

DEPARTMENT OF ENERGY

10 CFR Part 430

[EERE-2019-BT-STD-0039]

RIN 1904-AF60

Energy Conservation Program: Energy Conservation Standards for Dishwashers

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

ACTION: Direct 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 dishwashers. In this direct final rule, the U.S. Department of Energy (“DOE”) is adopting amended energy conservation standards for dishwashers. DOE 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 22, 2024. If adverse comment are received by August 12, 2024 and DOE determines that such comments may provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o), a timely withdrawal of this rule will be published in the **Federal Register**. The incorporation by reference of certain material listed in this rule was approved by the Director as of February 17, 2023. If no such adverse comments are received, compliance with the amended standards established for dishwashers in this direct final rule is required on and after April 23, 2027. Comments regarding the likely competitive impact of the standards contained in this direct final rule should be sent to the Department of Justice contact listed in the **ADDRESSES** section on or before May 24, 2024.

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-

2019-BT-STD-0039. The docket web page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to submit a comment or review other public comments and the docket, contact the Appliance and Equipment Standards Program staff at (202) 287-1445 or by email:

ApplianceStandardsQuestions@ee.doe.gov.

The U.S. Department of Justice Antitrust Division invites input from market participants and other interested persons with views on the likely competitive impact of the standards contained in this direct final rule. Interested persons may contact the Antitrust Division at www.energy.standards@usdoj.gov on or before the date specified in the **DATES** section. Please indicate in the “Subject” line of your email the title and Docket Number of this direct final rule.

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION:**Table of Contents**

- I. Synopsis of the Direct Final Rule
 - A. Benefits and Costs to Consumers
 - B. Impact on Manufacturers
 - C. National Benefits and Costs
 - D. Conclusion
- II. Introduction
 - A. Authority
 - B. Background
 - 1. Current Standards
 - 2. Current Test Procedure
 - 3. The Joint Agreement
- III. General Discussion
 - A. Scope of Coverage
 - B. Fairly Representative of Relevant Points of View
 - C. Technological Feasibility
 - 1. General
 - 2. Maximum Technologically Feasible Levels
 - D. Energy Savings
 - 1. Determination of Savings
 - 2. Significance of Savings
 - E. Economic Justification
 - 1. Specific Criteria
 - a. Economic Impact on Manufacturers and Consumers
 - b. Savings in Operating Costs Compared To Increase in Price (LCC and PBP)
 - c. Energy Savings
 - d. Lessening of Utility or Performance of Products
 - e. Impact of Any Lessening of Competition
 - f. Need for National Energy and Water Conservation
 - g. Other Factors
 - 2. Rebuttable Presumption
- IV. Methodology and Discussion of Related Comments
 - A. Market and Technology Assessment
 - 1. Product Classes
 - 2. Technology Options
 - B. Screening Analysis
 - 1. Screened-Out Technologies
 - a. Desiccant Drying
 - b. Reduced Inlet-Water Temperature
 - c. Supercritical Carbon Dioxide Washing
 - d. Ultrasonic Washing
 - e. Thermoelectric Heat Pumps
 - f. Water Re-Use System
 - 2. Remaining Technologies
 - C. Engineering Analysis
 - 1. Efficiency Analysis
 - a. Baseline Efficiency
 - b. Higher Efficiency Levels
 - 2. Cost Analysis
 - 3. Cost-Efficiency Results
 - D. Markups Analysis
 - E. Energy and Water Use Analysis
 - F. Life-Cycle Cost and Payback Period Analysis
 - 1. Product Cost
 - 2. Installation Cost
 - 3. Annual Energy and Water Consumption
 - 4. Energy and Water Prices
 - a. Energy Prices
 - b. Water and Wastewater Prices
 - 5. Maintenance and Repair Costs
 - 6. Product Lifetime
 - 7. Discount Rates
 - 8. Energy Efficiency Distribution in the No-New-Standards Case
 - 9. Payback Period Analysis
 - G. Shipments Analysis
 - H. National Impact Analysis
 - 1. Product Efficiency Trends
 - 2. National Energy and Water Savings
 - 3. Net Present Value Analysis
 - I. Consumer Subgroup Analysis
 - 1. Low-Income Households
 - 2. Senior-Only Households
 - 3. Well-Water Households
 - J. Manufacturer Impact Analysis
 - 1. Overview
 - 2. Government Regulatory Impact Model and Key Inputs
 - a. Manufacturer Production Costs
 - b. Shipments Projections
 - c. Capital and Product Conversion Costs
 - d. Manufacturer Markup Scenarios
 - 3. Discussion of MIA Comments
 - K. Emissions Analysis
 - 1. Air Quality Regulations Incorporated in DOE’s Analysis
 - L. Monetizing Emissions Impacts
 - 1. Monetization of Greenhouse Gas Emissions
 - a. Social Cost of Carbon Dioxide
 - b. Social Cost of Methane and Nitrous Oxide
 - c. Sensitivity Analysis Using EPA’s New SC-GHG Estimates
 - 2. Monetization of Other Emissions Impacts
 - M. Utility Impact Analysis

- N. Employment Impact Analysis
- O. Regulatory Impact Analysis
- P. Other Comments
 1. Non-Regulatory Approaches
 2. Test Procedure Usage Factors
 3. National Academy of Sciences Report
- V. Analytical Results and Conclusions
 - A. Trial Standard Levels
 - B. Economic Justification and Energy Savings
 1. Economic Impacts on Individual Consumers
 - a. Life-Cycle Cost and Payback Period
 - b. Consumer Subgroup Analysis
 - c. Rebuttable Presumption Payback
 2. Economic Impacts on Manufacturers
 - a. Industry Cash Flow Analysis Results
 - b. Direct Impacts on Employment
 - c. Impacts on Manufacturing Capacity
 - d. Impacts on Subgroups of Manufacturers
 - e. Cumulative Regulatory Burden
 3. National Impact Analysis
 - a. Significance of Energy and Water Savings
 - b. Net Present Value of Consumer Costs and Benefits
 - c. Indirect Impacts on Employment
 4. Impact on Utility or Performance of Products
 - a. Cleaning Performance
 - b. Drying Performance
 - c. Cycle Length
 - d. Water Dilution
 - e. Equipment Lifetime and Energy Savings
 5. Impact of Any Lessening of Competition
 6. Need of the Nation To Conserve Energy
 7. Other Factors
 8. Summary of Economic Impacts
 - C. Conclusion
 1. Benefits and Burdens of TSLs Considered for Dishwashers Standards
 2. Annualized Benefits and Costs of the Adopted Standards
- VI. Severability
- VII. Procedural Issues and Regulatory Review
 - A. Review Under Executive Orders 12866, 13563, and 14094
 - B. Review Under the Regulatory Flexibility Act
 - C. Review Under the Paperwork Reduction Act
 - D. Review Under the National Environmental Policy Act of 1969
 - E. Review Under Executive Order 13132
 - F. Review Under Executive Order 12988
 - G. Review Under the Unfunded Mandates Reform Act of 1995
 - H. Review Under the Treasury and General Government Appropriations Act, 1999
 - I. Review Under Executive Order 12630
 - J. Review Under the Treasury and General Government Appropriations Act, 2001
 - K. Review Under Executive Order 13211
 - L. Information Quality
 - M. Materials Incorporated by Reference
 - N. Congressional Notification

VIII. Approval of the Office of the Secretary

I. Synopsis of the Direct 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 EPCA² established the Energy Conservation Program for Consumer Products Other Than Automobiles. (42 U.S.C. 6291–6309) These products include dishwashers, the subject of this direct final rule. (42 U.S.C. 6292(a)(6))

Pursuant to EPCA, any new or amended energy conservation standard must, among other things, be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6295(o)(3)(B))

In light of the above and under the authority provided by 42 U.S.C. 6295(p)(4), DOE is issuing this direct final rule amending energy conservation standards for dishwashers.

The adopted standards in this direct final rule were proposed in a letter submitted to DOE jointly by groups representing manufacturers, energy and environmental advocates, consumer groups, and a utility. This letter, titled “Energy Efficiency Agreement of 2023” (hereafter, the “Joint Agreement”³), recommends specific energy conservation standards for dishwashers that, in the commenters’ view, would satisfy the EPCA requirements in 42 U.S.C. 6295(o). DOE subsequently received letters of support for the Joint Agreement from States—including New York, California, and Massachusetts⁴—and utilities—including San Diego Gas

and Electric (“SDG&E”) and Southern California Edison (“SCE”) ⁵—advocating for the adoption of the recommended standards.

In accordance with the direct final rule provisions at 42 U.S.C. 6295(p)(4), DOE has determined that the recommendations contained in the Joint Agreement are compliant with 42 U.S.C. 6295(o). As required by 42 U.S.C. 6295(p)(4)(A)(i), DOE is also simultaneously publishing a notice of proposed rulemaking (“NOPR”) that contains identical standards to those adopted in this direct final rule. Consistent with the statute, DOE is providing a 110-day public comment period on the direct final rule. (42 U.S.C. 6295(p)(4)(B)) If DOE determines that any comments received provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o) or any other applicable law, DOE will publish the reasons for withdrawal and continue the rulemaking under the NOPR. (42 U.S.C. 6295(p)(4)(C)) See section II.A of this document for more details on DOE’s statutory authority.

The amended standards that DOE is adopting in this direct final rule are the efficiency levels recommended in the Joint Agreement (shown in Table I.1) expressed in terms of maximum estimated annual energy use (“EAEU”) in kilowatt hours per year (“kWh/yr”) and maximum per cycle water consumption in gallons per cycle (“gal/cycle”) as measured according to DOE’s dishwasher test procedure codified at title 10 of the Code of Federal Regulations (“CFR”) part 430, subpart B, appendix C2 (“appendix C2”).

Table I.1 The amended standards recommended in the Joint Agreement are represented as trial standard level (“TSL”) ³ in this document (hereinafter the “Recommended TSL”) and are described in section V.A of this document. The Joint Agreement’s standards for dishwashers apply to all products listed in Table I.1 and manufactured in, or imported into, the United States starting 3 years after publication of a final rule in the **Federal Register**.

⁵ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0057.

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 This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0055.

⁴ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0056.

Table I.1 Energy Conservation Standards for Dishwashers (Compliance Starting April 23, 2027)

Product Class	Maximum Estimated Annual Energy Use (<i>kWh/year</i>)	Maximum Per-Cycle Water Consumption (<i>gal/cycle</i>)
PC 1: Standard-Size Dishwasher*	223	3.3
PC 2: Compact-Size Dishwasher	174	3.1

* The energy conservation standards in this table do not apply to standard-size dishwashers with a cycle time for the normal cycle of 60 minutes or less.

A. Benefits and Costs to Consumers

Table I.2 summarizes DOE's evaluation of the economic impacts of the adopted standards on consumers of

dishwashers, as measured by the average life-cycle cost ("LCC") savings and the simple payback period ("PBP").⁶ The average LCC savings are positive for all product classes, and the

PBP is less than the average lifetime of dishwashers, which is estimated to be 15.2 years (*see* section IV.F.6 of this document).

Table I.2 Impacts of Adopted Energy Conservation Standards on Consumers of Dishwashers (the Recommended TSL)

Product Class	Average LCC Savings (<i>2022\$</i>)	Simple Payback Period (<i>years</i>)
Standard-Size	\$17	3.9
Compact-Size	\$32	0.0

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

B. Impact on Manufacturers⁷

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 (2024–2056). Using a real discount rate of 8.5 percent, DOE estimates that the INPV for manufacturers of dishwashers in the case without amended standards is \$735.8 million. Under the adopted standards, which align with the Recommended TSL for dishwashers, DOE estimates the change in INPV to range from –20.2 percent to –13.1 percent, which represents a change in INPV of approximately –\$148.8 million to –\$96.7 million. In order to bring products into compliance with amended standards, it is estimated that industry will incur total conversion costs of \$126.9 million.

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

C. National Benefits and Costs

DOE's analyses indicate that the adopted energy conservation standards for dishwashers would save a significant amount of energy. Relative to the case without amended standards, the lifetime energy savings for dishwashers purchased in the 30-year period that begins in the anticipated year of compliance with the amended standards (2027–2056), amount to 0.31 quadrillion British thermal units ("Btu"), or quads.⁸ This represents a savings of 2.6 percent relative to the energy use of these products in the case without amended standards (referred to as the "no-new-standards case").

The cumulative net present value ("NPV") of total consumer benefits of the standards for dishwashers ranges from \$1.23 billion (at a 7-percent discount rate) to \$2.90 billion (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 dishwashers purchased during the period 2027–2056.

In addition, the adopted standards for dishwashers 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 9.48 million metric tons ("Mt")⁹ of carbon dioxide ("CO₂"), 1.41 thousand tons of sulfur dioxide ("SO₂"), 22.37 thousand tons of nitrogen oxides ("NO_x"), 98.97 thousand tons of methane ("CH₄"), 0.06 thousand tons of nitrous oxide ("N₂O"), and 0.01 tons of mercury ("Hg").¹⁰

DOE estimates the value of climate benefits from a reduction in greenhouse gases ("GHG") using four different estimates of the social cost of CO₂ ("SC-CO₂"), the social cost of methane ("SC-CH₄"), and the social cost of nitrous oxide ("SC-N₂O").¹¹ Together these represent the social cost of GHG ("SC-GHG"). DOE used interim SC-GHG

⁶ 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.8 of this document). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (*see* section IV.F.9 of this document).

⁷ All monetary values in this document are expressed in 2022 dollars and, where appropriate,

are discounted to 2024 unless explicitly stated otherwise.

⁸ 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.

⁹ A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO₂ are presented in short tons.

¹⁰ DOE calculated emissions reductions relative to the no-new-standards-case, which reflects key assumptions in the *Annual Energy Outlook 2023* ("AEO2023"). AEO2023 reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the Inflation Reduction Act. *See* section IV.K of this document for further discussion of AEO2023 assumptions that affect air pollutant emissions.

¹¹ Estimated climate-related benefits are provided in compliance with Executive Order 12866.

values (in terms of benefit per ton of GHG avoided) developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (“IWG”).¹² 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 \$0.54 billion. 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. DOE notes, however, that the

¹² To monetize the benefits of reducing GHG emissions this analysis uses values that are based on the *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990* published February 2021 by the IWG. (“February 2021 SC–GHG TSD”). www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf.

adopted standards would be economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE estimated the monetary health benefits of SO₂ and NO_x emissions reductions using benefit per ton estimates from the U.S. Environmental Protection Agency (“EPA”),¹³ as discussed in section IV.L of this document. DOE did not monetize the reduction in mercury emissions because the quantity is very small. DOE estimated the present value of the health benefits would be \$0.37 billion using a 7-percent discount rate, and \$0.94 billion using a 3-percent discount rate.¹⁴

¹³ U.S. EPA. Estimating the Benefit per Ton of Reducing Directly Emitted PM_{2.5}, PM_{2.5} Precursors and Ozone Precursors from 21 Sectors. Available at www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors.

¹⁴ DOE estimates the economic value of these emissions reductions resulting from the considered

DOE is currently only monetizing health benefits from changes in ambient fine particulate matter (“PM_{2.5}”) concentrations from two precursors (SO₂ and NO_x), and from changes in ambient ozone from one precursor (NO_x), 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 dishwashers. 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.

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TSLs for the purpose of complying with the requirements of Executive Order 12866.

Table I.3 Summary of Monetized Benefits and Costs of Adopted Energy Conservation Standards for Dishwashers (TSL 3 – the Recommended TSL)

	Billion \$2022
3% discount rate	
Consumer Operating Cost Savings	3.16
Climate Benefits*	0.54
Health Benefits**	0.94
Total Benefits†	4.64
Consumer Incremental Product Costs‡	0.26
Net Monetized Benefits†	4.38
Change in Producer Cash Flow (INPV)**	(0.15) – (0.10)
7% discount rate	
Consumer Operating Cost Savings	1.38
Climate Benefits* (3% discount rate)	0.54
Health Benefits**	0.37
Total Benefits†	2.29
Consumer Incremental Product Costs‡	0.15
Net Monetized Benefits†	2.13
Change in Producer Cash Flow (INPV)**	(0.15) – (0.10)

Note: This table presents the costs and benefits associated with dishwashers shipped in 2027–2056. These results include consumer, climate, and health benefits that accrue after 2056 from the products shipped in 2027–2056.

* 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** Health benefits are calculated using benefit-per-ton values for NO_x and SO₂. DOE is currently only monetizing (for SO₂ 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, but DOE does not have a single central

SC-GHG point estimate. DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates.

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

‡‡ Operating Cost Savings are calculated based on the life cycle costs analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, manufacturer impact analysis, or "MIA"). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted-average cost of capital value of 8.5 percent that is estimated in the MIA (see chapter 12 of the direct final rule technical support document ("TSD") for a complete description of the industry weighted average cost of capital). For dishwashers, the change in INPV ranges from -\$149 million to -\$97 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the Tiered scenario, which models a reduction of manufacturer markups due to reduced product differentiation as a result of amended standards. DOE includes the range of estimated change in INPV in the previous table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation for this direct final rule, the net benefits would range from \$4.23 billion to \$4.28 billion at 3-percent discount rate and would range from \$1.98 billion to \$2.03 billion at 7-percent discount rate. Parentheses () indicate negative values.

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The benefits and costs of the adopted 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.¹⁵

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 dishwashers shipped in 2027–2056. The benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated

based on the lifetime of dishwashers shipped in 2027–2056. Total benefits for both the 3-percent and 7-percent cases are presented using the average GHG social costs with 3-percent discount rate.¹⁶ Estimates of total benefits are presented for all four SC-GHG discount rates in section V.B.8 of this document.

Table I.4 presents the total estimated monetized benefits and costs associated with the adopted standard, 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 SO₂ 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 \$14.0 million per year in increased equipment costs, while the estimated annual benefits are \$127.2 million in reduced equipment operating costs, \$29.0 million in climate benefits, and \$34.3 million in health benefits. In this case, the net benefit would amount to \$176.4 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the standards is \$14.0 million per year in increased equipment costs, while the estimated annual benefits are \$171.2 million in reduced operating costs, \$29.0 million in climate benefits, and \$50.8 million in health benefits. In this case, the net benefit would amount to \$237.0 million per year.

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¹⁵To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2024, 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

2024. 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.

¹⁶As discussed in section IV.L.1 of this document, DOE agrees with the IWG that using consumption-based discount rates (*e.g.*, 3 percent)

is appropriate when discounting the value of climate impacts. Combining climate effects discounted at an appropriate consumption-based discount rate with other costs and benefits discounted at a capital-based rate (*i.e.*, 7 percent) is reasonable because of the different nature of the types of benefits being measured.

Table I.4 Annualized Benefits and Costs of Adopted Standards for Dishwashers (the Recommended TSL) (2027-2056)

	Million 2022\$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
3% discount rate			
Consumer Operating Cost Savings	171.2	164.1	175.8
Climate Benefits*	29.0	28.3	29.3
Health Benefits**	50.8	49.6	51.3
Total Benefits†	251.0	242.0	256.4
Consumer Incremental Product Costs‡	14.0	17.0	13.2
Net Benefits	237.0	224.9	243.1
Change in Producer Cashflow (INPV)‡‡	(14) – (9)	(14) – (9)	(14) – (9)
7% discount rate			
Consumer Operating Cost Savings	127.2	122.5	130.5
Climate Benefits* (3% discount rate)	29.0	28.3	29.3
Health Benefits**	34.3	33.5	34.5
Total Benefits†	190.5	184.3	194.3
Consumer Incremental Product Costs‡	14.0	16.7	13.3
Net Benefits	176.4	167.6	181.0
Change in Producer Cashflow (INPV)‡‡	(14) – (9)	(14) – (9)	(14) – (9)

Note: This table presents the costs and benefits associated with dishwashers shipped in 2027–2056. These results include consumer, climate, and health benefits that accrue after 2056 from the products shipped in 2027–2056. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* 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 and IV.H 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. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** Health benefits are calculated using benefit-per-ton values for NO_x and SO₂. DOE is currently only monetizing (for SO₂ 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 DOE does not have a single central SC-GHG point estimate.

