Discount rate and statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	(million 2021$)			
1	3.63	15.19	23.58	46.17
2	19.00	79.47	123.39	241.61
3	42.78	178.91	277.80	543.96

As discussed in section IV.L.2 of this document, DOE estimated the climate benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for microwave ovens. Table V.18 presents the value of the CH_4 emissions reduction at each TSL, and Table V.19 presents the value of the N_2O emissions reduction at each TSL. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

TABLE V.18—PRESENT VALUE OF METHANE EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055

TSL	SC–CH_4 case			
	Discount rate and statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	(million 2021$)			
1	1.11	3.22	4.46	8.51
2	5.82	16.83	23.33	44.56
3	13.10	37.90	52.52	100.31

TABLE V.19—PRESENT VALUE OF NITROUS OXIDE EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055

TSL	SC–N_2O Case			
	Discount rate and statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	(million 2021$)			
1	0.01	0.06	0.09	0.15
2	0.08	0.29	0.45	0.78
3	0.17	0.66	1.02	1.76

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 global and U.S. economy continues to evolve rapidly. DOE, together with other Federal agencies, will continue to review methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. DOE notes, however, that the adopted standards would be economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the economic benefits associated with NO_X and SO_2 emissions reductions anticipated to result from the considered TSLs for microwave ovens. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.20 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.21 presents similar results for SO_2 emissions reductions. The results in these tables reflect application of EPA's low dollar-per-ton values, which DOE used to be conservative. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

TABLE V.20—PRESENT VALUE OF NO_X EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055

TSL	7% Discount rate	3% Discount rate
	(million 2021$)	
1	10.11	23.20
2	52.89	121.38
3	119.07	273.27

TABLE V.21—PRESENT VALUE OF SO_2 EMISSIONS REDUCTION FOR MICROWAVE OVENS SHIPPED IN 2026–2055

TSL	7% Discount rate	3% Discount rate
	(million 2021$)	
1	4.17	9.26
2	21.80	48.47
3	49.08	109.13

Not all the public health and environmental benefits from the reduction of greenhouse gases, NO_X, and SO_2 are captured in the values above, and additional unquantified benefits from the reductions of those pollutants as well as from the reduction of direct PM and other co-pollutants may be significant. DOE has not included monetary benefits of the reduction of Hg emissions because the amount of reduction is very small.

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)(VII)) No other factors were considered in this analysis.

8. Summary of Economic Impacts

Table V.22 presents the NPV values that result from adding the estimates of the economic benefits resulting from reduced GHG and NO_X and SO_2 emissions to the NPV of consumer benefits calculated for each TSL considered in this rulemaking. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered products and are measured for the lifetime of products shipped in 2026–2055. The climate benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits, and are also calculated based on the lifetime of microwave ovens shipped in 2026–2055.

TABLE V.22—CONSUMER NPV COMBINED WITH PRESENT VALUE OF CLIMATE BENEFITS AND HEALTH BENEFITS

Category	TSL 1	TSL 2	TSL 3
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2021$)			
5% Average SC–GHG case	0.1	0.5	1.1
3% Average SC–GHG case	0.1	0.6	1.3
2.5% Average SC–GHG case	0.1	0.7	1.4
3% 95th percentile SC–GHG case	0.2	0.8	1.7
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2021$)			
5% Average SC–GHG case	0.1	0.3	0.5
3% Average SC–GHG case	0.1	0.3	0.7
2.5% Average SC–GHG case	0.1	0.4	0.8
3% 95th percentile SC–GHG case	0.1	0.5	1.1

C. Conclusion

When considering new or amended energy conservation standards, the standards that DOE adopts for any type (or class) of covered product must 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))

In the August 2022 SNOPR, DOE proposed energy conservation standards for microwave ovens at TSL 2, as constructed for that analysis. The minimum wattages corresponding to TSL 2 from the August 2022 SNOPR are shown in Table V.23. 87 FR 52282 (Aug. 25, 2022).

TABLE V.23—PROPOSED ENERGY CONSERVATION STANDARDS FOR MICROWAVE OVENS

Product class	Maximum allowable average standby power (watts)
PC 1: Microwave-Only Ovens and Countertop Convection Microwave Ovens	0.6 W
PC 2: Built-In and Over-the-Range Convection Microwave Ovens	1.0 W

For this final rule, DOE considered the impacts of amended standards for microwave ovens 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 as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

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. 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 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 (for example, between renters and owners, or builders and purchasers). Having 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 DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forego the purchase of a product in the standards case, this decreases sales for product manufacturers, and the impact on manufacturers attributed to lost revenue 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 standard decreases the number of products purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the final rule TSD. However, 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.[60]

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 conservation standards, and potential enhancements to the methodology by which these impacts are defined and estimated in the regulatory process.[61] DOE welcomes comments on how to more fully assess the potential impact of energy conservation standards on consumer choice and how to quantify this impact in its regulatory analysis in future rulemakings.

1. Benefits and Burdens of TSLs Considered for Microwave Ovens Standards

Table V.24 and Table V.25 summarize the quantitative impacts estimated for each TSL for microwave ovens. The national impacts are measured over the lifetime of microwave ovens purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2026–2055). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. DOE is presenting monetized benefits in accordance with the applicable Executive orders and DOE would reach the same conclusion presented in this notice in the absence of the social cost of greenhouse gases, including the Interim Estimates presented by the Interagency Working Group. The efficiency levels contained in each TSL are described in section V.A of this document.

[60] P.C. Reiss and M.W. White. Household Electricity Demand, Revisited. *Review of Economic Studies.* 2005. 72(3): pp. 853–883. doi: *10.1111/0034–6527.00354.*

[61] Sanstad, A.H. *Notes on the Economics of Household Energy Consumption and Technology Choice.* 2010. Lawrence Berkeley National Laboratory. Available at *www1.eere.energy.gov/buildings/appliance_standards/pdfs/consumer_ee_theory.pdf* (last accessed July 1, 2021).

TABLE V.24—SUMMARY OF ANALYTICAL RESULTS FOR MICROWAVE OVENS TSLS: NATIONAL IMPACTS

Category	TSL 1	TSL 2	TSL 3
Cumulative FFC National Energy Savings			
Quads	0.01	0.06	0.12
Cumulative FFC Emissions Reduction			
CO_2 (*million metric tons*)	0.36	1.87	4.21
CH_4 (*thousand tons*)	2.41	12.64	28.45
N_2O (*thousand tons*)	0.00	0.02	0.04
SO_2 (*thousand tons*)	0.55	2.88	6.49
NO_X (*thousand tons*)	0.16	0.85	1.91
Hg (*tons*)	0.00	0.01	0.01
Present Value of Benefits and Costs (3% discount rate, billion 2021$)			
Consumer Operating Cost Savings	0.08	0.43	0.98
Climate Benefits *	0.02	0.10	0.22
Health Benefits **	0.03	0.17	0.38
Total Benefits †	0.13	0.70	1.58
Consumer Incremental Product Costs ‡	0.00	0.08	0.27
Consumer Net Benefits	0.08	0.35	0.71
Total Net Benefits	0.13	0.62	1.31
Present Value of Benefits and Costs (7% discount rate, billion 2021$)			
Consumer Operating Cost Savings	0.040	0.211	0.475
Climate Benefits *	0.018	0.097	0.217
Health Benefits **	0.014	0.075	0.168
Total Benefits †	0.073	0.382	0.860
Consumer Incremental Product Costs ‡	0.002	0.047	0.154
Consumer Net Benefits	0.039	0.164	0.320
Total Net Benefits	0.072	0.336	0.706

Note: This table presents the costs and benefits associated with microwave ovens shipped in 2026–2055. These results include benefits to consumers which accrue after 2055 from the products shipped in 2026–2055.

* Climate benefits are calculated using four different estimates of the SC–CO_2, SC–CH_4, and SC–N_2O. Together, these represent the global SC–GHG. For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are shown, but DOE does not have a single central SC–GHG point estimate. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for NO_X and SO_2) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. The health benefits are presented at real discount rates of 3 and 7 percent. *See* section IV.L of this document for more details.