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

‡‡ Operating Cost Savings are calculated based on the life-cycle cost analysis and national impact analysis

as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted-average cost of capital value of 8.5 percent that is estimated in the MIA (*see* chapter 12 of the direct final rule TSD for a complete description of the industry weighted-average cost of capital). For dishwashers, the change in INPV ranges from -\$14 million to -\$9 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. *See* section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the Tiered scenario, which models a reduction of manufacturer markups due to reduced product differentiation as a result of amended standards. DOE includes the range of estimated annualized change in INPV in the previous table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into annualized the net benefit calculation for this direct final rule, the annualized net benefits would range from \$223 million to \$228 million at 3-percent discount rate and would range from \$163 million to \$168 million at 7-percent discount rate. Parentheses () indicate negative values.

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DOE's analysis of the national impacts of the adopted standards is described in sections IV.J.3 and IV.L of this document.

D. Conclusion

DOE has determined that the Joint Agreement was submitted jointly by interested persons that are fairly representative of relevant points of view, in accordance with 42 U.S.C. 6295(p)(4)(A). After considering the recommended standards and weighing the benefits and burdens, DOE has determined that the recommended standards are in accordance with 42 U.S.C. 6295(o), which contains the criteria for prescribing new or amended standards. Specifically, the Secretary of Energy ("Secretary") has determined that the adoption of the recommended standards would result in the significant conservation of energy and is the maximum improvement in energy efficiency that is technologically feasible and economically justified. In determining whether the recommended standards are economically justified, the Secretary has determined that the benefits of the recommended standards exceed the burdens. The Secretary has further concluded that the recommended standards, when considering the benefits of energy savings, positive NPV of consumer benefits, emission reductions, the estimated monetary value of the emissions reductions, and positive

average LCC savings, would yield benefits that outweigh the negative impacts on some consumers and on manufacturers, including the conversion costs that could result in a reduction in INPV for manufacturers.

Using a 7-percent discount rate for consumer benefits and costs and NO_x and SO₂ reduction benefits, and a 3-percent discount rate case for GHG social costs, the estimated cost of the standards for dishwashers is \$14.0 million per year in increased dishwasher costs, while the estimated annual benefits are \$127.2 million in reduced dishwasher operating costs, \$29.0 million in climate benefits, and \$34.3 million in health benefits. The net benefit amounts to \$176.4 million per year. DOE notes that the net benefits are substantial even in the absence of the climate benefits¹⁷ and DOE would adopt the same standards in the absence of such benefits.

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.¹⁸ For example, some covered products and equipment have most of their energy consumption occur

¹⁷ The information on climate benefits is provided in compliance with Executive Order 12866.

¹⁸ 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).

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 0.31 quads FFC, the equivalent of the primary annual energy use of 2.1 million homes. In addition, they are projected to reduce cumulative CO₂ emissions by 9.48 Mt. Based on these findings, DOE has determined the energy savings from the standard levels adopted in this direct 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 TSD.¹⁹

In accordance with these and other statutory provisions discussed in this document, DOE analyzed the benefits and burdens of four TSLs for dishwashers. The TSLs and their associated benefits and burdens are discussed in detail in sections V.A through V.C of this document. As discussed in section V.C.1 of this document, DOE has tentatively

¹⁹ The TSD is available in the docket for this rulemaking at www.regulations.gov/docket/EERE-2019-BT-STD-0039/document.

determined that TSL 3 (the Recommended TSL) represents the maximum improvement in energy efficiency that is technologically feasible and economically justified.

II. Introduction

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

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 dishwashers, the subject of this document. (42 U.S.C. 6292(a)(6)) EPCA prescribed energy conservation design standards for these products (42 U.S.C. 6295(g)(1) and (10)(A)), and directed DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6295(g)(4) and (10)(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))

In establishing energy conservation standards with both energy and water use performance standards for dishwashers manufactured after 2010, Congress also directed DOE to “determin[e] whether to amend” those standards. 42 U.S.C. 6295(g)(10)(B). Congress’s directive, in section 6295(g)(10)(B), to consider whether “to amend the standards for dishwashers” refers to “the standards” established in the immediately preceding section, 6295(g)(10)(A). There, Congress established energy conservation standards with *both* energy and water use performance standards for dishwashers. Indeed, the energy and water use performance standards for dishwashers (both standard and compact) are each contained within a single subparagraph. *See Id.* Everything in section 6295(g)(10) suggests that Congress intended both of those twin standards to be evaluated when it came time, “[n]ot later than January 1, 2015,” to consider amending them. (*Id.* 6295(g)(10)(B)(i)) Accordingly, DOE understands its authority, under section

6295(g)(10)(B), to include consideration of amended energy and water use performance standards for dishwashers.

DOE similarly understands its obligation under 42 U.S.C. 6295(m) to amend “standards” for covered products to include amending both the energy and water use performance standards for dishwashers. Neither section 6295(g)(10)(B) nor section 6295(m) limit their application to “energy use standards.” Rather, they direct DOE to consider amending “the standards,” 42 U.S.C. 6295(g)(10)(B), or simply “standards,” *Id.* 6295(m)(1)(B), which may include both energy use standards and water use standards.

Finally, DOE is promulgating these standards as a direct final rule pursuant to section 42 U.S.C. 6295(p)(4). That section also extends broadly to any “energy or water conservation standard” without qualification. Thus, pursuant to section 6295(p)(4), DOE may, so long as the other relevant conditions are satisfied, promulgate a direct final rule that includes water use performance standards for a covered product like dishwashers, where Congress has already established energy and water use performance standards.

DOE is aware that the definition of “energy conservation standard,” in section 6291(6), expressly references water use only for four products specifically named: showerheads, faucets, water closets, and urinals. *See Id.* However, DOE does not read the language in 6291(6) as fully delineating the scope of DOE’s authority under EPCA. Rather, as is required of agencies in applying a statute, individual provisions, including section 6291(6) of EPCA, must be read in the context of the statute as a whole.

The energy conservation program was initially limited to addressing the energy use, meaning electricity and fossil fuels, of 13 covered products (*See* sections 321 and 322 of the Energy and Policy Conservation Act, Public Law 94–163, 89 Stat 871 (December 22, 1975)) Since its inception, Congress has expanded the scope of the energy conservation program several times, including by adding covered products, prescribing energy conservation standards for various products, and by addressing water use for certain covered products. For example, in the Energy Policy Act of 1992, Congress amended the list of covered products in 42 U.S.C. 6292 to include showerheads, faucets, water closets and urinals and expanded DOE’s authority to regulate water use for these products. (*See* Sec. 123, Energy Policy Act of 1992, Public Law 102–486, 106 Stat 2776 (Oct. 24, 1992)). When it did so, Congress also made

corresponding changes to the definition of “consumer product” (42 U.S.C. 6291(1)), the definition of “energy conservation standard” (42 U.S.C. 6291(6)), the section governing the promulgation of test procedures (42 U.S.C. 6293), the criteria for prescribing new or amended energy conservation standards (42 U.S.C. 6295(o)), and elsewhere in EPCA.

Later, Congress further expanded the scope of the energy conservation program several times. For instance, Congress added products and energy conservation standards directly to 42 U.S.C. 6295, the section of EPCA that contains statutorily prescribed standards as well as DOE’s standard-setting authorities. *See* 42 U.S.C. 6295(a) (stating that the “purposes of this section are to—(1) provide Federal energy conservation standards applicable to covered products; and (2) authorize the Secretary to prescribe amended or new energy conservation standards for each type (or class) of covered product.”)). When Congress added these new standards and standard-setting authorities to 42 U.S.C. 6295 after the Energy Policy Act of 1992, it often did so without making any conforming changes to other provisions in EPCA, *e.g.*, sections 6291 or 6292. For example, in the Energy Policy Act of 2005, Congress prescribed standards by statute, or gave DOE the authority to set standards for, battery chargers, external power supplies, ceiling fans, ceiling fan light kits, beverage vending machines, illuminated exit signs, torchieres, low voltage dry-type distribution transformers, traffic signal modules and pedestrian modules, certain lamps, dehumidifiers, and commercial prerinse spray valves in 42 U.S.C. 6295 without updating the list of covered products in 42 U.S.C. 6292. (*See* Sec. 135, Energy Policy Act of 2005, 119 Stat 594 (Aug. 8, 2005)).

Congress also expanded the scope of the energy conservation program by directly adding water use performance standards for certain products to 42 U.S.C. 6295. For example, in the Energy Policy Act of 2005, Congress added a water use performance standard (but no energy use performance standard) for commercial prerinse spray valves (“CPSVs”) and did so without updating the list of covered products in 42 U.S.C. 6292 to include CPSVs and without adding CPSVs to the list of enumerated products with water use performance standards in the “energy conservation standard” definition in 42 U.S.C. 6291(6). In the Energy Independence and Security Act of 2007 (“EISA 2007”), Congress amended 42 U.S.C. 6295 by prescribing energy conservation

standards for residential clothes washers and dishwashers that included both energy and water use performance standards. (See Sec. 301, EISA 2007, Public Law 110–140, 121 Stat 1492 (Dec. 19, 2007)). Again, when it did so, Congress did not add these products to the list of enumerated products with water use performance standards in the definition of “energy conservation standard” in 42 U.S.C. 6291(6).

In considering how to treat these products and standards that Congress has directly added to 42 U.S.C. 6295 without making conforming changes to the rest of the statute, including the list of covered products in 42 U.S.C. 6292, and the water-use products in the definition of an “energy conservation standard,” DOE construes the statute as a whole. When Congress added products and standards directly to 42 U.S.C. 6295 it must have meant those products to be covered products and those standards to be energy conservation standards, given that the purpose of 42 U.S.C. 6295 is to provide “energy conservation standards applicable to covered products” and to “authorize the Secretary to prescribe amended or new energy conservation standards for each type (or class) of covered product.” Elsewhere in EPCA, the statute’s references to covered products and energy conservation standards can only be read coherently as including the covered products and energy conservation standards Congress added directly to section 6295, even if Congress did not make conforming edits to 6291 or 6292. For example, manufacturers are prohibited from “distribut[ing] in commerce any new covered product which is not in conformity with an applicable energy conservation standard.” (42 U.S.C. 6302(a)(5) (emphasis added)) It would defeat congressional intent to allow a manufacturer to distribute a product, e.g., a CPSV or ceiling fan, that violates an applicable energy conservation standard that Congress prescribed simply because Congress added the product directly to 42 U.S.C. 6295 without also updating the list of covered products in 42 U.S.C. 6292(a). In addition, preemption in EPCA is based on “the effective date of an energy conservation standard established in or prescribed under section 6295 of this title for any covered product.” (42 U.S.C. 6297(c) (emphasis added)) Nothing in EPCA suggests that standards Congress adopted in 6295 lack preemptive effect, merely because Congress did not make conforming amendments to 6291, 6292, or 6293.

It would similarly defeat congressional intent for a manufacturer

to be permitted to distribute a covered product, e.g., a residential clothes washer or dishwasher, that violates a water use performance standard because Congress added the standard to 42 U.S.C. 6295 without also updating the definition of energy conservation standard in 42 U.S.C. 6291(6). By prescribing directly, in 6295(g)(10), energy conservation standards for dishwashers that include both energy and water use performance standards, Congress intended that energy conservation standards for dishwashers include both energy use and water use.

DOE recognizes that some might argue that Congress’s specific reference in section 6291(6) to water standards for showerheads, faucets, water closets, and urinals could “create a negative implication” that energy conservations standards for other covered products may not include water use standards. See *Marx v. Gen. Revenue Corp.*, 568 U.S. 371, 381 (2013). “The force of any negative implication, however, depends on context.” *Id.*; see also *NLRB v. SW Gen., Inc.*, 580 U.S. 288, 302 (2017) (“The *expressio unius* canon applies only when circumstances support a sensible inference that the term left out must have been meant to be excluded.” (alterations and quotation marks omitted)). In this context, the textual and structural cues discussed above show that Congress did not intend to exclude from the definition of energy conservation standard the water use performance standards that it specifically prescribed, and directed DOE to amend, in section 6295. To conclude otherwise would negate the plain text of 6295(g)(10). Furthermore, to the extent the definition of energy conservation standards in section 6291(6), which was last amended in the Energy Policy Act of 1992, could be read as in conflict with the energy and water use performance standards prescribed by Congress in EISA 2007, any such conflict should be resolved in favor of the more recently enacted statute. See *United States v. Estate of Romani*, 523 U.S. 517, 530–531 (1998) (“[A] specific policy embodied in a later federal statute should control our construction of the priority statute, even though it had not been expressly amended.”). Accordingly, based on a complete reading of the statute, DOE has determined that products and standards added directly to 42 U.S.C. 6295 are appropriately considered “covered products” and “energy conservation standards” for the purposes of applying the various provisions in EPCA.

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 the 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 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(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 dishwashers appear at title 10 of the CFR part 430, subpart B, appendix C1 (“appendix C1”) and appendix C2.

DOE must follow specific statutory criteria for prescribing new or amended standards for covered products, including dishwashers. Any new or amended standards for a 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)) 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 if DOE determines by rule that the standard is not technologically feasible or economically justified. (42 U.S.C. 6295(o)(3)(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)(3)(B)) 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 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))

EPCA specifies requirements when promulgating an energy conservation standard for a covered product that has two or more subcategories. A rule prescribing an energy conservation standard for a type (or class) of product 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))

Additionally, pursuant to the amendments contained in EISA 2007, final rules for new or amended energy conservation standards promulgated after July 1, 2010, are required to address standby mode and off mode energy use. (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts a standard for a covered product after that date, it must, if justified by the criteria for adoption of standards under EPCA (42 U.S.C. 6295(o)), incorporate standby mode and off mode energy use into 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)) DOE’s current test procedures and standards for dishwashers address standby mode and off mode energy use, as do the amended standards adopted in this direct final rule.

Finally, EISA 2007 amended EPCA, in relevant part, to grant DOE authority to issue a final rule (*i.e.*, a “direct final rule”) establishing an energy conservation standard upon receipt of a statement submitted jointly by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates), as determined by the Secretary, that contains recommendations with respect to an energy or water conservation standard. (42 U.S.C. 6295(p)(4)) Pursuant to 42 U.S.C. 6295(p)(4), the Secretary must also determine whether a jointly-submitted recommendation for

an energy or water conservation standard satisfies 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable.

The direct final rule must be published simultaneously with a NOPR that proposes an energy or water conservation standard that is identical to the standard established in the direct final rule, and DOE must provide a public comment period of at least 110 days on this proposal. (42 U.S.C. 6295(p)(4)(A)–(B)) While DOE typically provides a comment period of 60 days on proposed standards, for a NOPR accompanying a direct final rule, DOE provides a comment period of the same length as the comment period on the direct final rule—*i.e.*, 110 days. Based on the comments received during this period, the direct final rule will either become effective, or DOE will withdraw it not later than 120 days after its issuance if: (1) one or more adverse comments is received, and (2) DOE determines that those comments, when viewed in light of the rulemaking record related to the direct final rule, may provide a reasonable basis for withdrawal of the direct final rule under 42 U.S.C. 6295(o). (42 U.S.C. 6295(p)(4)(C)) Receipt of an alternative joint recommendation may also trigger a DOE withdrawal of the direct final rule in the same manner. (*Id.*)

DOE has previously explained its interpretation of its direct final rule authority. In a final rule amending the Department’s “Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products” at 10 CFR part 430, subpart C, appendix A, DOE noted that it may issue standards recommended by interested persons that are fairly representative of relative points of view as a direct final rule when the recommended standards are in accordance with 42 U.S.C. 6295(o) or 42 U.S.C. 6313(a)(6)(B), as applicable. 86 FR 70892, 70912 (Dec. 13, 2021). But the direct final rule provision in EPCA does not impose additional requirements applicable to other standards rulemakings, which is consistent with the unique circumstances of rules issued through consensus agreements under DOE’s direct final rule authority. *Id.* DOE’s discretion remains bounded by its statutory mandate to adopt a standard that results in the maximum improvement in energy efficiency that is technologically feasible and economically justified—a requirement found in 42 U.S.C. 6295(o). *Id.* As such, DOE’s review and analysis of the Joint Agreement is limited to whether the recommended standards satisfy the criteria in 42 U.S.C. 6295(o).

B. Background

1. Current Standards

In a direct final rule published on May 30, 2012 (“May 2012 Direct Final Rule”), DOE adopted the current energy conservation standards for dishwashers manufactured on or after May 30, 2013, consistent with the levels proposed in a letter submitted to DOE by groups representing manufacturers, energy and environmental advocates, and consumer groups on July 30, 2010. 77 FR 31918, 31918–31919. This collective set of comments, titled “Agreement on Minimum Federal Efficiency Standards, Smart Appliances, Federal Incentives and Related Matters for Specified Appliances” (the “July 2010 Joint Petition”),²⁰ recommended specific

energy conservation standards for dishwashers that, in the commenters’ view, would satisfy the EPCA requirements in 42 U.S.C. 6295(o). 77 FR 31918, 31919. The July 2010 Joint Petition proposed energy conservation standard levels for the standard-size and compact-size dishwasher product classes based on the same capacity definitions that existed at that time. 77 FR 31918, 31926. In the May 2012 Direct Final Rule, DOE analyzed the benefits and burdens of multiple standard levels for dishwashers, including a standard level that corresponded to the recommended levels in the July 2010 Joint Petition, and determined that the levels recommended in the Joint Petition

satisfied the EPCA requirements set forth under 42 U.S.C. 6295(o). 77 FR 31918, 31921.

In a final determination published on December 13, 2016 (“December 2016 Final Determination”), DOE concluded that amended energy conservation standards would not be economically justified at any level above the standards established in the May 2012 Direct Final Rule, and therefore determined not to amend the standards. 81 FR 90072. The current energy and water conservation standards are set forth in DOE’s regulations at 10 CFR part 430, § 430.32(f), and are repeated in Table II.1. The currently applicable DOE test procedure for dishwashers appears at appendix C1.

Table II.1 Federal Energy Conservation Standards for Dishwashers

Product Class	Maximum Estimated Annual Energy Use* (kWh/year)	Maximum Per-Cycle Water Consumption* (gal/cycle)
Standard-Size Dishwasher	307	5.0
Compact-Size Dishwasher	222	3.5

* Using appendix C1

The regulatory text at 10 CFR 430.32(f) references the Association of Home Appliance Manufacturers (“AHAM”) standard AHAM DW–1–2020²¹ to define the items in the test load that comprise the serving pieces and each place setting. The number of serving pieces and place settings help determine the capacity of the dishwasher, which is used to determine the applicable product class.

2. Current Test Procedure

On December 22, 2021, DOE published a test procedure NOPR (“December 2021 TP NOPR”) proposing amendments to the dishwasher test procedure at appendix C1 and a new test procedure at appendix C2. 86 FR 72738. On January 18, 2023, DOE published a final rule amending the test procedure at appendix C1 and establishing a new test procedure at appendix C2 (“January 2023 TP Final Rule”). 88 FR 3234. The new appendix C2 specifies updated annual cycles and low-power mode hours, both of which are used to calculate the EAEU metric, and introduces a minimum cleaning performance threshold to validate the selected test cycle. 88 FR 3234, 3236.

Subsequently, on July 27, 2023, DOE published a final rule adding clarifying

instructions to the dishwasher test procedure at appendix C1 regarding the allowable dosing options for each type of detergent; clarifying the existing detergent reporting requirements; and adding an enforcement provision for dishwashers to specify the detergent and dosing method that DOE would use for any enforcement testing of dishwasher models certified in accordance with the applicable dishwasher test procedure prior to July 17, 2023 (*i.e.*, the date by which the January 2023 TP Final Rule became mandatory for product testing). 88 FR 48351.

EPCA authorizes DOE to design test procedures that measure energy efficiency, energy use, water use, or estimated annual operating cost of a covered product during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(3)) In general, a consumer-acceptable level of cleaning performance (*i.e.*, a representative average use cycle) can be easier to achieve through the use of higher amounts of energy and water use during the dishwasher cycle. Conversely, maintaining acceptable cleaning performance can be more difficult as energy and water levels are reduced. Improving one aspect of dishwasher

performance, such as reducing energy and/or water use as a result of energy conservation standards, may require a trade-off with one or more other aspects of performance, such as cleaning performance. 88 FR 3234, 3250–3251. As discussed, the currently applicable energy conservation standards for dishwashers are based on appendix C1, which does not prescribe a method for testing dishwasher cleaning performance.