† Total and net benefits include consumer, climate, and health benefits. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate.

‡ Costs include incremental equipment costs as well as installation costs.

TABLE V.25—SUMMARY OF ANALYTICAL RESULTS FOR MICROWAVE OVENS TSLS: MANUFACTURER AND CONSUMER IMPACTS

Category	TSL 1	TSL 2	TSL 3
Industry NPV (*million 2021$*) (No-new-standards case INPV = 1,426)	1,422–1,426	1,389–1,426	1,339–1,426
Industry NPV (*% change*)	(0.3)–0.0	(2.6)–0.0	(6.1)–0.0
Consumer Average LCC Savings (2021$)			
PC 1	$0.25	$0.99	$2.16
PC 2	$0.00	$0.83	$1.95
Shipment-Weighted Average *	$0.24	$0.98	$2.15
Consumer Simple PBP (years)			
PC 1	0.3	1.3	2.0
PC 2	0.0	0.8	2.6
Shipment-Weighted Average *	0.3	1.3	2.0

TABLE V.25—SUMMARY OF ANALYTICAL RESULTS FOR MICROWAVE OVENS TSLS: MANUFACTURER AND CONSUMER IMPACTS—Continued

Category	TSL 1	TSL 2	TSL 3
Percent of Consumers that Experience a Net Cost			
PC 1	0%	5%	12%
PC 2	0%	7%	42%
Shipment-Weighted Average *	0%	5%	13%

DOE first considered TSL 3, which represents the max-tech efficiency levels. TSL 3 would save an estimated 0.12 quads of energy, an amount that DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $0.32 billion using a discount rate of 7 percent, and $0.71 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 4.21 Mt of CO_2, 1.91 thousand tons of SO_2, 6.49 thousand tons of NO_X, 0.012 tons of Hg, 28.45 thousand tons of CH_4, and 0.04 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 3 is $0.22 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.17 billion using a 7-percent discount rate and $0.38 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 3 is $0.71 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 3 is $1.31 billion. The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 3, the average LCC impact is a savings of $2.16 for Product Class 1 and $1.95 for Product Class 2. The simple payback period is 2.0 years for Product Class 1 and 2.6 years for Product Class 2. The fraction of consumers experiencing a net LCC cost is 11.7 percent for Product Class 1 and 42.2 percent for Product Class 2.

At TSL 3, the projected change in manufacturer INPV ranges from a decrease of approximately $87.5 million, which corresponds to a decrease of approximately 6.1 percent, to no change in INPV. At this TSL, free cash flow is estimated to decrease by 43.3 percent compared to the no-new-standards case value in the year before the compliance year. DOE estimates that industry must invest $108.3 million to comply with standards set at TSL 3. DOE estimates that approximately 11 percent of Product Class 1 (microwave-only oven and countertop convection microwave oven) shipments and approximately 5 percent of Product Class 2 (built-in and over-the-range convection microwave oven) shipments would meet the efficiency levels analyzed at TSL 3, in the no-new-standards case. Redesigning approximately 90 percent of microwave ovens models, which represents approximately 11 million annual shipments, will significantly strain manufacturers' limited resources during the 3-year compliance period, given the number of microwave oven models that need to be redesigned during this time-period. It is unclear if most microwave oven manufacturers will have the engineering capacity to complete the necessary redesigns within the 3-year compliance period. If manufacturers require more than three years to redesign all their non-compliant microwave oven models, they will likely prioritize redesigns based on sales volume, which could lead to some microwave oven models being temporary or permanent unavailable.

DOE has determined through its engineering analysis that many of the features which comprise the full complement of existing consumer functionality are implemented in microwave ovens currently available on the market at or near the max-tech efficiency levels at TSL 3. DOE has not, however, identified or analyzed any currently available microwave ovens that include all such features in the same unit. Furthermore, DOE is aware of several emerging technologies (*e.g.,* television displays and interior cameras) which would provide additional consumer utility distinct from existing products. Although DOE research suggests that the implementation of these emerging technologies would not require a significant amount of standby power, because microwave ovens that incorporate them are not yet commercially available, DOE is unable to verify that products that implemented these technologies along with the complete set of features that would maintain full consumer utility could meet the efficiency levels at TSL 3. Accordingly, there is uncertainty as to whether or not a standard at TSL 3 may stifle innovation and risk impacting customer utility.

The Secretary concludes that at TSL 3 for microwave ovens, the benefits of energy savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the uncertainty of impacts to customer utility and product innovation and the percentage of consumers in Product Class 2 that would experience a net LCC cost. Consequently, the Secretary has concluded that TSL 3 is not economically justified.

DOE then considered TSL 2, which represents efficiency level 2 for microwave ovens. TSL 2 would save an estimated 0.06 quads of energy, an amount DOE considers significant. Under TSL 2, the NPV of consumer benefit would be $0.16 billion using a discount rate of 7 percent, and $0.35 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 2 are 1.87 Mt of CO_2, 0.85 thousand tons of SO_2, 2.88 thousand tons of NO_X, 0.005 tons of Hg, 12.64 thousand tons of CH_4, and 0.02 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average SC–GHG at a 3-percent discount rate) at TSL 2 is $0.10 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 2 is $0.07 billion using a 7-percent discount rate and $0.17 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 2 is $0.34 billion.

Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 2 is $0.62 billion. The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 2, the average LCC impact is a savings of $0.99 for Product Class 1 and $0.83 for Product Class 2. The simple payback period is 1.3 years for Product Class 1 and 0.8 years for Product Class 2. The fraction of consumers experiencing a net LCC cost is 5.1 percent for Product Class 1 and 7.4 percent for Product Class 2.

At TSL 2, the projected change in manufacturer INPV ranges from a decrease of approximately $37.2 million, which corresponds to a decrease of approximately 2.6 percent, to no change in INPV. At this TSL, free cash flow is estimated to decrease by 18.4 percent compared to the no-new-standards case value in the year before the compliance year. DOE estimates that industry must invest $46.1 million to comply with standards set at TSL 2. DOE estimates that approximately 40 percent of Product Class 1 (microwave-only oven and countertop convection microwave oven) shipments and approximately 64 percent of Product Class 2 (built-in and over-the-range convection microwave oven) shipments would meet or exceed the efficiency levels analyzed at TSL 2, in the no-new-standards case. Manufacturers would be required to redesign approximately 60 percent of all microwave oven models, representing 7.3 million annual shipments, to meet the efficiency levels required at TSL 2.

DOE has determined that the standby power requirements of TSL 2 provide sufficient power budgets for manufacturers to implement the full complement of features that currently provide consumer utility. In addition, based on DOE's assessment of the expected standby power requirements for identified emerging technologies, DOE has concluded that the standby power levels at TSL 2 do not preclude the implementation of these technologies or stifle further innovation.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that a standard set at TSL 2 for microwave ovens would be economically justified. At this TSL, the average LCC savings for both product classes of microwave ovens is positive. An estimated 5 percent of Product Class 1 consumers and 7 percent of Product Class 2 consumers would experience a net cost. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 2, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent, is over four times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 2 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $0.10 billion in climate benefits (associated with the average SC–GHG at a 3-percent discount rate), and $0.17 billion (using a 3-percent discount rate) or $0.07 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

Accordingly, the Secretary has concluded that TSL 2 would offer the maximum improvement in efficiency that is technologically feasible and economically justified and would result in the significant conservation of energy. Although results are presented here in terms of TSLs, DOE analyzes and evaluates all possible ELs for each product class in its analysis. For both Product Class 1 (microwave-only oven and countertop convection microwave oven) and Product Class 2 (built-in and over-the-range convection microwave oven), TSL 2 is comprised of the highest efficiency level below max-tech. The ELs one level below max-tech, representing the finalized standard levels, result in positive LCC savings for both classes, reduce the number of consumers experiencing a net cost, and reduce the decrease in INPV and conversion costs to the point where DOE has concluded they are economically justified, as discussed for TSL 2 in the preceding paragraphs.