The January 2023 TP Final Rule established a new test procedure at appendix C2, which includes provisions for a minimum cleaning index threshold of 70 to validate the selected test cycle. 88 FR 3234, 3261. The cleaning index is calculated based on the number and size of particles remaining on each item of the test load at the completion of a dishwasher cycle as specified in AHAM DW–2–2020.²² Items that do not have any soil particles are scored 0 (*i.e.*, completely clean). No single item in the test load can exceed a score of 9. Individual scores for each item in the test load are combined as a weighted average to calculate the per cycle cleaning index. A cleaning index of 100 indicates a completely clean test load. *Id.* at 88 FR 3255. In the January 2023 TP Final Rule, DOE specified that the

²⁰ DOE Docket No. EERE-2011-BT-STD-0060-0001.

²¹ Uniform Test Method for Measuring the Energy Consumption of Dishwashers. AHAM DW–1–2020. Copyright 2020.

²² Household Electric Dishwashers. AHAM DW–2–2020. Copyright 2020.

cleaning index is calculated by only scoring soil particles on all items in the test load and that spots, streaks, and rack contact marks on glassware are not included in the cleaning index calculation.²³ *Id.* at 88 FR 3248. Manufacturers must use the results of testing under the new appendix C2 to determine compliance with the energy conservation standards adopted in this direct final rule. Accordingly, DOE used appendix C2 as finalized in the January 2023 TP Final Rule as the basis for the analysis in this direct final rule. *Id.* at 88 FR 3234.

DOE adopted a minimum cleaning performance threshold in appendix C2 to determine if a dishwasher, when tested according to the DOE test procedure, “completely washes a normally soiled load of dishes,” so as to better represent consumer use of the product (*i.e.*, to produce test results that are more representative of an average consumer use cycle). 88 FR 3234, 3253, 3255. Based on the data available, DOE determined that the cleaning performance threshold provides a reasonable proxy for when consumers are likely to be satisfied with performance on the normal cycle. 88 FR 3234, 3261. The cleaning index threshold established as part of the new appendix C2 ensures that energy and water savings are being realized for products that comply with the amended energy conservation standards for dishwashers established by this direct final rule. 88 FR 3234, 3253, 3254.

The standards enacted by this direct final rule are expressed in terms of the EAEU and water consumption metrics as measured according to the newly established test procedure contained in appendix C2.

3. The Joint Agreement

On September 25, 2023, DOE received a joint statement (*i.e.*, the Joint Agreement) recommending standards for dishwashers, that was submitted by groups representing manufacturers,

energy and environmental advocates, consumer groups, and a utility.²⁴ In addition to the recommended standards for dishwashers, the Joint Agreement also included separate recommendations for several other covered products.²⁵ And, while acknowledging that DOE may implement these recommendations in separate rulemakings, the Joint Agreement also stated that the recommendations were recommended as a complete package and each recommendation is contingent upon the other parts being implemented. DOE understands this to mean the Joint Agreement is contingent upon DOE initiating rulemaking processes to adopt all the recommended standards in the agreement. That is distinguished from an agreement where issuance of an amended energy conservation standard for a covered product is contingent on issuance of amended energy conservation standards for the other covered products. If the Joint Agreement were so construed, it would conflict with the anti-backsliding provision in 42 U.S.C. 6295(o)(1), because it would imply the possibility that, if DOE were unable to issue an amended standard for a certain product, it would have to withdraw a previously issued standard for one of the other products. The anti-backsliding provision, however, prevents DOE from withdrawing or amending an energy conservation standard to be less stringent. As a result, DOE will be proceeding with individual rulemakings that will evaluate each of the recommended standards separately under the applicable statutory criteria.

A court decision issued after DOE received the Joint Agreement is also relevant to this rule. On March 17, 2022, various States filed a petition seeking review of a final rule revoking two final rules that established product classes for dishwashers with a cycle time for the normal cycle of 60 minutes or less, top-loading residential clothes washers and certain classes of consumer clothes

dryers with a cycle time of less than 30 minutes, and front-loading residential clothes washers with a cycle time of less than 45 minutes (collectively, “short-cycle product classes”). The petitioners argued that the final rule revoking the short-cycle product classes violated EPCA and was arbitrary and capricious. On January 8, 2024, the United States Court of Appeals for the Fifth Circuit granted the petition for review and remanded the matter to DOE for further proceedings consistent with the Fifth Circuit’s opinion. *See Louisiana v. United States Department of Energy*, 90 F.4th 461 (5th Cir. 2024).

On February 14, 2024, following the Fifth Circuit’s decision in *Louisiana v. United States Department of Energy*, DOE received a second joint statement from this same group of stakeholders in which the signatories reaffirmed the Joint Agreement, stating that the recommended standards represent the maximum levels of efficiency that are technologically feasible and economically justified.²⁶ In the letter, the signatories clarified that “short-cycle” product classes for residential clothes washers, consumer clothes dryers, and dishwashers did not exist at the time that the signatories submitted their recommendations and it is their understanding that these classes also do not exist at the current time. Accordingly, the parties clarified that the Joint Agreement did not address short-cycle product classes. The signatories also stated that they did not anticipate that the recommended energy conservation standards in the Joint Agreement will negatively affect features or performance, including cycle time, for dishwashers.

The Joint Agreement recommends standard levels for dishwashers as presented in Table II.2. (Joint Agreement, No. 55 at p. 5) Details of the Joint Agreement recommendations for other products are provided in the Joint Agreement posted in the docket.²⁷

²³ In the December 2021 TP NOPR, DOE proposed a cleaning index threshold of 65 calculated by scoring soil particles on all items as well as spots, streaks, and rack contact marks on glassware. 86 FR 72738, 72756, 72758. In the January 2023 TP Final Rule, DOE noted that the specified cleaning index threshold of 70 is equivalent to the cleaning index threshold of 65 that was proposed in the December 2021 TP NOPR. 88 FR 3234, 3261.

²⁴ The signatories to the Joint Agreement include the AHAM, American Council for an Energy Efficient Economy, Alliance for Water Efficiency, ASAP, Consumer Federation of America, Consumer Reports, Earthjustice, National Consumer Law Center, Natural Resources Defense Council,

Northwest Energy Efficiency Alliance, and Pacific Gas and Electric Company. Members of AHAM’s Major Appliance Division that make the affected products include: Alliance Laundry Systems, LLC; Asko Appliances AB; Beko US Inc.; Brown Stove Works, Inc.; BSH Home Appliances Corporation; Danby Products, Ltd.; Electrolux; Elicamex S.A. de C.V.; Faber; Fotile America; GE Appliances, a Haier Company; L’Atelier Paris Haute Design LLC; LG Electronics; Liebherr USA, Co.; Midea America Corp.; Miele, Inc.; Panasonic Appliances Refrigeration Systems (PAPRSA) Corporation of America; Perlick Corporation; Samsung Electronics America, Inc.; Sharp Electronics Corporation; Smeg S.p.A.; Sub-Zero Group, Inc.; The Middleby

Corporation; U-Line Corporation; Viking Range, LLC; and Whirlpool Corporation.

²⁵ The Joint Agreement contained recommendations for 6 covered products: refrigerators, refrigerator-freezers, and freezers; clothes washers; clothes dryers; dishwashers; cooking products; and miscellaneous refrigeration products.

²⁶ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

²⁷ The Joint Agreement is available in the docket at www.regulations.gov/comment/EERE-2019-BT-STD-0039-0055.

Table II.2 Recommended Amended Energy Conservation Standards for Dishwashers

Product Class	Standard Levels Using Test Procedure Appendix C2		Compliance Date
	Estimated Annual Energy Use (<i>kWh/year</i>)	Per-Cycle Water Consumption (<i>gal/cycle</i>)	
Standard-Size Dishwasher (≥ 8 place settings plus 6 serving pieces)	223	3.3	3 years after publication of this direct final rule
Compact-Size Dishwasher (< 8 place settings plus 6 serving pieces)	174	3.1	3 years after publication of this direct final rule

DOE notes that it was conducting a rulemaking to consider amending the standards for dishwashers when the Joint Agreement was submitted. As part of that process, on January 24, 2022, DOE published a notification of a webinar and availability of preliminary technical support document (“January 2022 Preliminary Analysis”). 87 FR 3450. Subsequently, on May 19, 2023, DOE published a NOPR and announced a public meeting (“May 2023 NOPR”) seeking comment on its proposed amended standard to inform its decision consistent with its obligations under EPCA and the Administrative Procedure Act (“APA”). 88 FR 32514. DOE held a public meeting on June 8, 2023, to discuss and receive comments on the NOPR and NOPR TSD. The NOPR TSD is available at: www.regulations.gov/document/EERE-2019-BT-STD-0039-0032.

Although DOE is adopting the Joint Agreement as a direct final rule and no longer proceeding with its own rulemaking, DOE did consider relevant comments, data, and information obtained during that rulemaking process in determining whether the recommended standards from the Joint Agreement are in accordance with 42 U.S.C. 6295(o). Any discussion of comments, data, or information in this direct final rule that were obtained during DOE’s own prior rulemaking will include a parenthetical reference that provides the location of the item in the public record.²⁸

III. General Discussion

DOE is issuing this direct final rule after determining that the recommended standards submitted in the Joint

Agreement meet the requirements in 42 U.S.C. 6295(p)(4). More specifically, DOE has determined that the recommended standards were submitted by interested parties that are fairly representative of relevant points of view and the recommended standards satisfy the criteria in 42 U.S.C. 6295(o).

On March 17, 2022, various States filed a petition seeking review of the final rule revoking two final rules that established the short-cycle product classes. The petitioners argued that the final rule revoking the short-cycle product classes violated EPCA and was arbitrary and capricious. On January 8, 2024, the United States Court of Appeals for the Fifth Circuit granted the petition for review and remanded the matter to DOE for further proceedings consistent with the Fifth Circuit’s opinion. See *Louisiana v. United States Department of Energy*, 90 F.4th 461 (5th Cir. 2024).

Following the Fifth Circuit’s decision, the signatories to the Joint Agreement submitted a second letter to DOE, which stated that Joint Recommendation did not “address” “short-cycle product classes.”²⁹ That is because, as the letter explained, such product classes “did not exist” at the time of the Joint Agreement.

In a recently published request for information (“RFI”), DOE is commencing a rulemaking process on remand from the Fifth Circuit (the “Remand Proceeding”) by soliciting further information, relevant to the issues identified by the Fifth Circuit, regarding any short-cycle product classes. 89 FR 17338 (March 11, 2024). In that Remand Proceeding, DOE will conduct the analysis required by 42 U.S.C. 6295(q)(1)(B) to determine whether any short-cycle products have a “capacity or other performance-related feature [that] . . . justifies a higher or

lower standard from that which applies (or will apply) to other products. . . .”

The current standards applicable to any products within the scope of that proceeding remain unchanged by this rule. See 10 CFR 430.32(f). Consistent with the Joint Parties’ letter, short-cycle products are not subject to the amended standards adopted by this direct final rule. If the short-cycle products that DOE will consider in the Remand Proceeding were subject to these standards, that would have the practical effect of limiting the options available in the Remand Proceeding. That is because EPCA’s anti-backsliding provision precludes DOE from prescribing any amended standard “which increases the maximum allowable energy use” of a covered product. 42 U.S.C. 6295(o)(1). Accordingly, were the products at issue in the Remand Proceeding also subject to the amended standards adopted here, the Department could only reaffirm the standards adopted in this direct final rule or adopt more stringent standards.

The Joint Agreement specifies the product classes for dishwashers: standard-size and compact-size. Although these product classes were not further divided by cycle time, DOE understands them to exclude standard-size dishwashers with an average cycle time of 60 minutes or less. As noted previously, any such “short-cycle” dishwashers will be considered in the Remand Proceeding; the current standards applicable to such “short-cycle” dishwashers are unchanged by this rule.

Under the direct final rule authority at 42 U.S.C. 6295(p)(4), DOE evaluates whether recommended standards are in accordance with criteria contained in 42 U.S.C. 6295(o). DOE does not have the authority to revise recommended standards submitted under the direct final rule provision in EPCA. Therefore, DOE did not analyze any additional product classes beyond those product classes included in the Joint Agreement.

²⁸ The parenthetical reference provides a reference for information located in the docket of DOE’s rulemaking to develop energy conservation standards for dishwashers. (Docket No. EERE–2019–BT–STD–0039, which is maintained at www.regulations.gov). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

²⁹ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

That is, DOE has not separately considered or established amended standards applicable to any short-cycle product classes. In the event that DOE establishes short-cycle product classes, pursuant to the rulemaking on remand from the Fifth Circuit, DOE will necessarily consider what amended standards ought to apply to any such product classes and will do so in conformance with EPCA.

DOE notes that the data and analysis used to support this direct final rule includes information for standard-size and compact-size dishwashers that is not distinguished by cycle time and is representative of all dishwashers currently on the market today. To the extent that any short-cycle products were included in this data and analysis, DOE believes the amount of such data is negligible.

A. Scope of Coverage

This direct final rule covers those consumer products that meet the definition of “dishwasher” as codified at 10 CFR 430.2.

Dishwasher means a cabinet-like appliance which with the aid of water and detergent, washes, rinses, and dries (when a drying process is included) dishware, glassware, eating utensils, and most cooking utensils by chemical, mechanical and/or electrical means and discharges to the plumbing drainage system. 10 CFR 430.2.

See section IV.A.1 of this document for discussion of the product classes analyzed in this direct final rule.

B. Fairly Representative of Relevant Points of View

Under the direct final rule provision in EPCA, recommended energy conservation standards must be submitted by interested persons that are fairly representative of relevant points of view (including representatives of manufacturers of covered products, States, and efficiency advocates) as determined by DOE. (42 U.S.C. 6295(p)(4)(A)) With respect to this requirement, DOE notes that the Joint Agreement included a trade association, AHAM, which represents 16 manufacturers of dishwashers.³⁰ The Joint Agreement also included environmental and energy-efficiency advocacy organizations, consumer advocacy organizations, and a gas and

electric utility company. Additionally, DOE received a letter in support of the Joint Agreement from the States of New York, California, and Massachusetts (See comment No. 56). DOE also received a letter in support of the Joint Agreement from the gas and electric utility, SDG&E, and the electric utility, SCE (See comment No. 57). As a result, DOE has determined that the Joint Agreement was submitted by interested persons who are fairly representative of relevant points of view.

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. Section 7(b)(2) through (5) of appendix A. Section IV.B of this document discusses the results of the screening analysis for dishwashers, 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 direct final rule TSD.

2. Maximum Technologically Feasible Levels

When DOE proposes to adopt a new or amended standard for a type or class of covered product, it must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for such product. (42 U.S.C. 6295(o)(2)(A)) Accordingly, in the

engineering analysis, DOE determined the maximum technologically feasible (“max-tech”) improvements in energy efficiency for dishwashers, 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.1.b of this document and in chapter 5 of the direct final rule TSD.

D. Energy Savings

1. Determination of Savings

For each TSL, DOE projected energy savings from application of the TSL to dishwashers purchased in the 30-year period that begins in the year of compliance with the amended standards (2027–2056).³¹ The savings are measured over the entire lifetime of dishwashers 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 dishwashers. 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 full-fuel-cycle (“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.³² DOE’s approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or

³⁰ These companies include: Asko Appliances AB; Beko US Inc.; BSH Home Appliances Corporation; Danby Products, Ltd.; Electrolux; Fotile America; GE Appliances, a Haier Company; LG Electronics; Midea America Corp.; Miele, Inc.; Samsung Electronics America, Inc.; Sharp Electronics Corporation; Smeg S.p.A.; Sub-Zero Group, Inc.; The Middleby Corporation; and Whirlpool Corporation.

³¹ DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

³² 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).

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.³³ 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, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors.

As stated, the standard levels adopted in this direct final rule are projected to result in national energy savings of 0.31 quads FFC, the equivalent of the primary annual energy use of 2.1 million homes. Based on the amount of FFC savings, the corresponding reduction in emissions, and the need to confront the global climate crisis, DOE has determined the energy savings from the standard levels adopted in this direct 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 new or amended standards on manufacturers, DOE conducts a manufacturing impact analysis (“MIA”), as discussed in section IV.J of this

document. DOE first uses an annual cash-flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include (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 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 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.H 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 dishwashers 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

³³ 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).

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)) DOE will transmit a copy of this direct final rule to the Attorney General with a request that the Department of Justice (“DOJ”) provide its determination on this issue. DOE will consider DOJ’s comments on the rule in determining whether to withdraw the direct final rule. DOE will also publish and respond to the DOJ’s comments in the **Federal Register** in a separate notice.

f. Need for National Energy and Water 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 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 effect potential amended energy conservation standards would have on the payback period for consumers. These analyses include, but are not limited to, the 3-year payback period contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C.

6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE’s evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section IV.F.9 of this document.

IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to dishwashers. Separate subsections address each component of DOE’s analyses, including relevant comments DOE received during its separate rulemaking to amend the energy conservation standards for dishwashers prior to receiving the Joint Agreement.

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: www.regulations.gov/docket?D=EERE-019-BT-STD-0039. Additionally, DOE used output from the latest version of the EIA’s *Annual Energy Outlook* (“AEO”) for the emissions and utility impact analyses.

A. 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 dishwashers. The key findings of DOE’s market assessment are summarized in the following sections. See chapter 3 of the direct final rule TSD for further discussion of the market and technology assessment.

1. Product Classes

The Joint Agreement specifies two product classes for dishwashers. (Joint Agreement, No. 55 at p. 8) In this direct final rule, DOE is adopting the product classes from the Joint Agreement, as follows:

(1) Standard-size dishwashers (≥8 place settings plus 6 serving pieces); and

(2) Compact-size dishwashers (<8 place settings plus 6 serving pieces). *Id.*

Where the place settings are as specified in AHAM DW–1–2020 and the test load is as specified in section 2.4 of appendix C2. *Id.*

DOE further notes that product classes established through EPCA’s direct final rule authority are not subject to the criteria specified at 42 U.S.C. 6295(q)(1) for establishing product classes. Nevertheless, in accordance with 42 U.S.C. 6295(o)(4)—which is applicable to direct final rules—DOE has concluded that the standards adopted in this direct final rule will not result in the unavailability in any covered product type (or class) of performance characteristics, features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States

currently.³⁴ DOE's findings in this regard are discussed in detail in section V.B.4 of this document.

2. Technology Options

In this direct final rule, DOE considered 20 technology options, consistent with the table of technology options presented in the May 2023 NOPR. 88 FR 32514, 32527–32528. In general, technology options for dishwashers may reduce energy use alone, or reduce both energy and water use together. Most dishwashers in the United States use as their water source a hot water line that is typically tapped from the hot water line serving the adjacent kitchen faucet. Because the energy used to heat the water consumed by the dishwasher is included as part of the EAEU metric, technologies that decrease water use also inherently decrease energy use. Chapter 3 of the TSD for this direct final rule includes a detailed list and descriptions of all technology options identified for dishwashers, including a discussion of how each technology option reduces energy use only or both energy and water use together.

Among the technology options identified for dishwashers, the following reduce energy use only (*i.e.*, they reduce energy use without directly reducing water use): condensation drying, including use of a stainless steel tub; desiccant drying; fan/jet drying; improved motor efficiency; increased insulation; low-standby-loss electronic controls; reduced inlet-water temperature; thermoelectric heat pumps; ultrasonic washing; and variable-speed motors.

The following technology options reduce both energy and water use together (*i.e.*, they reduce water use, thereby also inherently reducing energy use): control strategies; flow-through heating; improved fill control; improved food filter; improved spray-arm geometry; microprocessor controls and fuzzy logic, including adaptive or soil-sensing controls; modified sump geometry, with and without dual pumps; super-critical carbon dioxide washing; variable washing pressures and flow rates; and water re-use system.

In developing the list of technology options for this direct final rule, DOE considered comments it had received in response to the May 2023 NOPR. Samsung Electronics America, Inc. ("Samsung") noted³⁵ that variable-speed pump motors reduce energy consumption by allowing the dishwasher to operate at the most suitable flow rate for each specific phase of the cleaning process. (Samsung, No. 52 at p. 2) Samsung agreed with DOE that enhancements in dishwasher components also contribute to energy efficiency, especially advanced technologies such as electronic and soil-sensing controls. Samsung commented that the technology options identified by DOE are achievable and can be implemented by manufacturers to significantly improve energy efficiency, reduce resource consumption, and promote sustainability while maintaining cleaning performance that consumers expect. (Samsung, No. 52 at pp. 2–3) As noted, DOE has maintained the technology options discussed in the May 2023 NOPR.

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 commercially viable, existing prototypes will not be considered further.

(2) *Practicability to manufacture, install, and service.* If it is determined that mass production of a technology in commercial products and reliable installation and servicing of the technology 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.* If a technology is determined to have a significant adverse impact on the utility of the product to subgroups of consumers, or 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) *Safety of technologies.* 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 technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further, due to the potential for monopolistic concerns.

10 CFR part 430, subpart C, appendix A, sections 6(b)(3) and 7(b).

In summary, 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 subsequent sections of this document discuss 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. The results of the screening analysis are discussed in greater detail in chapter 4 of the TSD for this direct final rule.

1. Screened-Out Technologies

The following sections detail the technology options that were screened out for this direct final rule, and the reasons why they were eliminated.

a. Desiccant Drying

Desiccant drying relies on a material such as zeolite³⁶ to adsorb moisture to aid in the drying process and reduce drying energy consumption. DOE is aware of dishwashers from one manufacturer on the market in the United States that use desiccant drying.³⁷

DOE has screened out desiccant drying from further consideration because it is a unique-pathway proprietary technology. Desiccant drying is a patented technology, and although multiple manufacturers hold patents for dishwasher designs with desiccant drying features, DOE is concerned that this technology option is not available for all manufacturers.

b. Reduced Inlet-Water Temperature

Reduced inlet-water temperature requires that dishwashers tap the cold water line for their water supply. Because most dishwashers in the United States tap the hot water line, this technology option would require significant alteration of existing dishwasher installations in order to

³⁶ Zeolite is a highly porous aluminosilicate mineral that adsorbs moisture and releases heat to aid in the drying process.

³⁷ See chapter 4, section 4.2.1.1 of the January 2022 Preliminary TSD.

³⁴ EPCA specifies that DOE may not prescribe an amended or new standard if the Secretary finds (and publishes such finding) that 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 at the time of the Secretary's finding. (42 U.S.C. 6295(o)(4))

³⁵ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0052.

accommodate newly purchased units incorporating this technology option. Therefore, DOE has determined that it would not be practicable to install this technology on the scale necessary to serve the relevant market at the time of the effective date of an amended standard.

c. Supercritical Carbon Dioxide Washing

Supercritical carbon dioxide washing, which uses supercritical carbon dioxide instead of conventional detergent and water to wash dishes, is currently being researched. Given that this technology is in the research stage, DOE has determined that it would not be practicable to manufacture, install and service this technology on the scale necessary to serve the relevant market at the time of the effective date of an amended standard. Furthermore, because this technology is in the research stage, it is not yet possible to assess whether it would have any adverse impacts on equipment utility to consumers or equipment availability, or any adverse impacts on consumers' health or safety.

d. Ultrasonic Washing

A dishwasher using ultrasonic waves to generate a cleaning mist was produced for the Japanese market in 2002; however, this model is no longer available on the market. Available information indicates that the use of a mist with ion generation instead of water with detergent would decrease cleaning performance, impacting consumer utility.

Ultrasonic dishwashing based upon soiled-dish immersion in a fluid that is then excited by ultrasonic waves has not been demonstrated. In an immersion-based ultrasonic dishwasher, standing ultrasonic waves within the washing cavity and the force of bubble cavitation implosion can damage fragile dishware. Because no manufacturers currently produce consumer ultrasonic dishwashers, it is impossible to assess whether this technology option would have any impacts on consumers' health or safety, or product availability.

Based on this information, DOE has screened out both identified product types that incorporate the ultrasonic washing technology option.

e. Thermoelectric Heat Pumps

The thermoelectric heat pump system aims to extract waste heat from drain water and recover heat normally lost during the drying process, and apply it to the washing, rinsing, and drying phases, effectively saving energy. The technology is not commercially

available yet as the technology is still in the research phase. Therefore, DOE has determined that it would not be practicable to manufacture, install and service this technology on the scale necessary to serve the relevant market at the time of the effective date of the amended standards. Furthermore, because this technology is in the research stage, it is not yet possible to assess whether it would have any adverse impacts on equipment utility to consumers or equipment availability, or any adverse impacts on consumers' health or safety.

f. Water Re-Use System

This system saves water from the final rinse of a given dishwasher cycle for use in a subsequent dishwasher cycle. A water re-use system dishwasher also performs "drain out" and "clean out" cycles if the dishwasher is not operated for a certain period of time. Both "drain out" and "clean out" events consume additional water and energy during the subsequent cycle, even though such a system saves water and energy consumption overall.

DOE has screened out this technology option as it has determined that leaking and contamination from a water holding tank could potentially present negative health or safety impacts.

2. Remaining Technologies

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

Technology options that reduce energy use only: condensation drying, including use of a stainless steel tub; fan/jet drying; improved motor efficiency; increased insulation; low-standby-loss electronic controls; and variable-speed motors.

Technology options that reduce both energy and water use together: control strategies; flow-through heating; improved fill control; improved food filter; improved spray-arm geometry; microprocessor controls and fuzzy logic, including adaptive or soil-sensing controls; modified sump geometry, with and without dual pumps; and variable washing pressures and flow rates.

DOE determined 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 direct final rule TSD.

C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of dishwashers. 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 products, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each dishwasher class, DOE estimates the baseline cost, as well as the incremental cost for the dishwasher 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 interpolate to define "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).

For this analysis, DOE used a combination of the efficiency-level and design-option approach. This approach involved physically disassembling commercially available products, reviewing publicly available cost information, and modeling equipment cost. From this information, DOE estimated the manufacturer production costs (“MPCs”) for a range of products currently available on the market. DOE then considered the incremental steps manufacturers may take to reach higher efficiency levels. In its modeling, DOE started with the baseline MPC and added the expected design options at each higher efficiency level to estimate incremental MPCs. By doing this, the engineering analysis did not factor in the additional higher-cost features with no impact on efficiency that are included in some models. However, at efficiency levels where the product designs significantly deviated from the baseline product, DOE used the efficiency-level approach to determine an MPC estimate, while removing the costs associated with non-efficiency-related components or features. DOE also provides further discussion on the design options and efficiency improvements in chapter 5 of the direct final rule TSD.

a. Baseline Efficiency

For each dishwasher product class, DOE generally selects a baseline model as a reference point for each class, and measures changes resulting from potential energy conservation standards against the baseline. The baseline model in each dishwasher class represents the characteristics of a dishwasher 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 dishwashers, DOE identified products available on the market rated at the current energy conservation standards levels for both standard-size and compact-size dishwasher product classes. Accordingly, DOE analyzed these products as baseline units. DOE uses the baseline unit for comparison in several phases of the direct final rule analyses, including the engineering analysis, LCC analysis, PBP analysis, and NIA. To determine energy and water savings that will result from an amended energy conservation standard, DOE compares energy and water consumption at each of the higher energy efficiency levels to the energy and water consumption of the baseline unit. Similarly, to determine the changes in price to the consumer that will result from an amended energy conservation standard, DOE compares the price of a unit at each higher

efficiency level to the price of a unit at the baseline. Additional details on the selection of baseline units may be found in chapter 5 of the direct final rule TSD. In the May 2023 NOPR, DOE updated the baseline efficiency level for the compact-size dishwasher product class, when using appendix C2, from 178 kWh/year estimated in the January 2022 Preliminary Analysis to 191 kWh/year. 88 FR 32514, 32530. In the January 2022 Preliminary Analysis, DOE translated the current compact-size product class standard level of 222 kWh/year, which is based on appendix C1, to an EAEU based on appendix C2 using the baseline standby power use estimate of 2.3 watts from the December 2016 Final Determination (see chapter 7 of the December 2016 Final Determination TSD).³⁸ *Id.* at 32531. However, based on more recent testing of compact-size dishwashers, DOE determined in its analysis for the May 2023 NOPR that current baseline compact-size dishwashers consume 0.5 watts in standby mode. Using this updated standby power value to translate 222 kWh/year from appendix C1 to appendix C2, DOE calculated an updated baseline EAEU value of 191 kWh/year for compact-size dishwashers. *Id.* Accordingly, in the May 2023 NOPR, DOE proposed the baseline compact-size dishwasher efficiency level to be 191 kWh/year and 3.5 gal/cycle. *Id.* Table IV.1 presents the baseline levels identified for each dishwasher product class in the May 2023 NOPR.

Table IV.1: Baseline Dishwasher Efficiency Levels Evaluated in the May 2023 NOPR

Product Class	Estimated Annual Energy Use (kWh/year)*	Estimated Annual Energy Use (kWh/year)**	Per-Cycle Water Consumption (gal/cycle)
Standard-size	307	263	5.0
Compact-size	222	191	3.5

* Using appendix C1

** Using appendix C2

DOE sought comment on the baseline efficiency levels analyzed in the May 2023 NOPR for each product class. 88 FR 32514, 32531. DOE did not receive any comments related to the selected baseline efficiency levels, including the updated baseline efficiency level for compact-size dishwashers in the May 2023 NOPR. DOE therefore used the baseline efficiency levels from the May

2023 NOPR in its analysis for this direct final rule.

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). Using this approach, DOE identified four efficiency levels beyond the baseline for standard-size dishwashers and two for the compact-size product class. At each higher efficiency level, both energy use and water use decrease through the implementation of combinations of design options that individually either reduce energy use alone, or reduce both energy and water use together, as

³⁸ To translate the current dishwasher EAEU standards from appendix C1 to appendix C2, DOE separated the EAEU into annual active mode energy

use and annual standby mode energy use. DOE multiplied the annual active mode energy use by 184 cycles/year and divided by 215 cycles/year,

then added back the annual standby energy use to determine updated EAEU values based on 184 annual cycles.

discussed previously in section IV.A.2 of this document. Chapter 5 of the direct final rule TSD provides a detailed discussion of the specific design changes that DOE believes manufacturers would typically use to meet each higher efficiency level considered in this engineering analysis,

including a discussion of whether such design changes would reduce energy use only, or reduce both energy and water use together.

In defining the higher efficiency levels for this direct final rule, DOE considered comments it had received in

response to the higher efficiency levels proposed in the May 2023 NOPR.

Table IV.2 and Table IV.3 show the efficiency levels DOE evaluated for standard-size and compact-size dishwashers in the May 2023 NOPR. 88 FR 32514, 32534–32535.

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Table IV.2: Efficiency Levels for Standard-Size Dishwashers Evaluated in the May 2023 NOPR

Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Estimated Annual Energy Use (kWh/year)**	Per-Cycle Water Consumption (gal/cycle)
Baseline	307	263	5.0
1	270	232	3.5
2	260	223	3.3
3	240	206	3.2
4 (Max-Tech)	225	193	2.4

* Using appendix C1

** Using appendix C2

Table IV.3: Efficiency Levels for Compact-Size Dishwashers Evaluated in the May 2023 NOPR

Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Estimated Annual Energy Use (kWh/year)**	Per-Cycle Water Consumption (gal/cycle)
Baseline	220	191	3.5
1	203	174	3.1
2 (Max-Tech)	144	124	1.6

* Using appendix C1

** Using appendix C2

For standard-size dishwashers, EL 1 corresponded to the ENERGY STAR Version 6.0³⁹ (“ENERGY STAR V. 6.0”) level, EL 2 corresponded to a gap-fill efficiency level between ENERGY STAR V. 6.0 and ENERGY STAR V. 7.0, and EL 3 corresponded to the ENERGY STAR V. 7.0 level (which was also the ENERGY STAR Most Efficient criteria in 2022 and 2023). For compact-size dishwashers, EL 1 corresponded to the ENERGY STAR V. 6.0 level. For both standard-size and compact-size

dishwashers, the max-tech efficiency level corresponded to the highest efficiency unit available on the market at that time, excluding from consideration models that rely on technologies that were screened out previously. 88 FR 32514, 32534–32535. In the May 2023 NOPR, DOE requested feedback on the efficiency levels analyzed for each product class in this proposal. 88 FR 32514, 32335. DOE did not receive any comments related to the selected efficiency levels. DOE therefore

used the baseline and incremental efficiency levels from the May 2023 NOPR in its analysis for this direct final rule.

For the reasons discussed, DOE analyzed for this direct final rule the efficiency levels for standard-size and compact-size dishwashers that were proposed in the May 2023 NOPR, as reproduced in Table IV.4 and Table IV.5, respectively.

³⁹ENERGY STAR Version 6.0 Program Requirements available at: www.energystar.gov/

[sites/default/files/asset/document/ENERGY%20STAR%20Residential%20Dishwasher%20Version%206.0%20Final%20Program%20Requirements_0.pdf](https://www.federalregister.gov/sites/default/files/asset/document/ENERGY%20STAR%20Residential%20Dishwasher%20Version%206.0%20Final%20Program%20Requirements_0.pdf)

[sites/default/files/asset/document/ENERGY%20STAR%20Residential%20Dishwasher%20Version%206.0%20Final%20Program%20Requirements_0.pdf](https://www.federalregister.gov/sites/default/files/asset/document/ENERGY%20STAR%20Residential%20Dishwasher%20Version%206.0%20Final%20Program%20Requirements_0.pdf)

Table IV.4: Analyzed Efficiency Levels for Standard-Size Dishwashers

Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Estimated Annual Energy Use (kWh/year)**	Per-Cycle Water Consumption (gal/cycle)
Baseline	307	263	5.0
1	270	232	3.5
2	260	223	3.3
3	240	206	3.2
4 (Max-Tech)	225	193	2.4

* Using appendix C1

** Using appendix C2

Table IV.5: Analyzed Efficiency Levels for Compact-Size Dishwashers

Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Estimated Annual Energy Use (kWh/year)**	Per-cycle water consumption (gal/cycle)
Baseline	220	191	3.5
1	203	174	3.1
2 (Max-Tech)	144	124	1.6

* Using appendix C1

** Using appendix C2

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DOE notes that the compact-size max-tech unit that was analyzed in the May 2023 NOPR was not included in DOE's Compliance Certification Database ("CCD") as of September 2023. Models that are discontinued over the course of a DOE rulemaking timeline remain applicable in conducting the analysis in accordance with EPCA requirements because such models incorporate technologically feasible design options that manufacturers may use to achieve the corresponding efficiency levels in commercial products. The CCD included models that exceed the efficiency of the max-tech unit analyzed in the May 2023 NOPR; however, for these units, there is a discrepancy between the rated EAEU in DOE's CCD and the EAEU listed on the model's EnergyGuide label,⁴⁰ therefore, DOE did not consider these units for its max-tech analysis. Accordingly, DOE has retained the same compact-size max-tech unit analyzed in this direct final rule as that identified in the May 2023 NOPR.

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,

⁴⁰The CCD lists models with an EAEU of 114 kWh/year and water consumption of 1.6 gallons/cycle. However, the EnergyGuide label for these units lists the EAEU as 154 kWh/year and water consumption of 1.8 gallons/cycle. Accordingly, DOE did not consider this unit as the max-tech unit for this final rule analysis.

including the availability and reliability of public information, characteristics of the regulated product, the availability and timeliness of purchasing the dishwasher 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.

In this direct final rule, DOE conducted the analysis using the physical teardown approach. For each product class, DOE tore down a representative sample of models spanning the entire range of efficiency levels, as well as multiple manufacturers within each product class. DOE aggregated the results so that the cost-efficiency relationship

developed for each product class reflects DOE's assessment of a market-representative "path" to achieve each higher efficiency level. The resulting bill of materials provides the basis for the MPC estimates.

To account for manufacturers' profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price ("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 appliance manufacturing and whose combined product range includes dishwashers. See section IV.J.2.d of this document and chapter 12 of the direct final rule TSD for additional detail on the manufacturer markup.

3. Cost-Efficiency Results

To develop the incremental MPCs associated with improving product efficiency for each product class, DOE started with the baseline unit cost model and added the expected changes associated with improving efficiency at each higher efficiency level. By doing this, DOE excluded the costs of any non-efficiency related components from the more efficient units.

Table IV.6 shows the baseline MPCs for standard-size and compact-size dishwashers estimated for the May 2023 NOPR. 88 FR 32514, 32536. Table IV.7 and Table IV.8 show the incremental

MPCs from the baseline developed in the May 2023 NOPR for standard-size and compact-size dishwashers,

respectively, in 2022 dollars. *Id.* at 88 FR 32536–32537.
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Table IV.6: Baseline Manufacturer Production Costs in the May 2023 NOPR

Product Class	Estimated Annual Energy Use (<i>kWh/year</i>)*	Per-Cycle Water Consumption (<i>gal/cycle</i>)	Baseline MPC (2022\$)
Standard-size	263	5.0	\$184.35
Compact-size	191	3.5	\$215.17

* Using appendix C2

Table IV.7: Incremental Manufacturer Production Costs for Standard-Size Dishwashers in the May 2023 NOPR

Efficiency Level	Estimated Annual Energy Use (<i>kWh/year</i>)*	Per-Cycle Water Consumption (<i>gal/cycle</i>)	Incremental MPC (2022\$)
Baseline	263	5.0	-
1	232	3.5	\$10.17
2	223	3.3	\$10.17
3	206	3.2	\$61.50
4 (Max-Tech)	193	2.4	\$91.25

* Using appendix C2

Table IV.8: Incremental Manufacturer Production Costs for Compact-Size Dishwashers in the May 2023 NOPR

Efficiency Level	Estimated Annual Energy Use (<i>kWh/year</i>)*	Per-Cycle Water Consumption (<i>gal/cycle</i>)	Incremental MPC (2022\$)
Baseline	191	3.5	-
1	174	3.1	-
2 (Max-Tech)	124	1.6	\$39.45

* Using appendix C2

For this direct final rule, DOE updated the underlying raw material and component prices used in its cost model to reflect raw material and

component prices as of March 2023. Table IV.9 presents the baseline MPCs for each product class as determined for this final rule, in 2023 dollars. Table

IV.10 and Table IV.11 provide the incremental MPCs for each efficiency level for both product classes as determined for this final rule.

Table IV.9: Baseline Manufacturer Production Costs

Product Class	Estimated Annual Energy Use (<i>kWh/year</i>)*	Per-Cycle Water Consumption (<i>gal/cycle</i>)	Baseline MPC (2023\$)
Standard-size	263	5.0	\$171.50
Compact-size	191	3.5	\$192.27

* Using appendix C2

Table IV.10: Incremental Manufacturer Product Costs for Standard-Size Dishwashers

Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Per-Cycle Water Consumption (gal/cycle)	Incremental MPC (2023\$)
Baseline	263	5.0	-
1	232	3.5	\$16.78
2	223	3.3	\$16.78
3	206	3.2	\$74.67
4 (Max-Tech)	193	2.4	\$117.83

* Using appendix C2

Table IV.11: Incremental Manufacturer Product Costs for Compact-Size Dishwashers

Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Per-Cycle Water Consumption (gal/cycle)	Incremental MPC (2023\$)
Baseline	191	3.5	-
1	174	3.1	-
2 (Max-Tech)	124	1.6	\$38.17

* Using appendix C2

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The detailed description of DOE's determination of costs for baseline and higher efficiency levels is provided in chapter 5 of the direct final rule TSD.

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.

DOE considered two distribution channels through which dishwashers move from manufacturers to consumers. The majority of dishwasher sales go through the direct retailer channel, in which manufacturers sell the products directly to retailers, who then sell to consumers. This direct retailer channel accounts for 85 percent of the dishwasher market. The rest of the market goes through a separate distribution channel, in which manufacturers sell the products to wholesalers, who in turn sell the products to general contractors, then to consumers. The main parties in the post-manufacturer distribution channels are retailers, wholesalers, and general contractors.

DOE developed baseline and incremental markups for each actor in the distribution chain. 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.⁴¹

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.⁴²

For this direct final rule, DOE considered comments it had received regarding the markups analysis conducted for the May 2023 NOPR. The approach for determining markups in this direct final rule was the same approach DOE had used for the May 2023 NOPR analysis.