As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. The walk-down is not a comparative analysis, as a comparative analysis would result in the maximization of net benefits instead of energy savings that are technologically feasible and economically justified, which would be contrary to the statute. 86 FR 70892, 70908.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for microwave ovens at TSL 2. The amended energy conservation standards for microwave ovens, which are expressed as watts, are shown in Table V.26.

TABLE V.26—AMENDED ENERGY CONSERVATION STANDARDS FOR MICROWAVE OVENS

Product class	Maximum allowable average standby power (watts)
PC 1: Microwave-Only Ovens and Countertop Convection Microwave Ovens	0.6
PC 2: Built-In and Over-the-Range Convection Microwave Ovens	1.0

2. Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is (1) the annualized national economic value (expressed in 2020$) of the benefits from operating products that meet the adopted standards (consisting primarily of operating cost savings from using less energy), minus increases in product purchase costs, and (2) the annualized monetary value of the climate and health benefits.

Table V.27 shows the annualized values for microwave ovens under TSL 2, expressed in 2021$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NO_X and SO_2 reductions, and the 3-percent discount rate case for GHG social costs, the estimated cost of the adopted standards for microwave ovens is $4.3 million per year in increased equipment installed costs, while the estimated annual benefits are $19.5 million from

reduced equipment operating costs, $5.2 million in GHG reductions, and $6.9 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $27.3 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the adopted standards for microwave ovens is $4.3 million per year in increased equipment costs, while the estimated annual benefits are $23.5 million in reduced operating costs, $5.2 million from GHG reductions, and $9.2 million from reduced NO_X and SO_2 emissions. In this case, the net benefit amounts to $33.5 million per year.

TABLE V.27—ANNUALIZED BENEFITS AND COSTS OF ADOPTED STANDARDS (TSL 2) FOR MICROWAVE OVENS

	Million 2021$/year		
	Primary estimate	Low-net-benefits estimate	High-net-benefits estimate
3% discount rate			
Consumer Operating Cost Savings	23.5	22.2	25.0
Climate Benefits*	5.2	5.1	5.4
Health Benefits**	9.2	9.0	9.4
Total Benefits†	37.9	36.3	39.8
Consumer Incremental Product Costs‡	4.3	4.4	4.1
Net Benefits	33.5	31.9	35.7
7% discount rate			
Consumer Operating Cost Savings	19.5	18.6	20.5
Climate Benefits* (3% discount rate)	5.2	5.1	5.4
Health Benefits**	6.9	6.7	7.1
Total Benefits†	31.6	30.4	32.9
Consumer Incremental Product Costs‡	4.3	4.3	4.1
Net Benefits	27.3	26.0	28.9

Note: This table presents the costs and benefits associated with microwave ovens shipped in 2026–2055. These results include benefits to consumers which accrue after 2055 from the products shipped in 2026–2055. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2022* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a medium decline rate in the Primary Estimate, a low decline rate in the Low Net Benefits Estimate, and a high decline rate in the High Net Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F.1 and IV.H.1 of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

* Climate benefits are calculated using four different estimates of the global SC–GHG (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC–GHG at a 3-percent discount rate are shown, but the Department does not have a single central SC–GHG point estimate, and it emphasizes the importance and value of considering the benefits calculated using all four sets of SC–GHG estimates. On March 16, 2022, the Fifth Circuit Court of Appeals (No. 22–30087) granted the Federal government's emergency motion for stay pending appeal of the February 11, 2022, preliminary injunction issued in *Louisiana* v. *Biden,* No. 21–cv–1074–JDC–KK (W.D. La.). As a result of the Fifth Circuit's order, the preliminary injunction is no longer in effect, pending resolution of the Federal government's appeal of that injunction or a further court order. Among other things, the preliminary injunction enjoined the defendants in that case from ''adopting, employing, treating as binding, or relying upon'' the interim estimates of the social cost of greenhouse gases—which were issued by the Interagency Working Group on the Social Cost of Greenhouse Gases on February 26, 2021—to monetize the benefits of reducing greenhouse gas emissions. As reflected in this rule, DOE has reverted to its approach prior to the injunction and presents monetized benefits where appropriate and permissible under law.