In response to the March 2023 NOPR, AHAM commented⁴³ that it, along with

⁴¹ 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.

⁴² US Census Bureau, Annual Retail Trade Survey, 2017. www.census.gov/programs-surveys/arts.html

⁴³ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0051.

AHRI and other stakeholders, disputes DOE's distinction between markups from manufacturers to end customers for the base case, those for costs added to meet proposed standards, and the use of incremental versus average markups. (AHAM, No. 51 at p. 18) AHAM stated that in its comments on the 2015 NOPR contained quotes from actual retailers about their actual practices and they contradict the DOE process. (*Id.*)

DOE's incremental markup approach assumes that an increase in operating profits, which is implied by keeping a fixed average markup when the product price goes up, is unlikely to be viable over time in a reasonably competitive market like household appliance retailers. The Herfindahl-Hirschman Index reported by the 2017 Economic Census indicates that the household appliance stores sector (NAICS 443141) is a competitive marketplace.⁴⁴ DOE recognizes that actors in the distribution chains are likely to seek to maintain the same markup on appliances in response to changes in MSPs after an amendment to energy conservation standards. However, DOE believes that retail

⁴⁴ 2017 Economic Census, Selected sectors: Concentration of largest firms for the U.S. Available at www.census.gov/data/tables/2017/econ/economic-census/naics-sector-44-45.html. The Herfindahl-Hirschman Index value can be found by navigating to the "Concentration of largest firms for the U.S." table and then filtering the industry code to NAICS 443141. The Herfindahl-Hirschman Index reported for the largest 50 firms in household appliance stores sector, is 123.8. Generally, a market with an HHI value of under 1,000 is considered to be competitive.

pricing is likely to adjust over time as those actors are forced to readjust their markups to reach a medium-term equilibrium in which per-unit profit is relatively unchanged before and after standards are implemented.⁴⁵

According to economic theory, firms in a perfectly competitive market are expected to achieve only normal profits in the long run, and any short-term economic profit would be eroded by entry and increased competition over time. While it is acknowledged that no real-world market perfectly fits the conditions of perfect competition, the theory provides insights into industries and sectors that share certain characteristics. As indicated by industry data,⁴⁶ the appliance retail sector is a competitive marketplace; thus, DOE contends that an increase in profitability, which is implied by keeping a fixed average markup when the production cost goes up, is not likely viable in the long run.

DOE acknowledges that markup practices in response to amended standards are complex and varying with business conditions. However, DOE's analysis necessarily only considers changes in appliance offerings that occur in response to amended standards and isolates the effect of amended standards from other factors. DOE agrees that empirical data on markup practices would be desirable, but such information is closely held and difficult to obtain. Consequently, DOE relies to economic theory as the foundation for developing the markup analysis. Hence, DOE continues to maintain that its assumption that standards do not facilitate a sustainable increase in profitability is reasonable.

The comments submitted by AHAM during the 2015 NOPR contain quotes from their interviews with retailers, but do not provide the details and the interview questions used by their consultant based on data confidentiality reasons. However, without knowing what questions were posed to the contractors and retailers, it is challenging for DOE to evaluate the applicability of those quotes. As noted,

⁴⁵ A recent retrospective study by LBNL compared ex-ante projections of the 2011 Direct Final Rule for Room ACs with ex-post data across various analytical inputs. While the observed product price data remain sparse, the available market data suggests that for some product classes, prices did not significantly increase after the standard change, and for others, the prices aligned with DOE's projections. Ganeshalingam, M., Ni, C., and Yang, H.-C. 2021. A Retrospective Analysis of the 2011 Direct Final Rule for Room Air Conditioners. Lawrence Berkeley National Laboratory. LBNL-2001413.

⁴⁶ IBISWorld, US Industry Reports (NAICS): <https://my.ibisworld.com/us/en/industry/home>.

DOE's analysis necessarily considers a situation in which nothing changes except for those changes in appliance offerings that occur in response to amended standards, and this needs to be addressed clearly in the framing of the questions.

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

E. Energy and Water Use Analysis

The purpose of the energy and water use analysis is to determine the annual energy and water consumption of dishwashers at different efficiencies in representative U.S. single-family homes, and multi-family residences, and to assess the energy and water savings potential of increased dishwasher efficiency. In order to determine representative life-cycle costs (as discussed in IV.F), both annual energy and water consumption are considered at each efficiency level because the technologies to improve energy efficiency may also reduce water usage (as discussed in IV.C.1.b). The energy and water use analysis estimates the range of energy and water use of dishwashers in the field (*i.e.*, as they are actually used by consumers). The energy and water use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy and water savings and the savings in consumer operating costs that could result from adoption of amended or new standards.

For this direct final rule, DOE considered comments it had received regarding the energy and water use analysis conducted for the May 2023 NOPR. The approach used to estimate the energy and water consumption for this direct final rule is largely the same as the approach DOE had used for the May 2023 NOPR analysis.

In the May 2023 NOPR, DOE determined the average annual energy and water consumption of dishwashers by multiplying the per-cycle energy and water consumption by the number of cycles per year. 88 FR 32514, 32537. DOE used the EIA's 2020 *Residential Energy Consumption Survey* ("RECS") data to calculate an estimate of annual number of cycles.⁴⁷ *Id.* Having determined number of cycles of dishwasher use per year for each RECS household, DOE determined the corresponding annual energy and water consumption. *Id.* In the May 2023 NOPR, DOE determined the average

⁴⁷ U.S. Department of Energy-Energy Information Administration, Residential Energy Consumption Survey, 2015 Public Use Microdata Files, 2020. Washington, DC. Available at www.eia.doe.gov/meu/recs/recspubuse20/pubuse20.html.

annual cycles of operation for dishwashers to be 197 cycles per year based on *RECS 2020*. (*Id.* 88 FR 32538)

In response to the May 2023 NOPR, Alliance for Water Efficiency ("AWE") recommended⁴⁸ that DOE consider using actual data for its assumptions about cycles per year. (AWE, No. 44 at p. 2) AWE commented that a significant difference exists between the 197 cycles per year that DOE is using and the 95 cycles per year the water industry typically uses. (*Id.*) AWE stated that the water industry frequently relies on residential end use data from Residential End Uses of Water, Version 2 Water Research Foundation Report #4309b ("*REUW 2016*"). (*Id.*) AWE also stated that its experience and academic research suggest there are often large gaps between consumer survey responses and actual behavior when it comes to fixture and appliance usage. (*Id.* at p. 3) AWE commented that DOE could explore acquiring data from companies using smart devices, sub-meters, or sensors installed on water meters and supply lines in thousands of homes across the United States that collect real-time end use data, which could then be disaggregated. (*Id.*)

DOE has reviewed the *REUW 2016* report published by the Water Research Foundation, which analyzed dishwasher end-use data from detailed log data from 762 households. DOE acknowledges that RECS is based on household reported frequency of average dishwasher usage per week, rather than on contemporaneous logs taken by households or meters installed on household dishwashers, which could be more reliable on an individual basis. However, unlike the *REUW 2016*, which is based on households in the service areas of 21 U.S. utilities, the *RECS 2020* consists of a nationally representative sample of housing units including more than 10,000 households that report dishwasher usage. DOE also acknowledges AWE's concern that survey data can be different from field metered data. For a comparison between survey data and field metered data, DOE referred to a report from Sun *et al.* that showed that the average annual dishwasher cycle counts obtained from Pecan Street field metered data based on a limited household sample size and limited geographic locations were comparable with the average cycle counts reported by *RECS 2020* with a difference of three percent.⁴⁹ Therefore,

⁴⁸ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0044.

⁴⁹ Sun, Q., *et al.* 2022. Using Field-Metered Data to Characterize Consumer Usage Patterns of Residential Dishwashers. Lawrence Berkeley National Laboratory, Berkeley, CA.

DOE considers RECS to be the most nationally representative dataset to approximate consumer dishwasher usage in the U.S. and uses it in the analysis for this direct final rule.

AHAM commented that DOE eliminated the numerical threshold for the significant conservation of energy savings determination that was in the prior Process Rule, reverting to its earlier approach of determining whether energy savings are significant on a case-by-case basis. AHAM noted that the amended standards for dishwasher would result in 0.31 quads, but DOE could achieve far greater savings through other means such as public education. AHAM stated that on a monthly basis, savings are so minuscule as to render them meaningless relative to the potential increase in up-front purchase costs, particularly for dishwashers on the lower end of the price scale. AHAM recommended that DOE use median savings as a way to partially overcome the bias in the RECS data where a few outlier high usage RECS data points distort the results. (AHAM, No. 51 at p. 6) AHAM stated using the median LCC savings, the savings are approximately \$0.72 cents per year, which is an amount so small as not to even be noticed by consumers on their monthly balance sheets. (*Id.* at pp. 6–7) AHAM further stated that proposed standards that are not cost effective are not economically justified under EPCA because the savings do not justify the manufacturer and consumer burdens that result from the amended standards and DOE should issue a determination not to amend standards beyond EL 1 for dishwashers. (*Id.*)

As described in section IV.E of this document, DOE's energy and water use analysis for this direct final rule is derived based on *RECS 2020*, which provides household's dishwasher loads information ranging from 1 cycle to 21 cycles per week, once after every meal. The household survey-based annual energy and water use for each household then feed into the LCC analysis. Excluding minimum and maximum values from the RECS households samples would result in a less accurate representation of the actual national dishwasher usage patterns and consumption distribution exhibited by the household sample. However, as a standardized approach, DOE presents the distributions of LCC savings for each product class and efficiency level as histograms and boxplots in chapter 8 of the direct final rule TSD, which can also be generated via the published LCC spreadsheet tool. This approach allows stakeholders to observe the full range of LCC savings over the relevant time

scale, which accounts for the total costs and savings to a consumer over the lifetime of a new unit purchased in the compliance year, enabling a more informed evaluation of the potential impacts of the proposed standards. In addition, DOE's decision on amended standards is not solely determined by the average LCC savings. While LCC savings play a role, they are considered alongside other critical factors, including the percentage of negatively impacted consumers, the simple payback period, and the overall impact on manufacturers. DOE further notes, that while AHAM submitted these comments in response to the May 2023 NOPR, since then AHAM became a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

The California Investor-Owned Utilities (“CA IOUs”)⁵⁰ recommended⁵¹ that DOE conduct a representative consumer survey to review the assumption that consumers turn off the power-dry feature 50 percent of the time if such options exists, and in the absence of such information, amend the test procedure to test the default cycle with all manufacturer recommended settings for everyday use enabled. The CA IOUs expressed concern that DOE lacked solid supportive data and defaulted to the Department of Commerce Voluntary Labeling Program's position that for “any feature requiring a consumer interaction and for which actual usage is unknown,” a “50 percent frequency” was assumed. (CA IOUs, No. 50 at p. 6) The CA IOUs commented that in practice, it is unclear how often consumers actually choose to disable power-dry and that DOE is reducing the annual energy consumption of 15 units by an average of 6 percent without proof of the expected consumer behavior. The CA IOUs cited to a 2007 Proctor & Gamble study that indicated 66 percent of households use the power-dry feature regularly. The CA IOUs suggested that DOE collect data to update this conclusion based on consumer use of power-dry, its relation to the ability to disable the feature, and its presence in default operation or recommendation for everyday use. (*Id.* at p. 7)

DOE updates its analyses with the most current, nationally representative data. As pointed out by the CA IOU, the 2007 Proctor & Gamble study did not specify if the dishwashers of the

participants had the option to turn off heated dry, or if the heated dry option was by default on or off, and it was unclear how the consumer samples were selected. DOE is unaware of any nationally representative consumer data showing consumer selection of drying options. Conducting a survey as suggested is not viable within the context of this rulemaking, but DOE may consider doing so for a future rulemaking. The calculation of EAEU at 10 CFR 430.23 assumes dishwashers with the power dry feature use it 50 percent of the time. In the absence of any other nationally representative data set, DOE is using the same assumption in this direct final rule analysis. DOE did not include drying option selections in this direct final rule analysis, but may consider other assumptions regarding use of drying features in future dishwasher test procedure rulemakings.

AWE commented that DOE should more thoroughly consider and evaluate the energy embedded in the water that will be saved from the proposed standard, in addition to end-user energy use. (AWE, No. 44 at p. 4) AWE has developed a water conservation tracking tool for evaluating the water savings, costs, and benefits of urban water conservation programs and for projecting future water demands. (*Id.*) AWE further stated that DOE could also adjust this based on the assumptions it is currently using for private wells and DOE can calculate the emissions-related benefits in the same way it has calculated them for direct energy savings. (*Id.* at p. 5)

DOE has previously determined that EPCA does not direct DOE to consider the energy used for utility water treatment and delivery. In a May 2012 Final Rule on Residential Clothes Washers, DOE noted that EPCA directs DOE to consider “the total projected amount of energy, or as applicable, water, savings likely to result directly from the imposition of the standard.”⁷⁷ FR 32308, 32346 (quoting 42 U.S.C. 6295(o)(2)(B)(i)(III)). In the May 2012 Final Rule on Residential Clothes Washers, DOE interpreted “directly from the imposition of the standard” to include energy used in the generation, transmission, and distribution of fuels used by appliances. Unlike the energy used for water treatment and delivery, primary energy savings and the full-fuel-cycle measure are in a distribution chain that is directly linked to the energy used by appliances. (*Id.*)

Chapter 7 of the direct final rule TSD provides details on DOE's energy and water use analysis for dishwashers.

⁵⁰ The “CA IOUs” includes Pacific Gas and Electric Company, SDG&E, and SCE; collectively, the California Investor-Owned Utilities.

⁵¹ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0050.

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 dishwashers. Because the technologies to improve energy efficiency may also reduce water usage (as discussed in IV.C.1.b), the economic impacts in the LCC and PBP include both energy consumption and water consumption. 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 total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy and water 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 dishwashers 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 and water consumption for the dishwashers and the appropriate energy and water prices. By developing a representative sample of households, the analysis captured the variability in energy and water consumption and energy and water prices associated with the use of dishwashers.

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 and water consumption, energy and water 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 dishwasher user samples. For this rulemaking, the Monte Carlo approach is implemented in MS Excel together with the Crystal Ball™ add-on.⁵² The

⁵² 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/middleware/technologies/crystalball.html (last accessed Oct. 19, 2023).

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 dishwashers as if each were to purchase a new product in the first year of required compliance with amended standards. Amended standards apply to dishwashers manufactured 3 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(m)(4)(B)) Therefore, DOE used 2027 as the first year of compliance with any amended standards for dishwashers.

Table IV.12 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 direct final rule TSD and its appendices.

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of models by generating probability distributions and summarizing results within Excel. Available at www.oracle.com/middleware/technologies/crystalball.html (last accessed Oct. 19, 2023).

Table IV.12 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	Baseline installation cost based on manufacturers' inputs. Assumed no change in installation costs with efficiency level.
Annual Energy and Water Use	Per cycle energy and water use multiplied by the number of cycles per year. Variability: Based on the <i>RECS 2020</i> .
Energy and Water Prices	Electricity: Based on Edison Electric Institute data for 2022. Natural Gas: Based on EIA's Natural Gas Navigator for 2022. LPG and Fuel Oil: Based on EIA's State Energy Consumption, Price, and Expenditures Estimates data for 2022. Variability: Regional energy prices determined by Census Division. Water: Based on 2022 AWWA/Raftelis Survey, AHS 2021,** CDC 2023,† NGWA 2020.‡ Variability: Regional water prices determined by Census Region.
Energy and Water Price Trends	Based on <i>AEO 2023</i> price projections. Water: Forecasted using BLS historic water price index information.
Repair and Maintenance Costs	Repair costs vary by product class and by efficiency level based on manufacturers' inputs.
Product Lifetime	Average: 15.2 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	2027

* 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 direct final rule TSD.

** American Housing Survey, www.census.gov/programs-surveys/ahs.html

† Center for Disease Control, www.cdc.gov/healthywater/drinking/private/wells/maintenance.html#print

‡ National Ground Water Association, www.ngwa.org/docs/default-source/default-document-library/groundwater/usa-groundwater-use-fact-sheet.pdf?sfvrsn=5c7a0db8_4

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For this direct final rule, DOE considered comments it had received regarding the LCC analysis conducted for the May 2023 NOPR. The LCC approach used for this direct final rule is largely the same as the approach DOE had used for the May 2023 NOPR analysis.

In response to the May 2023 NOPR, AHAM commented that DOE should focus on conducting a purchase decision analysis instead of relying on outcomes and long-term cost analyses. (AHAM, No. 51 at p. 18) AHAM commented that the logical basis for regulation lies in identifying consumer and systemic market failures, where consumer failure refers to making "incorrect" decisions due to a lack of information. (*Id.*) AHAM stated that systemic market failure relates to mispricing of inputs (such as underpricing of the environmental impacts in energy prices) or other similar conditions. AHAM commented that while there are many critiques of how accurate a rational choice model is for true consumer behavior, including the recent insights of behavioral

economics, all of these discussions start from the premise of a purchase decision choice model. AHAM commented on the importance of considering the actual conditions and expectations of purchasers in DOE's LCC model, separate from the broader economic impact analysis, which should be in the National Impact Analysis. (*Id.*) AHAM suggested that the LCC model should assess the extent of market failure by comparing the actual rate of energy-efficient product purchases with the rate that rational consumers would choose. (*Id.*)

The LCC analysis currently relies on market data on the distribution of efficiency of products to assign products with varying efficiency performance to each household when compliance with the standard becomes required. This approach is intended to simulate the range of individual outcomes resulting from the hypothetical setting of a revised energy conservation standard at various levels of efficiency when the data needed to develop a product-specific consumer choice model are currently unavailable. This is a

methodological decision made by DOE after considering the existence of various systematic market failures (*e.g.*, information asymmetries, bounded rationality, etc.) and their implication in rational versus actual purchase behavior. Considering that individual consumer decisions may be driven by multiple factors and may vary based on demographic features as well as available information to consumers at the time of purchase, the data required to develop a product specific complex consumer choice model were unavailable in the case of dishwashers. In the LCC analysis, DOE aims to simulate the range of individual outcomes resulting from a hypothetical setting of revised energy efficiency standards. Both the distribution and the national average values were considered. Moreover, the outcome of the LCC is not considered in isolation, but in the context of the broader set of analyses, including the NIA. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

AHAM stated that there have been changes in DOE's analysis for standard-size dishwashers between the January 2022 Preliminary Analysis and the May 2023 NOPR including the percentage of consumers experiencing a net cost decreased from 43 percent to 3 percent and the payback period decreased from 7 to 2.4 years and it is unclear how DOE arrived at the new conclusions that have a significant impact on overall energy savings estimates and economic analysis. (AHAM, No. 51 at p. 26) Whirlpool Corporation ("Whirlpool") questioned⁵³ why there is such a big departure in consumer cost-effectiveness for EL 2 between the January 2022 Preliminary Analysis and the May 2023 NOPR. (Whirlpool, No. 45 at pp. 3–4) Whirlpool commented that compared to the 43 percent of consumers who were estimated to experience a net cost from EL 2 in the January 2022 Preliminary Analysis, only 3 percent of consumers are now estimated to experience a net cost from this level in the May 2023 NOPR. (*Id.*) Whirlpool further commented that given this very large apparent change in the data and the impact that this has on DOE's overall selection of TSLs, DOE should provide stakeholders with supporting information/data that led to this drastic change in the analysis. (*Id.*)

DOE updates its analytical inputs with the most recent available data sources, in response to stakeholder comment, and based on information obtained through testing, teardowns, manufacturer interviews, and any additional research and analysis. Input updates include MPCs, energy and water prices and price trends, dollar year, price learning trends, product efficiency distributions, discount rate, sales tax, and shipments. For this final rule, the LCC inputs are summarized in Table IV.12. Because of those input changes, the LCC results were changed in the May 2023 NOPR analysis, and again in the direct final rule analysis compared to those from the January 2022 Preliminary Analysis. In this case, the primary driver of the decrease in percent of consumers with a net cost is based on a change in MPC between the January 2022 Preliminary Analysis and the May 2023 NOPR, driven by DOE's updated engineering analysis. Specifically, based on manufacturer feedback, DOE revisited its teardown analysis and observed that the same technology options exist at both EL 1 and EL 2, with EL 2 units having improved control started and design tolerances. For these reasons, the MPC

at EL 2 is the same as that at EL 1, which decreases the percent of consumers with a net cost at EL 2. DOE notes that AHAM (of which Whirlpool is a member) supported the Recommended TSL, which includes the same EL as the standards proposed in the May 2023 NOPR for standard-size dishwashers.

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 dishwashers, DOE obtained historical Producer Price Index ("PPI") data for appliances from the Bureau of Labor Statistics ("BLS"). A PPI for "all-other-miscellaneous-household-appliances" was available for the time period between 1988 and 2014.⁵⁴ However, the all-other-miscellaneous-household-appliances PPI was discontinued beyond 2014 due to insufficient sample size. To extend the price index beyond 2014, DOE assumed that the price index of primary products of major household appliance manufacturing would trend similarly to all other miscellaneous household appliances. This is because, based on communications with BLS researchers, discontinued series are often grouped into the primary products under the more aggregated PPI series. Examining the PPI of all other miscellaneous household appliances and primary products of major household appliances shows that the magnitudes of both price trends align with each other. Inflation-adjusted price indices were calculated by dividing the PPI series by the gross domestic product index from Bureau of Economic Analysis for the same years. Using data from 1988–2021, the estimated learning rate (defined as the fractional reduction in price expected

from each doubling of cumulative production) is 24.2 percent, which results in an average annual price decline of 0.96 percent. See chapter 8 of the direct final rule TSD for further details on this topic.

For this direct final rule, DOE considered comments it had received regarding the methodology for calculating consumer product costs that was presented in the May 2023 NOPR. The approach used for this direct final rule is largely the same as the approach DOE had used for the May 2023 NOPR analysis.

In response to the May 2023 NOPR, Northwest Energy Efficiency Alliance ("NEEA") encouraged⁵⁵ DOE to consider a specific learning curve for variable-speed drives when conducting future dishwasher standards analyses similar to its approach in the recent refrigerator standards rulemaking. (NEEA, No. 53 at p. 2)

DOE did not consider a specific price learning curve for variable-speed drives due to the lack of data regarding the data regarding the relevant market share of products. DOE will consider all available technology options and their related learning curves when conducting future dishwasher standards analyses for standards rulemakings.

AHAM commented that DOE's application of a "learning or experience curve" to reduce expected extra manufacturing costs required to meet proposed standard levels lacks a solid theoretical foundation for why an experience or learning curve should exist, what functional form it should take and whether it should be a continuous function. (AHAM, No. 51 at p. 19) AHAM commented that the approach, based solely on empirical relationships, demands clear alignment with the actual products in question and the data used to develop the relationship. AHAM stated that when the data takes a new shape, DOE must adjust its equations to reflect that change as continuing to use old data and equations simply to create a longer time series is not acceptable. (*Id.*) AHAM commented that DOE's justification that continued use of learning rates is justified by past price declines is DOE confusing past correlation with future causation and the very severe limitations of forward projection without a sound theoretical basis for assuming that the correlation will continue. (*Id.*) AHAM further stated that there is no particularly strong reason to expect that any future trends will be modeled with a continuous

⁵³ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0045.

⁵⁴ 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/.

⁵⁵ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0053.

function of the form DOE is proposing and that there is an apparent “flattening” of the data in DOE’s learning curve equation. Additionally, AHAM stated that all recent data is above the line drawn by the equation should give DOE significant pause to consider whether it is modeling a relationship that no longer holds, no matter what the regressions statistics from past data show. (*Id.* at pp. 19–20) AHAM commented that such “learning” should not be projected beyond labor and materials costs, given it does not logically apply to overheads, sales, marketing, general and administrative costs, or depreciation and financing costs. (*Id.* at p. 20)

DOE notes that there is considerable empirical evidence of consistent price declines for appliances in the past few decades. Several studies examined retail prices of various household appliances, including dishwashers, during different periods of time and showed that prices had been steadily falling while efficiency had been increasing, for example Dale, *et al.* (2009) and Taylor, *et al.* (2015). Given the limited data availability on historical manufacturing costs broken out by different components, DOE utilized the PPI published by the BLS as a proxy for manufacturing costs to represent the analyzed product as a whole. While products may experience varying degrees of price learning during different product stages, DOE modeled the average learning rate based on the full historical PPI series to capture the overall price evolution in relation to the cumulative shipments. When fitting the historical PPI and cumulative annual shipments to the experience curve, which takes the form of a power function, the resulting R-square value is 91 percent. Despite that the observed data could deviate above or below the fitted curve during certain periods, the high value of R-square indicates a reasonable fit overall, although DOE recognizes the difficulty when projecting regression results out of sample. In addition, DOE also conducted sensitivity analyses that are based on a particular segment of the PPI data for “all other miscellaneous household appliances and primary products of major household appliances” to investigate the impact of alternative product price projections (low price learning and constant price) in the NIA of this rulemaking. In all scenarios that DOE considered, the impact of the price projection on the Net Present Value estimates is limited to negative three percent to one percent for the adopted TSL. Overall, the impact

would not affect the policy decision. For details of the sensitivity results, *see* appendix 10C of the direct final rule TSD. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the product. Based on inputs provided by manufacturers, DOE concluded that installation costs would not be impacted by increased efficiency levels. DOE received no stakeholder comments on this issue.

3. Annual Energy and Water Consumption

For each sampled household, DOE determined the energy and water consumption for dishwashers at different efficiency levels using the approach described previously in section IV.E of this document. Both energy and water consumption are considered in the LCC analysis because the technologies to improve energy efficiency may also reduce water usage (as discussed in section IV.C.1.b of this document).

4. Energy and Water Prices

a. 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 EEI Typical Bills and Average Rates reports. 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).⁵⁶

⁵⁶ 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. Available at ees.lbl.gov/publications/residential-electricity-prices-review.

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 *AEO2023*, which has an end year of 2050.⁵⁷ To estimate price trends after 2050, the 2046–2050 average was used for all years.

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.

DOE obtained data for calculating regional prices of natural gas from the EIA publication, *Natural Gas Navigator*.⁵⁸ This publication presents monthly volumes of natural gas deliveries and average prices by State for residential, commercial, and industrial customers. DOE used the complete annual data for 2022 to calculate an average annual price for each Census Division. Residential natural gas prices were adjusted by applying seasonal marginal price factors to reflect a change in a consumer’s bill associated with a change in energy consumed.

DOE assigned average prices to each household in the LCC sample based on its location and its baseline electricity and gas consumption. For sampled households who were assigned a product efficiency greater than or equal to the considered level for a standard in the no-new-standards case, DOE assigned marginal prices to each household based on its location and the decremented electricity and gas consumption. In the LCC sample, households could be assigned to one of nine Census Divisions. *See* chapter 8 of the direct final rule TSD for details.

To estimate energy prices in future years, DOE multiplied the 2022 energy prices by the projection of annual average price changes for each of the nine Census Divisions from the Reference case in *AEO2023*, which has an end year of 2050.⁵⁹ To estimate price trends after 2050, the 2046–2050 average was used for all years.

b. Water and Wastewater Prices

DOE obtained residential water and wastewater price data from the Water

⁵⁷ EIA. *Annual Energy Outlook 2023*. Available at www.eia.gov/outlooks/aeo/ (last accessed Oct. 19, 2023).

⁵⁸ U.S. Department of Energy—Energy Information Administration. *Natural Gas Navigator 2022*. Available at www.eia.gov/naturalgas/data.php.

⁵⁹ EIA. *Annual Energy Outlook 2023*. Available at www.eia.gov/outlooks/aeo/ (last accessed June 20, 2023).

and Wastewater Rate Survey conducted by Raftelis Financial Consultants and the American Water Works Association.⁶⁰ The survey covers approximately 445 water utilities and 334 wastewater utilities analyzing each industry (water and wastewater) separately. For each water or wastewater utility, DOE calculated the average-price-per-unit volume by dividing the total volumetric cost by the volume delivered. DOE also calculated the marginal price by dividing the incremental cost by the increased volume charged at each consumption level.

The samples that DOE obtained of the water and wastewater utilities is too small to calculate regional public sector prices for all U.S. Census Divisions. Therefore, DOE calculated regional costs for water and wastewater service at the Census Region level (Northeast, South, Midwest, and West) by weighting each State in a region by its population.

For this direct final rule analysis, DOE has updated its methodology for developing water prices for consumers who rely on a private well-water system, instead of the public supply system in consideration of stakeholder comments. DOE primarily considered well maintenance costs and pump operating costs when developing the average water price. Conversely, DOE only considered pump operating costs when developing the marginal price for well users. As a result, the estimated average and marginal water prices for well users are \$1.24 and \$0.39 per thousand gallons, respectively. For septic tank users, DOE considered only the septic tank maintenance cost when determining the average price and excluded the marginal cost component, as any marginal costs are likely to be negligible. DOE is unable to develop Census-region-level well-water and septic tank prices due to the limitation of available data; consequently, the same values were used for each Census Region.

To determine the current percentage of the U.S. population served by private wells and septic tanks, DOE used historical American Housing Survey (“AHS”) data from 1970 to 2021 to develop a projection for 2027, the effective year of potential new standards for dishwashers.⁶¹

DOE then conducted random simulations to determine the percentage

of households in rural areas served by private wells and septic tanks. Based on the estimated percentages, well-water prices and septic tank prices were assigned to sampled households accordingly. Furthermore, DOE estimated the septic tank user population and assigned corresponding septic tank prices to households relying on public water systems.

To estimate the future trend for public water and wastewater prices, DOE used data on the historic trend in the national water price index (U.S. city average) from 1988 through 2022 provided by the Labor Department’s BLS.⁶² DOE extrapolated the future trends based on the linear growth from 1988 to 2022. DOE used the extrapolated trend to forecast prices through 2050. To estimate the price trend after 2050, DOE used a constant value derived from the average values from 2046 through 2050.

To estimate the future trend for the average well-water and septic tank prices, DOE used data on the historic trend in the overall national consumer price index from 1988 through 2022 provided by the Labor Department’s BLS.⁶³ DOE extrapolated the future trends based on the linear growth from 1988 to 2022. DOE used the extrapolated trend to forecast prices through 2050. To estimate the price trend after 2050, DOE used a constant value derived from the average values from 2046 through 2050. In addition, to estimate the future trend for the marginal well-water price, the electricity trend was used, as described previously in section IV.F.4.a of this document.

In response to the May 2023 NOPR, AHAM commented that it previously suggested DOE should consider the actual water costs for households on well systems. (AHAM, No. 51 at p. 12)

AHAM commented that DOE’s May 2023 NOPR approach to septic system costs is incorrect and stated that DOE should acknowledge that there are no incremental costs for consumers using septic systems and treat these both well water users and septic tank users as a separate subgroup instead of averaging them into composite water and sewer costs. (AHAM, No. 51 at pp. 12–14)

As described in section IV.I.3 of this document, for this direct final rule, DOE

updated its method for estimating well-water and septic costs. The updated average well-water and septic tank prices are 17.1 percent of the combined cost of public water and sewer costs. In addition, DOE assigned either septic tank or public sewer prices to well-water households based on the probability distributions obtained from the AHS 2021 data.

AHAM commented that the economic value of water is undefined and an inappropriate measure in the life cycle cost analysis. AHAM stated that if DOE is relying, even implicitly, on the AWWA/RFC study for its definition of economic value, as matter of administrative law, it must make the underlying reference available for public comment before it can use it as a source. According to AHAM, private well users pay the actual marginal cost of water, primarily the electricity for pumping, not an “economic value.” While there are embedded costs for drilling a well, these costs are sunk and the marginal cost is only the electricity. (AHAM, No. 51, at p. 13) AHAM suggested that if DOE insists on the “economic value,” DOE should define it, demonstrate how well-water use reduces water availability, and quantify the actual “economic value” of lost well water. (*Id.*) AHAM further stated that even if there is an “economic value” of well water, it should be considered in the NIA, not the LCC. (*Id.* at 16.)

DOE concurs that “economic value of water” is not the actual price that well users would pay. Hence, for this direct final rule, DOE has adjusted its methodology regarding water price for well users and septic tank price. To derive well-water price, DOE conducted a literature review and took into consideration the inputs provided by AHAM. As a result, DOE estimated the average water price for well users to be \$1.24 per thousand gallons, with a marginal price of \$0.39 per thousand gallons representing the electricity cost for pumping. Regarding septic tank price, DOE estimated the average cost to be \$1.30 per thousand gallons and excluded the marginal cost component, as it may be negligible or close to \$0 per thousand gallons. For references and details of the well-water and septic tank prices, see chapter 8 of the direct final rule TSD. In addition, in the LCC, DOE has explicitly assigned water and wastewater sources, along with corresponding specific prices, to RECS households randomly using different probability distributions for urban and rural households by Census Region based on AHS 2021 data. Similarly, both the public and private water and wastewater costs were accounted for in

⁶⁰ Raftelis Financial Consultants, Inc. 2020 RFC/ AWWA Water and Wastewater Rate Survey. 2021. Charlotte, NC, Kansas City, MO, and Pasadena, CA.

⁶¹ The U.S. Census Bureau. The American Housing Survey. Years 1970–2021. Available at www.census.gov/programs-surveys/ahs.html (last accessed June 12, 2023).

⁶² U.S. Department of Labor–Bureau of Labor Statistics, Consumer Price Indexes, Item: Water and sewerage maintenance, Series Id: CUSR0000SEHG01, U.S. city average, 2022. Washington, DC. Available at www.bls.gov/cpi/home.htm#data.

⁶³ U.S. Department of Labor–Bureau of Labor Statistics, Consumer Price Indexes, All Items, Series Id: CUUR0000SA0, U.S. city average, 2022. Washington, DC. Available at www.bls.gov/cpi/home.htm#data.

the NIA. The term “economic value” of water refers to the National Groundwater Association’s use of the term.⁶⁴ The AWWA/Raftelis data used to develop the public water and wastewater costs are available from an online subscription.⁶⁵

AWE commented that DOE should extrapolate from the annualized rate increases for 1998 to 2020 from the AWWA/Raftelis Water and Wastewater Rate Survey. (AWE, No. 44 at p. 1) AWE stated that instead of using AWWA/Raftelis for historic and current pricing and a CPI-based approach for future price trends, AWE supports the use of data from the AWWA/Raftelis Survey as the basis for DOE’s calculation for both the historic and current water and wastewater prices and for price trends. (*Id.* at p. 2) AWE commented that it is confident that the price trend data in the AWWA/Raftelis Survey are more accurate and representative because it is based on a review of the actual rates from a large sample set of utilities from nearly all U.S. states on a biennial basis and that it is better to use rate data when performing calculations based on specific volumes of water saved rather than data on average customer bills, which is what the water and sewerage maintenance item from CPI is based on. (*Id.*)

AWWA/Raftelis conducts water and wastewater rates survey, which used to be every two years and now every six months, for U.S. water and wastewater utilities. For each of the AWWA/Raftelis surveys, utilities in the sample respond voluntarily to the survey questions, with a limited number of overlapping utilities in each survey year. For this reason, it is possible that the annual change in rates may be affected by which utilities respond to the survey, which is also known as sample bias. In addition, the rate data are reported in usage tiers set by each utility and not on actual household water consumption.

The BLS Water and Sewer CPI sample represents 600 to 700 quotes for water or sewer service, and the sample is consistent for four years, which reduces the possible year over year bias as compared to AWWA/Raftelis. Additionally, the Water and Sewer CPI was estimated based on consumer water bills that reflect household water

consumption. Therefore, DOE concludes that the BLS’ CPI water and sewer data better reflect the nationally representative price trends than the AWWA/Raftelis data. DOE therefore used the CPI for water and sewer for its public utilities’ water and wastewater price trend forecast for this final rule.

DOE used a similar methodology to develop future water and wastewater prices in its clothes washer standard rulemaking as it used in the March 2024 final rule analysis. DOE used a constant value derived from the average values from 2046 through 2050 to estimate the price trend after 2050, whereas in the May 2023 NOPR, published May 19, 2023 (88 FR 32514), DOE used the 2050 value for the price trend after 2050.⁶⁶

AHAM stated DOE should recognize that not all households directly pay for water and sewer. (AHAM, No. 51 at p. 16) As such, AHAM asserted that DOE is overestimating the actual annual operating cost savings that these consumers would receive from reduced water use in dishwashers. (*Id.*) AHAM commented that in many circumstances the costs for water and sewer are either borne by landlords or are combined into generalized common charges. (*Id.*)

AHAM identified two subgroups of consumers who might not see monetary savings from a reduction in water use as a result of an amended standard: (1) condominium owners in multi-family buildings where water and sewer costs are included in common charges and (2) low-income renters in multi-family housing where water is not sub-metered and/or costs are covered by landlords. (AHAM, No. 51 at p. 16) As it applies to multi-family housing, AHAM stated that installing sub-metering equipment may cost thousands of dollars per unit including plumbing charges and many landlords do not find it attractive or practical to sub-meter. (*Id.*) Additionally, for condominium properties, the owner owns the dishwasher, leading to a reverse split-incentive such that the household will not see the benefit directly and will have a negative LCC savings. Further, raising the price of a dishwasher will also encourage the household to continue repairing the dishwasher rather than purchasing a more expensive new one, reducing or eliminating the project national savings. As such, AHAM recommend that DOE recognize this sub-group and address the relevant financial situation. (*Id.* at pp. 16–17)

⁶⁶ Additional details regarding the dishwasher analysis are provided in the May 2023 NOPR TSD, available at www.regulations.gov/document/EERE-2019-BT-STD-0039-0032.

DOE notes that while RECS does identify multi-family housing, it does not provide information on whether a household’s water bill is included in the rent, included in the common charges, or paid directly to the utility. For the first group of multi-family unit owners (such as apartments, condominiums, and co-ops) identified in RECS and reporting that energy bills are not paid directly to the utilities, DOE posits that those households also do not directly pay their water bills, considering that some multi-family units may have a shared water meters, which is more common than shared electricity or gas meters. It is, therefore, likely that households that do not directly pay their energy bills to the utilities, also do not directly pay for their water bill. This group represents less than 1.2 percent of the national sample, indicating a relatively small group. For the second group of low-income renters in multi-family buildings, DOE adopted a conservative approach assuming that those households that reported as not paying their energy bill would also not pay their water bill and, therefore, do not accrue any operating cost savings from the considered standards. This issue is accounted for in the low-income subgroup analysis. Based on DOE’s assessment, the low-income subgroup has comparable LCC savings and fraction of consumers experiencing a net cost as the national sample. See section IV.I.1 and section V.B.1.b of this document for the detailed methodology and the results of the low-income subgroup analysis.

With regards to the split-incentive issue, the existence of a split incentive across a substantial number of U.S. households, in which a tenant pays for the cost of electricity while the landlord furnishes appliances, has been identified through a number of studies of residential appliance use broadly, and for dishwashers in low-income settings in specific. Building from early work including Jaffe and Stavins (1994),⁶⁷ Murtishaw and Sathaye (2006)⁶⁸ discussed the presence of landlord–tenant split-incentives (*i.e.*, the “principal-agent problem”) in the context of refrigeration, water heating, space heating, and lighting in rental housing. While the study did not solely focus on the low-income household,

⁶⁷ A.B. Jaffe and R.N. Stavins (1994) The energy-efficiency gap What does it mean? Energy Policy, 22 (10) 804–810, Available at [doi.org/10.1016/0301-4215\(94\)90138-4](https://doi.org/10.1016/0301-4215(94)90138-4).

⁶⁸ Murtishaw, S., & Sathaye, J. (2006). Quantifying the Effect of the Principal-Agent Problem on US Residential Energy Use. Lawrence Berkeley National Laboratory. Available at escholarship.org/uc/item/6f14t11t.

⁶⁴ Groundwater Use in the United States of America. National Ground Water Association, www.ngwa.org/docs/default-source/default-document-library/groundwater/usa-groundwater-use-fact-sheet.pdf?sfvrsn=5c7a0db8_4.