** Health benefits are calculated using benefit-per-ton values for NO_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC–GHG with 3-percent discount rate, but the Department does not have a single central SC–GHG point estimate.

‡ Costs include incremental equipment costs as well as installation costs.

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563, and 14094

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' 58 FR 51735 (Oct. 4, 1993), as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review, 76 FR 3821 (Jan. 21, 2011) and E.O. 14094, ''Modernizing Regulatory Review,'' 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, 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 E.O. 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 (''OIRA'') in the Office of Management and Budget (''OMB'') 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 this preamble, this final regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this final rule does not constitute a ''significant regulatory action'' under section 3(f) of E.O. 12866. Accordingly, this action was not submitted to OIRA for review under E.O. 12866.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (''IRFA'') and a final regulatory flexibility analysis (''FRFA'') 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 E.O. 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.energy.gov/gc/office-general-counsel*).

DOE reviewed this final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE certifies that this final rule would not have a significant economic impact on a substantial number of small entities. The factual basis of this certification is set forth in the following paragraphs.

For manufacturers of microwave ovens, the 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. (*See* 13 CFR part 121.) The size standards are listed by NAICS code and industry description and are available at *www.sba.gov/document/support-table-size-standards.* Manufacturing microwave ovens is classified under NAICS 335220, ''Major Household Appliance Manufacturing.'' The SBA sets a threshold of 1,500 employees or fewer for an entity to be considered as a small business for this category.

DOE identified manufacturers using DOE's CCD,[62] the California Energy Commission's Modernized Appliance Efficiency Database System (''MAEDbS''),[63] and prior microwave oven rulemakings. DOE used the publicly available information and subscription-based market research tools (*e.g.,* reports from DB Hoovers [64]) to identify 37 companies that sell microwave ovens covered by this rulemaking in the United States. Of these 37 companies that sell microwave ovens in the United States, 19 are private labelers. These private labelers out-source the manufacturing of the microwave ovens to other companies. Therefore, DOE estimates there are 18 original equipment manufacturers (''OEMs'') that manufacture microwave ovens covered by this rulemaking. Of the 18 OEMs, DOE was not able to identify any OEMs of microwave ovens covered by this rulemaking with fewer than 1,500 total employees (including parent companies and subsidiaries), and that are domestically located. Therefore, DOE did not identify any companies that meet SBA's definition of a ''small business.''

DOE did not receive any comments on the August 2022 SNOPR, which stated that there were not any small businesses that manufactured microwave ovens sold in the United States. Therefore, DOE concludes and certifies that this final rule would not have a significant economic impact on a substantial number of small entities and has not prepared a FRFA for this rulemaking.

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 procedures 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. (*See generally* 10 CFR part 429). 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 35 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 of 1969 (''NEPA''), DOE has analyzed this proposed action rule in accordance with NEPA and DOE's NEPA implementing regulations (10 CFR part 1021). DOE has determined that this rule qualifies for categorical exclusion under 10 CFR part 1021, subpart D, appendix B5.1 because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, none of the exceptions identified in B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. Therefore, DOE has determined that promulgation of this rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, and does not require an environmental assessment or an environmental impact statement.

E. Review Under Executive Order 13132

E.O. 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

[62] DOE's Compliance Certification Database is available at *www.regulations.doe.gov/ccms* (last accessed January 11, 2023).

[63] California Energy Commission's MAEDbS is available at *cacertappliances.energy.ca.gov/Login.aspx* (last accessed January 11, 2023).