⁶⁵ The American Water Works Association & Raftelis Financial Consultants, Inc., 2022 RFC/ AWWA Water and Wastewater Rate Survey. 2023. Charlotte, NC. The latest report is available at <https://engage.awwa.org/PersonifyEBusiness/Bookstore/Product-Details/productId/194150460>.

they estimated that 35 percent of total residential site energy use is subject to split-incentives based on these four products alone. In the specific context of dishwashers, based on RECS 2020, 88 percent of low-income individuals who rented their homes and owned a dishwasher were found to pay the electricity bill resulting from their energy use, such that they were likely subject to a scenario in which their landlord purchased the appliance, but they paid the operating costs. Spurlock and Fujita (2022),⁶⁹ Houde and Spurlock (2016),⁷⁰ and citations therein (e.g., Davis 2012)⁷¹ also further elaborated on split-incentives in rental housing and their association with generally lower efficiency among the appliances used by renters. As a result, DOE's analysis concludes that there is a substantial fraction of split-incentive issue among low-income households. Therefore, DOE divide the low-income subgroup into renters and non-renters categories, for which different assumptions were applied. For low-income households who are homeowners and do pay for the product and energy costs, DOE considers that those households will experience an impact from any proposed standard and DOE then uses the same methodology applied to the national LCC analysis. For low-income households who are renters and do not pay for energy bills, DOE considers the amended standards will have no impact on those households. In the split-incentive case in which the low-income households who are renters and pay for energy bills, the landlord would bear the cost of the appliance, and the household would pay the operating costs and therefore accrue the operating cost savings from the considered standards. Although paid by different individuals, the difference between the incremental equipment cost and the life cycle operating cost savings would still be characterized as the LCC savings associated with the dishwasher in question in the national LCC analysis. Therefore, the split-incentives cases would not affect the methodology of the

national LCC savings estimates. More details can be found in section IV.I.1 of this document as well as in chapter 11 of the direct final rule TSD.

As in the case when some consumers may delay or forgo their purchase due to the increased first cost caused by the standards, DOE assumed that those consumers would hand wash their dishes and accounted for the possible increase in energy and water use as an additional cost to the standards case in the National Impact Analysis. DOE considered this as a conservative approach since there are alternatives to handwashing dishes such as extended repair, or purchasing a second-hand unit.

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. However, products having significantly higher efficiencies compared to baseline products are more likely to incur higher repair and maintenance costs, because their increased complexity and higher part count typically increases the cumulative probability of failure.

In this direct final rule analysis, DOE derived repair costs for dishwashers for each efficiency level based on manufacturers' inputs on the repair frequency and costs. DOE did not include routine maintenance costs as no evidence or data shows that the routine maintenance costs or frequency would vary with increased efficiency. See chapter 8 of the direct final rule TSD for further details.

6. Product Lifetime

For dishwashers, 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 dishwashers of approximately 15.2 years. DOE has found no evidence or information

related to variation in dishwasher lifetime by product class or efficiency level. See chapter 8 of the direct 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 dishwashers 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.⁷² 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 Finances⁷³ ("SCF") starting in 1995 and ending in 2019 and multiple sources for asset interest rates from 1993–2022. Using the SCF and other sources, DOE

⁷²The 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; 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.

⁷³U.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 Oct. 19, 2023).

⁶⁹C.A. Spurlock and K.S. Fujita (2022) Equity implications of market structure and appliance energy efficiency regulation, *Energy Policy*, 165 (112943). Available at doi.org/10.1016/j.enpol.2022.112943.

⁷⁰S. Houde, C.A. Spurlock (2016) Minimum Energy Efficiency Standards for Appliances: Old and New Economic Rationales. *Economics of Energy & Environmental Policy*, 5(2), 65–84. Available at www.jstor.org/stable/26189506.

⁷¹L.W. Davis (2012) Evaluating the slow adoption of energy efficient investments: are renters less likely to have energy efficient appliances? *The Design and Implementation of US Climate Policy*. University of Chicago Press (2012), pp. 301–316.

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 4.2 percent. See chapter 8 of the direct 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 dishwashers for 2027, DOE used data from the engineering analysis, the manufacturer interviews, and DOE's Compliance Certification Database. DOE assumed no annual efficiency improvement for the no-new-standards case based on the current market evaluation and the observation that there was no shift in efficiency distributions compared to those used in the December 2016 Final Determination.

DOE received no comments from stakeholders related to this assumption. The estimated market shares for the no-new-standards case for dishwashers are shown in Table IV.13. See chapter 8 of the direct final rule TSD for further information on the derivation of the efficiency distributions.

In response to the May 2023 NOPR, Appliance Standards Awareness Project *et al.*⁷⁴ ("ASAP *et al.*") commented⁷⁵ that DOE's assignment of efficiency levels in the no-new-standards case reasonably reflects actual consumer behavior. (ASAP *et al.*, No. 46 at p. 3) For the final rule, DOE maintained the approach used in the May 2023 NOPR to derive efficiency distributions in the no-new-standards case.

Table IV.13 No-New-Standards Case Efficiency Distribution for Dishwashers in 2027

TSL	Product Class 1 Standard-Size Dishwashers:			Product Class 2 Compact-Size Dishwashers:		
	Annual Energy Use* (kWh/year)	Water Use (gal/cycle)	Market Share (%)	Annual Energy Use* (kWh/year)	Water Use (gal/cycle)	Market Share (%)
Baseline	263	5.0	7	191	3.5	2
1	232	3.5	84	174	3.1	84
2	223	3.3	6	124	1.6	14
3	206	3.2	3			
4	193	2.4	0			

* Based on appendix C2

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

In response to the May 2023 NOPR, ASAP *et al.* stated that they agree with DOE's determination that assigning dishwasher efficiencies for the LCC analysis, which is in part random, is more representative of actual consumer behavior than assigning efficiencies based solely on cost-effectiveness. (ASAP *et al.*, No. 46 at p. 3)

ASAP *et al.* commented that consumer purchasing decisions for an infrequent purchase such as a dishwasher can be based on a variety of complex issues such as the timing of the purchase, competing demands for funds, and the information available to

the consumer. (ASAP *et al.*, No. 46 at p. 3)

ASAP *et al.* additionally noted the split-incentive or principal-agent problem in which there are misaligned incentives in rental properties because the landlord purchases and installs the dishwasher while the renter is responsible for paying the utility bill. (*Id.*)

While DOE acknowledges that economic factors play a role when consumers decide on what type of dishwasher to install, assignment of dishwasher efficiency for a given installation, based solely on economic measures such as life-cycle cost or simple payback period, most likely would not accurately reflect actual real-world installations. There are a number of market failures discussed in the economics literature that illustrate how purchasing decisions with respect to energy efficiency are unlikely to be perfectly correlated with energy use, as

described below. DOE finds that the method of assignment, which is in part random, simulates behavior in the dishwasher market, where market failures result in purchasing decisions not being perfectly aligned with economic interests. DOE further emphasizes that its approach does not assume that all purchasers of dishwasher products make economically irrational decisions (*i.e.*, the lack of a correlation is not the same as a negative correlation). By using this approach, DOE acknowledges the uncertainty inherent in the data and does not assume certain market conditions that are unsupported given the available evidence.

The following discussion provides more detail about the various market failures that affect dishwasher purchases. First, consumers are motivated by more than simple financial trade-offs. There are consumers who are willing to pay a premium for more

⁷⁴ The ASAP *et al.* includes Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of

America, Elevate, National Consumer Law Center, Natural Resources Defense Council, and Southwest Energy Efficiency Project.

⁷⁵ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0046.

energy-efficient products because they are environmentally conscious.⁷⁶ There are also several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as dishwashers. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the surrounding circumstances of the purchase, the alternatives available, and how they are presented for any given choice scenario.⁷⁷ The same consumer or decision maker may make different choices depending on the characteristics of the decision context (e.g., the timing of the purchase, competing demands for funds), which have nothing to do with the characteristics of the alternatives themselves or their prices. Consumers or decision makers also face a variety of other behavioral phenomena including loss aversion, sensitivity to information salience, and other forms of bounded rationality.⁷⁸ Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.⁷⁹ These characteristics describe almost all purchasing situations of appliances and equipment, including dishwashers. The installation of a new or replacement dishwashers is done very infrequently, as evidenced by the mean lifetime of 15.2 years. Further, if the purchaser of the dishwasher is not the entity paying the energy costs (e.g., a building owner and tenant), there may be little to no feedback on the purchase. Additionally, there are systematic market failures that are likely to contribute further complexity to how products are chosen by consumers, as

explained in the following paragraphs. The first of these market failures—the split-incentive or principal-agent problem—is likely to significantly affect dishwashers. The principal-agent problem is a market failure that results when the consumer that purchases the equipment does not internalize all of the costs associated with operating the equipment. Instead, the user of the product, who has no control over the purchase decision, pays the operating costs. There is a high likelihood of split-incentive problems in the case of rental properties where the landlord makes the choice of what dishwasher to install, whereas the renter is responsible for paying energy bills.

In addition to the split-incentive problem, there are other market failures that are likely to affect the choice of dishwasher efficiency made by consumers. For example, unplanned replacements due to unexpected failure of equipment such as dishwashers are strongly biased toward like-for-like replacement (i.e., replacing the non-functioning equipment with a similar or identical product). Time is a constraining factor during unplanned replacements, and consumers may not consider the full range of available options on the market, despite their availability. The consideration of alternative product options is far more likely for planned replacements and installations in new construction.

Additionally, Davis and Metcalf⁸⁰ conducted an experiment demonstrating that, even when consumers are presented with energy consumption information, the nature of the information available to consumers (e.g., from EnergyGuide labels) results in an inefficient allocation of energy efficiency across households with different usage levels. Their findings indicate that households are likely to make decisions regarding the efficiency of the air conditioning equipment of their homes that do not result in the highest net present value for their specific usage pattern (i.e., their decision is based on imperfect information and, therefore, is not necessarily optimal). Also, most consumers did not properly understand the labels (specifically whether energy consumption and cost estimates were national averages or specific to their

State). As such, consumers did not make the most informed decisions.

In part because of the way information is presented, and in part because of the way consumers process information, there is also a market failure consisting of a systematic bias in the perception of equipment energy usage, which can affect consumer choices. Attari *et al.*⁸¹ show that consumers tend to underestimate the energy use of large energy-intensive appliances (such as air conditioners, dishwashers, and clothes dryers), but overestimate the energy use of small appliances (such as light bulbs). Therefore, it is possible that consumers systematically underestimate the energy use associated with dishwashers, resulting in less cost-effective purchases.

These market failures affect a sizeable share of the consumer population. A study by Houde⁸² indicates that there is a significant subset of consumers that appear to purchase appliances without taking into account their energy efficiency and operating costs at all.

The existence of market failures in the residential sector is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned dishwasher efficiency in the no-new-standards case solely according to energy and water use or economic considerations, such as life-cycle cost or payback period, the resulting distribution of efficiencies within the consumer sample would not reflect any of the market failures or behavioral factors above. Thus, DOE concludes such a distribution would not be representative of the dishwasher market. Further, even if a specific household is not subject to the market failures above, the purchasing decision of dishwasher efficiency can be highly complex and influenced by a number of factors (e.g., aesthetics, brand, lifestyle, etc.) not captured by the building characteristics available in the RECS sample. These factors can lead to households or building owners choosing a dishwasher efficiency that deviates from the efficiency predicted using only energy use or economic considerations

⁷⁶ Ward, D.O., Clark, C.D., Jensen, K.L., Yen, S.T., & Russell, C.S. (2011). "Factors influencing willingness-to pay for the ENERGY STAR® label," *Energy Policy*, 39 (3), 1450–1458 (Available at: www.sciencedirect.com/science/article/abs/pii/S0301421510009171) (Last accessed August 1, 2023).

⁷⁷ Thaler, R.H., Sunstein, C.R., and Balz, J.P. (2014). "Choice Architecture" in *The Behavioral Foundations of Public Policy*, Eldar Shafir (ed).

⁷⁸ Thaler, R.H., and Bernartzi, S. (2004). "Save More Tomorrow: Using Behavioral Economics in Increase Employee Savings," *Journal of Political Economy* 112(1), S164–S187. See also Klemick, H., *et al.* (2015) "Heavy-Duty Trucking and the Energy Efficiency Paradox: Evidence from Focus Groups and Interviews," *Transportation Research Part A: Policy & Practice*, 77, 154–166 (providing evidence that loss aversion and other market failures can affect otherwise profit-maximizing firms).

⁷⁹ Thaler, R.H., and Sunstein, C.R. (2008). *Nudge: Improving Decisions on Health, Wealth, and Happiness*. New Haven, CT: Yale University Press.

⁸⁰ Davis, L.W., and G.E. Metcalf (2016): "Does better information lead to better choices? Evidence from energy-efficiency labels," *Journal of the Association of Environmental and Resource Economists*, 3(3), 589–625 (Available at: www.journals.uchicago.edu/doi/full/10.1086/686252) (Last accessed August 1, 2023).

⁸¹ Attari, S.Z., M.L. DeKay, C.I. Davidson, and W. Bruine de Bruin (2010): "Public perceptions of energy consumption and savings," *Proceedings of the National Academy of Sciences* 107(37), 16054–16059 (Available at: www.pnas.org/content/107/37/16054) (Last accessed August 1, 2023).

⁸² Houde, S. (2018): "How Consumers Respond to Environmental Certification and the Value of Energy Information," *The RAND Journal of Economics*, 49 (2), 453–477 (Available at: onlinelibrary.wiley.com/doi/full/10.1111/1756-2171.12231) (Last accessed August 1, 2023).

such as life-cycle cost or payback period.

There is a complex set of behavioral factors, with sometimes opposing effects, affecting the dishwasher market. It is impractical to model every consumer decision incorporating all of these effects at this extreme level of granularity given the limited available data. Given these myriad factors, DOE suspects the resulting distribution of such a model, if it were possible, would be very scattered with high variability. It is for this reason DOE utilizes a random distribution (after accounting for efficiency market share constraints) to approximate these effects. The methodology is not an assertion of economic irrationality, but instead, it is a methodological approximation of complex consumer behavior. The analysis is neither biased toward high or low energy savings. The methodology does not preferentially assign lower-efficiency dishwashers to households in the no-new-standards case where savings from the rule would be greatest, nor does it preferentially assign lower-efficiency dishwashers to households in the no-new-standards case where savings from the rule would be smallest. Some consumers were assigned the dishwashers that they would have chosen if they had engaged in perfect economic considerations when purchasing the products. Others were assigned less-efficient dishwashers even where a more-efficient product would eventually result in life-cycle savings, simulating scenarios where, for example, various market failures prevent consumers from realizing those savings. Still others were assigned dishwashers that were *more* efficient than one would expect simply from life-cycle costs analysis, reflecting, say, “green” behavior, whereby consumers ascribe independent value to minimizing harm to the environment.

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 and water savings by calculating the energy and water savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy and water 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 and water use, NPV, and future manufacturer cash flows.⁸³ 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 dishwashers are developed by considering the demand from replacements for units in stock that fail and the demand from first-time owners (“FTOs”), which are the households without existing dishwashers. DOE calculated shipments due to replacements using the retirement function developed for the LCC analysis and historical data from AHAM. DOE estimated the ratio of households that would become FTOs each year based on the historical housing stock data, the estimated shipments of replacement units and the estimated shipment to FTOs. DOE calculated shipments of FTOs by multiplying the forecasted housing stock by the annualized ratio of existing households without a dishwasher that

would purchase this product over the period 2027–2056, based on the housing stocks from *AEO2023*. See chapter 9 of the direct final rule TSD for details.

H. National Impact Analysis

The NIA assesses the national energy savings (“NES”), national water savings (NWS), 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.⁸⁴ (“Consumer” in this context refers to consumers of the product being regulated.) DOE calculates the NES, NWS, and NPV for the potential standard levels considered based on projections of annual product shipments, along with the annual energy and water consumption and total installed cost data from the energy and water use and LCC analyses. For the present analysis, DOE projected the energy and water savings, operating cost savings, product costs, and NPV of consumer benefits over the lifetime of dishwashers sold from 2027 through 2056.

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 and water 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 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 and water 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.14 summarizes the inputs and methods DOE used for the NIA analysis for the final rule. Discussion of these inputs and methods follows the

⁸³ 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.

⁸⁴ The NIA accounts for impacts in the United States and U.S. territories.

table. See chapter 10 of the direct final rule TSD for further details.

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Table IV.14 Summary of Inputs and Methods for the National Impact Analysis

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2027
Efficiency Trends	No-new-standards case: fixed efficiency distribution with no annual improvements. Standards cases: “Roll up” equipment to meet potential efficiency level.
Annual Energy and Water Consumption per Unit	Annual weighted-average values are a function of energy and water use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future product prices based on historical data.
Annual Energy and Water Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices; and as a function of the annual water consumption per unit and water prices.
Repair and Maintenance Cost per Unit	Varies with efficiency level and product class.
Energy and Water Price Trends	<i>AEO2023</i> projections (to 2050) and extrapolation thereafter. Historical Water CPI extrapolated projection to 2050 and constant value thereafter.
Energy Site-to-Primary and FFC Conversion	A time-series conversion factor based on <i>AEO2023</i> .
Discount Rate	3 and 7 percent.
Present Year	2024

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1. Product Efficiency Trends

A key component of the NIA is the trend in 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 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. DOE assumed that the shipment-weighted efficiency would not increase annually for the dishwasher product classes.

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 (2027). 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. More details can be found in chapter 10 of the direct final rule TSD.

2. National Energy and Water Savings

The national energy and water savings analysis involves a comparison of national energy consumption of the considered products between each potential standards case (“TSL”) and the case with no new or amended energy conservation standards. DOE calculated the national energy and water consumption by multiplying the number of units (stock) of each product (by vintage or age) by the unit energy and water consumption (also by vintage). DOE calculated annual NES and NWS based on the difference in national energy and water 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 *AEO2023*. Cumulative energy and water savings are the sum of the NES and NWS 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.

As discussed in section V.B.4 of this document, DOE has concluded that the standards adopted in this direct final rule will not lessen the utility or performance of the dishwashers under consideration in this rulemaking. Specifically, the amended standards adopted in this direct final rule require the use of the test procedure at appendix C2, which includes a minimum cleaning performance threshold to determine if a dishwasher “completely washes a normally soiled load of dishes,” so as to better represent consumer use of the product. Dishwashers that comply with the amended standards will provide consumer-acceptable level of cleaning performance and the rated energy and water consumption will be representative of consumer-acceptable cleaning performance. In the NES and NWS analysis, therefore, DOE assumed that the adopted standards would not result in a direct rebound effect purportedly arising from consumers resorting to handwashing, increased pre-rinsing, or other consumer behaviors that increase the energy and water consumption of dishwashing as a

result of reduced dishwasher cleaning performance. Use of the new test appendix C2 test procedure may instead improve dishwasher cleaning performance because dishwashers will meet a minimum cleaning performance index, thereby reducing consumer handwashing, pre-rinsing, and other less efficient behaviors. DOE has nevertheless taken a conservative approach and assumed no *reduction* in handwashing or other inefficient behavior (e.g., running a “heavy” cycle) as a result of this rulemaking.

However, in the NES and NWS analysis, DOE did account for the possible increase in energy and water use from handwashing dishes for households that would not purchase a new dishwasher purportedly due to the higher purchase costs under the amended standards. DOE adopted a conservative approach to these situations when households opt not to purchase a new dishwasher since there are alternatives to handwashing dishes: some households may keep their dishwasher longer than they might otherwise (i.e., extending the lifetime by repairing their unit); may use disposable plates and utensils; or may purchase a second-hand unit. Furthermore, for those households that still would forgo a new dishwasher, DOE did not account for the additional time or value of time required for handwashing.

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 sector⁸⁵ 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 direct final rule TSD.

For this direct final rule, DOE considered comments it had received in response to the May 2023 NOPR regarding national energy and water savings, including potential rebound effects.