[64] D&B Hoovers reports can be accessed at: *app.dnbhoovers.com.*

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. DOE has examined this rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this 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) Therefore, 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 E.O. 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, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (Feb. 7, 1996). Regarding the review required by section 3(a) and section 3(b) of E.O. 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 E.O. 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 E.O. 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. Public Law 104–4, Sec. 201 (codified at 2 U.S.C. 1531). For a 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 them. 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.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

DOE has concluded that this final rule may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include (1) investment in research and development and in capital expenditures by microwave ovens 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 and 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. In accordance with 42 U.S.C. 6295(m), this final rule establishes amended 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, as required by 6295(o)(2)(A) and 6295(o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this 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

Pursuant to E.O. 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), DOE has determined that this rule 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 information quality 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). Pursuant to OMB Memorandum M–19–15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf*. DOE has reviewed this 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

E.O. 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 this regulatory action, which sets forth amended energy conservation standards for microwave ovens, is not a significant energy action because the 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 this final rule.

L. Information Quality

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 2664, 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a report describing that peer review.[65] 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. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review DOE's analytical methodologies to ascertain whether modifications are needed to improve DOE's analyses. DOE is in the process of evaluating the resulting report.[66]

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 not a ''major rule'' as defined by 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects in 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.

[65] The 2007 ''Energy Conservation Standards Rulemaking Peer Review Report'' is available at *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (Last accessed January 23, 2023).

[66] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards*.

Signing Authority

This document of the Department of Energy was signed on April 20, 2023, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on June 13, 2023.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons set forth in the preamble, DOE amends part 430 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

■ 2. Section 430.32 is amended by revising paragraph (j)(3) to read as follows:

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

* * * * *

(j) * * *

(3) Microwave ovens:

(i) Microwave-only ovens and countertop convection microwave ovens manufactured on or after June 17, 2016, and before June 22, 2026, 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, and before June 22, 2026, shall have an average standby power not more than 2.2 watts.

(ii) Microwave-only ovens and countertop convection microwave ovens manufactured on or after June 22, 2026, shall have an average standby power not more than 0.6 watts. Built-in and over-the-range convection microwave ovens manufactured on or after June 22, 2026,

shall have an average standby power not more than 1.0 watt.

* * * * *

Note: The following letter will not appear in the Code of Federal Regulations.

U.S. Department of Justice
Antitrust Division
Jonathan S. Kanter
Assistant Attorney General
Main Justice Building
950 Pennsylvania Avenue NW
Washington, DC 20530–0001
(202) 514–2401/(202) 616–2645 (Fax)

XXXX XX, 2023

Ami Grace-Tardy
Assistant General Counsel for
Legislation, Regulation and Energy
Efficiency
U.S. Department of Energy
Washington, DC 20585
Ami.Grace-Tardy@hq.doe.gov

Dear Assistant General Counsel Grace-Tardy:

I am responding to your August 25, 2022 letter seeking the views of the Attorney General about the potential impact on competition of proposed energy conservation standards for microwave ovens. Your request was submitted under Section 325(o)(2)(B)(i)(V) of the Energy Policy and Conservation Act, as amended (EPCA), 42 U.S.C. 6295(o)(2)(B)(i)(V) and 42 U.S.C. 6316(a), which requires the Attorney General to make a determination of the impact of any lessening of competition that is likely to result from the imposition of proposed energy conservation standards. The Attorney General's responsibility for responding to requests from other departments about the effect of a program on competition has been delegated to the Assistant Attorney General for the Antitrust Division in 28 CFR 0.40(g). The Assistant Attorney General for the Antitrust Division has authorized me, as the Policy Director the Antitrust Division, to provide the Antitrust Division's views regarding the potential impact on competition of proposed energy conservation standards on his behalf.

In conducting its analysis, the Antitrust Division examines whether a proposed standard may lessen competition, for example, by substantially limiting consumer choice or increasing industry concentration. A lessening of competition could result in higher prices to manufacturers and consumers. We have reviewed the proposed standards contained in the Supplemental Notice of Proposed Rulemaking (87 FR 52282 August 24, 2022), and the related technical support documents. We also reviewed the transcript from the public meeting held on October 11, 2022, and reviewed public comments submitted by industry members in response to DOE's Request for Information in this matter.

Based on the information currently available, we do not believe that the proposed energy conservation standards for microwave ovens are likely to have a significant adverse impact on competition.

Sincerely,

David G.B. Lawrence,

Policy Director.

[FR Doc. 2023–12958 Filed 6–16–23; 8:45 am]

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