The CA IOUs stated DOE is underestimating the water and energy savings from dishwasher use compared to hand washing, noting DOE estimates that hand washing consumes 140 percent more energy and 200 percent more water than a dishwasher, based on two European studies from 2005–2006 and an article from the U.S. Geological Survey. The CA IOUs reviewed these data sources and identified limitations in their applicability or determined they were outdated in their estimates of energy and water used for handwashing dishes because the studies suggest cultural differences may dictate handwashing practices and the international studies may not accurately represent practices of American consumers. Additionally, the CA IOUs noted that the USGS article does not cite specific references and that the underlying data that the USGS uses significantly overestimates the dishwashers’ water consumption. (CA IOUs, No. 50 at pp. 2–3) The CA IOUs recommend incorporating a more extensive data set with more countries to mitigate bias when applying international studies and that DOE should reduce a dishwasher’s low-end water consumption to align with current regulations and market information. (*Id.* at pp. 3–4)

Regarding hand washing water consumption, DOE used the weighted average dishwasher water consumption in the no-new-standards case and assumed that hand washing would consume 200 percent of the water used in machine washing for the same load based on literature review data. A 2005 study conducted at Bonn University in Germany found that, on average, hand washing used 67 percent more energy and more than 450 percent more water than machine washing.⁸⁶ A United Kingdom (UK) study in 2006 quantified the energy and water consumption of

washing by hand as a function of place settings.⁸⁷ The study demonstrated that, on average, washing eight place settings by hand used approximately 210 percent more energy and 250 percent more water than washing by machine. The U.S. Geological Service (USGS) provided estimates for water consumption from dishwashers as compared to water consumption from doing dishes by hand.⁸⁸ The USGS reported that dishwashers typically use between 6 and 16 gallons per cycle, and that dishwashing by hand uses between 9 and 27 gallons per cycle. Using these sources, DOE estimated that hand washing consumed 200 percent of the water used in machine washing.

Excluding minimum or maximum values, as the CA IOUs suggest, would result in a less accurate representation of the actual water consumption patterns exhibited by dishwashers as well as by households’ hand washing. Further, DOE notes that the majority of studies cited by the CA IOUs occur in laboratory settings or span brief time periods (from a couple of hours to two weeks), so may not be representative of typical householder behaviors. Additionally, the sole field-metered study (Richter, 2011) found that relative to machine washing, handwashing used 200 percent more water,⁸⁹ which is consistent with the current DOE estimates for energy and water use with hand washing.

AHAM and Whirlpool commented that energy conservation standards beyond EL 1 will cause rebound consumer behavior, such as running the dishwasher more than once to reach the desired cleanliness, re-rinsing dishes before placing them in the dishwasher, or handwashing, all of which undercut projected energy and water savings. (AHAM, No. 51 at pp. 5–6; Whirlpool, No. 45 at p. 5) AHAM stated that consumers are already hesitant to use their dishwashers for reasons not yet known and DOE should not adopt energy conservation standards—which because of the anti-backsliding rule cannot be undone if the results are as AHAM predicts—that could make it less likely consumers will purchase or use their efficient dishwashers. (AHAM, No.

⁸⁷ Market Transformation Programme—Briefing Note. *BNW16: A comparison of washing up by hand with a domestic dishwasher*. February 13, 2006. Market Transformation Programme, United Kingdom.

⁸⁸ U.S. Geological Service (USGS). *How Much Water Do You Use at Home?* (Last accessed January 18, 2024.) <https://water.usgs.gov/edu/activity-percapita.php>.

⁸⁹ Richter, Christian Paul, 2011. *Use of dishwashers: observation of consumer habits in the domestic environment*. (Last accessed January 23, 2024.) <https://pubag.nal.usda.gov/catalog/547534>.

⁸⁵ 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 Oct. 19, 2023).

⁸⁶ Stamminger, R., R. Badura, G. Broil, S. Dorr, and A. Elschenbroich. *A European Comparison of Cleaning Dishes by Hand*. 2003. *Proceedings of EEDAL conference*. University of Bonn: Germany. (Last accessed February, 8, 2024.) <https://silos.tips/download/a-european-comparison-of-cleaning-dishes-by-hand>.

51 at pp. 5–6) Whirlpool commented that negative rebound effects, such as consumer compensatory behavior, would reduce much of the expected gains from amended standards. (Whirlpool, No. 45 at pp. 3, 5) Whirlpool further stated that DOE needs to perform a detailed analysis of these possible rebound effects, and include this analysis in this rulemaking docket, make the analysis available to stakeholders for review, and DOE should account for this in their determination in selecting an appropriate EL. (Whirlpool, No. 45 at p. 5) Competitive Enterprise Institute (“CEI *et al.*”) ⁹⁰ asserted ⁹¹ that the proposed rulemaking violates EPCA’s mandate that DOE cannot set an efficiency standard that compromises appliance quality or fails to save consumers a significant amount of energy and/or water. (CEI *et al.*, No. 48 at pp. 1–2) CEI *et al.* also asserted that the proposed rule saves so little energy and water that it fails any interpretation of this provision. CEI *et al.* commented that the proposed rule would save consumers \$17 over the life of a standard-size dishwasher, which works out to \$1.12 per year, but the savings are undercut if the proposed rule increases the need to hand wash dishes instead of running them in the dishwasher or to run the load twice. (CEI *et al.*, No. 48 at p. 5) CEI *et al.* stated that the insignificant direct energy savings for consumers cannot be salvaged by adding in the agency’s claims of environmental and public health benefits, including climate benefits. CEI *et al.* further asserted that the inclusion of “the need to confront the global climate crisis” as a factor in determining the significance of the energy savings is not appropriate and cannot rescue the proposed rule from significance. (*Id.*)

AWE encouraged DOE to carefully consider product performance in setting standards. (AWE, No. 44 at p. 6) AWE stated that there are many examples of high-performing products that are also water-efficient and noted that products must meet standards for both parameters to earn EPA’s WaterSense label. (*Id.*) AWE commented that poor

product performance can potentially undercut water and energy savings if it leads to a backlash of public opinion or contributes to the “hacking” of products. (*Id.*) Accordingly, AWE recommended DOE consider comments about product performance from manufacturers and other stakeholders. (*Id.*)

Sub-Zero Group, Inc. (“Sub-Zero”) asserted ⁹² that these design changes will cause consumers to compensate for performance degradation by pre-rinsing dishes or using wash cycle options that consume more energy. (Sub-Zero, No. 47 at pp. 1–2)

DOE has considered the evidence and arguments put forward by these commenters, reviewed available literature, and has concluded that the adopted standards are not likely to cause the types of consumer behavior suggested by commenters, such as increased handwashing, prewashing, and changes in dishwasher use. In a 2020 rulemaking, DOE considered similar comments and determined that a “short-cycle” product class for dishwashers was warranted. In part, DOE based that determination on its view that existing standards failed to account for pre-washing or consumers washing the same load multiple times. DOE determined that a short-cycle “could” prevent handwashing or re-washing. 85 FR 68723. DOE recognizes that the conclusion reached here is a departure from that in the 2020 rule. For the reasons that follow, DOE no longer agrees with the 2020 Rule’s assumption that diminished performance resulting from standards will result, in handwashing and rewashing. Whatever effect prior standards may have had on handwashing, pre-washing, and re-washing, DOE concludes that the standards adopted here are unlikely to have such an effect. Furthermore, as previously discussed, on February 14, 2024, DOE received a second joint statement from the same group of stakeholders that submitted the Joint Agreement in which the signatories corroborate this conclusion stating that dishwashers can provide cleaning performance at levels consistent with those on the market today when they meet the recommended standard levels.⁹³

DOE disagrees with the comments asserting that the standards adopted here will decrease dishwasher performance, thereby inducing

consumers to increase pre-washing, handwashing, or changes to dishwasher use. As an initial matter, the academic literature does not support the assertion that dishwasher efficiency is correlated with consumer dishwashing behavior.^{94 95 96} More importantly, as discussed in section IV.B of this document, DOE has determined that the technology options likely to be used to meet the standards would not have a significant adverse impact on the utility of the product to subgroups of consumers. Furthermore, as discussed in section V.B.4 of this document, DOE has determined that the adopted standards *cannot* compromise the utility that consumers expect from dishwashers because the test procedure at appendix C2 requires that a test cycle achieve a minimum cleaning performance threshold to determine if a dishwasher, when tested according to the DOE test procedure, completely washes a normally soiled load of dishes. Accordingly, the test procedure ensures that any dishwasher tested for certification will only have a valid energy and water representation if such dishwashers also meet or exceed a minimum level of cleaning performance. Thus, even if a diminishment in performance could lead to increased pre-washing or handwashing, there is no evidence to believe that the standards adopted here will result in any diminishment in performance. Therefore, DOE does not expect any rebound effect due to a theoretical compromised cleaning performance in the standards case. Additionally, DOE assumes that the consumer’s pre-clean behavior would not change in the standards case compared to the no-new standards case due to the cleaning performance issue, and therefore, has no impact on the savings estimates.

By contrast, DOE *does* recognize that a small portion of consumers possibly might forgo the purchase of a new dishwasher due to the increased purchase price, may use disposable plates and utensils, keep their current dishwasher longer than they otherwise would and handwash their dishes.

⁹⁰ The CEI *et al.* includes comments of the Competitive Enterprise Institute, AMAC Action, America First Policy Institute, American Consumer Institute, Americans for Prosperity, Caesar Rodney Institute, Center of the American Experiment, Consumers’ Research, Energy & Environment Legal Institute, Foundation Supporting Climate Science, Free Enterprise Project, Heartland Institute, Heritage Foundation, Independent Women’s Forum, Independent Women’s Voice, Institute for Energy Research, John Locke Foundation, Project 21, Rio Grande Foundation, and Roughrider Policy Center.

⁹¹ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0048.

⁹² Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0047.

⁹³ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

⁹⁴ Richter, Christian Paul, 2011. Use of dishwashers: observation of consumer habits in the domestic environment. (Last accessed January 23, 2024.) <https://pubag.nal.usda.gov/catalog/547534>.

⁹⁵ Stamminger, et al., 2017. A European Comparison of Cleaning Dishes by Hand. (Last accessed January 23, 2024.) <https://silo.tips/download/a-european-comparison-of-cleaning-dishes-by-hand>.

⁹⁶ Lotta Theresa Florianne Schencking and Rainer Stamminger, 2022. What science knows about our daily dishwashing routine. (last accessed January 23, 2024.) www.degruyter.com/document/doi/10.1515/tsd-2022-2423/html?lang=en.

Accordingly, DOE's national impact analysis accounts for consumer behaviors, such as handwashing, due to the price elasticity considered in the standards case.

Regarding EPA's WaterSense label, DOE notes that dishwashers are not products eligible for EPA's WaterSense label; additionally, WaterSense is a voluntary program, similar to EPA's ENERGY STAR Program, which includes voluntary energy and water use standards for dishwashers.

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 and water 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 dishwasher 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 2056, which is the end date of the projection period, the average dishwasher price is projected to drop 29.2 percent relative to 2020. DOE's projection of product prices is described in appendix 10C of the direct 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 dishwashers. In addition to the default price trend, DOE considered two product price sensitivity cases: (1) a constant price scenario; and (2) a high price decline scenario based on the combined PPI series of "all other miscellaneous household appliances" and "primary products of major household appliance manufacturing" between the years of 1988–2008, which shows a faster price decline than the full time series between the years of 1988–2022. The derivation of these price trends and the results of these sensitivity cases are described in appendix 10C of the direct 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 *AEO2023*, 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 *AEO2023* 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 direct final rule TSD.

The water cost savings are calculated using the estimated water savings in each year and the projected water and wastewater prices. To estimate water and wastewater prices in future years, DOE multiplied the weighted average marginal national water and wastewater prices by the weighted average of water price projections of both public and private water and wastewater sources. For the public water and wastewater sources, the water price projection was developed as a linear regression based on historical 1986–2022 water and sewerage maintenance CPI data to forecast prices through 2050. For years after 2050, DOE adopted a flat price trend based on average price from 2046 through 2050. For the private well marginal water cost, the cost is only related to the additional pumping energy use; therefore, DOE used the projection of annual national average residential electricity price changes in the Reference case from *AEO2023*. The Reference case has an end year of 2050. The 2046–2050 average was used for all years after 2050. For septic tank users, the marginal wastewater costs were considered as zero and no price trends were required.

DOE forecasted an initial drop in dishwasher shipments in response to an increase in purchase price attributable to potential standards-related efficiency increases. For the selected TSL (TSL3) and the max-tech TSL (TSL5), a 0.03 percent and a 2.29 percent of the shipments drop were projected during the 30-year analysis period compared to the No-New-Standards case, respectively. DOE assumed that those consumers who forgo buying a dishwasher because of the higher purchase price would then wash their dishes by hand, and DOE estimated the energy and water use of washing dishes by hand (*see* chapter 10 of the direct final rule TSD for details). As discussed in section V.B.4 of this document, DOE

has determined that the adopted standards are achievable without impacting consumer utility. Therefore, DOE does not expect consumers to behave differently in handwashing and pre-rinsing dishes among the considered efficiency levels.

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.⁹⁷ 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.

ASAP et al. commented that DOE's analysis shows that the consumer benefits, even at the more conservative discount rate, outweigh the maximum costs to manufacturers by over seven times. (ASAP, No. 46 at p. 1)

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 three subgroups: (1) low-income households, (2) senior-only households, and (3) well-water-using households. The analysis used subsets of the *RECS 2020* sample composed of

⁹⁷ U.S. Office of Management and Budget. Circular A-4: Regulatory Analysis. Available at www.whitehouse.gov/omb/information-for-agencies/circulars (last accessed April 10, 2024). DOE used the prior version of Circular A-4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version. Available at www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf (last accessed March 11, 2024).

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 direct final rule TSD describes the consumer subgroup analysis.

1. Low-Income Households

The identification of low-income households depends on family size and income level. Low-income households are significantly more likely to be renters or to live in subsidized housing

units, compared to households that are not low-income. In these cases, the landlord purchases the equipment and may pay the energy bill as well.

For this direct final rule analysis, DOE used RECS data to divide low-income households into three sub-subgroups: (1) renters who pay the energy bill, (2) renters who do not pay the energy bill, and (3) homeowners.⁹⁸ For large appliance such as dishwashers, renters are unlikely to be purchasers. Instead, the landlord would bear the cost, and some or none of the cost could get passed on to the renter. Renters who pay

the energy bill would receive the energy cost savings from higher-efficiency appliances. This disaggregation allows DOE to determine whether low-income households are disproportionately affected by an amended energy conservation standard in a more accurate manner.

Table IV.15 shows the distribution of low-income household dishwasher users with respect to whether they rent or own and whether they pay the energy bill.

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Table IV.15 Characterization of Low-Income Households in the Sample for Dishwashers

Type of Household*	Percentage of Low-Income Sample	Impact of Higher Efficiency on Energy and Water Bills	Impact of First Cost
Renters – Pay for Energy Bill**	48%	Full/Partial savings	None
Renters – Do Not Pay for Energy Bill**	6%	None	None
Owners	46%	Full/Partial savings [†]	Full

* RECS lists three categories: (1) Owned or being bought by someone in your household (classified as “Owners” in this table); (2) Rented (classified as “Renters” in this table); (3) Occupied without payment of rent (also classified as “Renters” in this table). Renters include occupants in subsidized housing including public housing, subsidized housing in private properties, and other households that do not pay rent. RECS does not distinguish homes in subsidized or public housing.

** RECS lists four categories for each of the fuels used by a household: (1) Household is responsible for paying for all used in this home; (2) All used in this home is included in the rent or condo fee; (3) Some is paid by the household, some is included in the rent or condo fee; and 4) Paid for some other way. “Do Not Pay for Energy Bill” includes only category (2). Partial energy bill savings would occur in cases of category (3).

*** It is assumed that incremental costs usually are not included in rent increases, but some portion of the incremental cost could be passed on in the rent over time.

[†] It is assumed that in the cases where buildings share electricity bills, owners would receive only partial benefit from savings.

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In response to the May 2023 NOPR, Samsung stated its appreciation for DOE’s analysis of the proposed standards levels on low-income households. Samsung commented that DOE’s analysis shows that it is unlikely that renters purchase large appliances like dishwashers. Samsung noted that landlords typically bear the cost while renters directly benefit from higher-efficiency appliances through reduced

energy costs. Samsung commented that considering the small percentage of low-income consumers in DOE’s analysis experiencing a net LCC cost at TSL 3 (2 percent for standard-size dishwashers and 0 percent for compact-size dishwashers) and the positive average LCC impact, TSL 3 offers equitable outcomes for different consumer groups. Samsung added that the simple payback periods indicate that the initial

investment in more efficient dishwashers can be recouped within a short timeframe. (Samsung, No. 52 at p. 3)

DOE agrees that TSL 3 provides equitable outcomes for different consumer groups.

AHAM commented that it commissioned Bellomy Research to conduct a study focusing on low-income households. (AHAM, No. 51 at p. 4)

⁹⁸The energy bill includes fuel types of electricity, natural gas, or propane consumed by a household.

AHAM commented that this research does not constitute a full marketplace analysis, but does provide additional information on the effects of higher appliance prices on low-income households and is helpful in understanding the real-world impact DOE's proposed standards may have. (*Id.*) AHAM stated 75 percent of U.S. households own a dishwasher and that fewer than 40 percent of households with gross incomes of under \$40,000 own a dishwasher and that costs are the primary consideration when considering a dishwasher purchase. AHAM noted that dishwashers may be seen as discretionary because handwashing is an option, and that this means that a significant portion of lower income populations are spending more than other consumers on their water and electricity bills due to handwashing. (*Id.* at p. 3) AHAM asserted that amended standards beyond EL 1 are unnecessary given these successes and unjustified under EPCA given the limited opportunity for energy savings and the disproportionate impacts amended standards will have on low-income consumers, noting that most standard-size dishwashers are certified to ENERGY STAR V. 6.0 (*i.e.*, EL 1). (*Id.* at pp. 1–2) AHAM commented that standards beyond EL 1 are likely to disproportionately, negatively impact low-income consumers and drive negative, unintended consumer behaviors that negate predicted savings. (AHAM, No. 51 at pp. 2–3) AHAM urged DOE to exercise restraint and consider energy conservation standards for dishwashers that do not exceed EL 1, as outlined in the January 2022 Preliminary TSD, and investigate other approaches to achieve additional energy and water savings without creating this undue burden on low-income and underserved communities. (*Id.* at p. 5)

DOE welcomes the opportunity to review the Bellomy report, but has not received a copy of the Bellomy research; nor is the report available online. DOE notes that, while unable to review the specific survey instrument and resulting dataset, this summary of AHAM survey findings implies that the framing does not reflect the context of a revised minimum energy conservation standard. Specifically, these are impacts AHAM is claiming would occur based on the full cost of a new dishwasher and are not specifically relevant to the potential increased incremental cost of purchasing a new dishwasher in a standards case (which is substantially less than the full cost of a dishwasher). Additionally, based on DOE's estimates, the installed price of EL1 is the same as

EL2 which is the selected level for the standard size dishwashers. Therefore, all consumers, including low-income consumers, would not experience additional incremental cost at EL2 compared to EL1. Moreover, DOE's low-income LCC subgroup analysis uses inputs specific to low-income consumers to estimate the impact of adopted standards. The results indicate that only two percent of the low-income consumers would experience a net cost. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

2. Senior-Only Households

DOE defined a senior-only household as having all occupants with ages of 65 years or greater. Using *RECS 2020* data, senior-only households represent 23 percent of households that have and use dishwashers.

3. Well-Water Households

AHAM recommended that DOE consider well-water users as a distinct sub-group given the differences in costs between publicly supplied and household-supplied water and the resulting impacts on operating cost savings. (AHAM at No. 51 at p. 16) AHAM further commented that at EL2 for standard dishwashers, using the appropriate cash costs for water and sewer, the mean LCC savings decline by nearly 50 percent. AHAM asserted that this makes it glaringly obvious that this group is worth direct consideration and DOE must acknowledge that its proposed standards create significant burden for them and adjust its proposal accordingly. (*Id.*)

DOE defined a well-water household as (1) having a dedicated water well for that particular household; (2) distributing water to no other households from its water well; and (3) having no connection to a public water utility water line. *RECS 2020* data do not indicate whether a household uses a water well, so DOE used AHS data to estimate the percentage of households with dedicated water wells. Additionally, DOE used AHS data from 1970 to 2021 to develop a projection by U.S. Census Region. Use of septic tanks for wastewater effluent was also noted.

Given that the majority of wells and septic tanks are located in rural areas, the probability of a household owning a well and/or a septic tank is significantly higher in rural areas than in urban areas. Therefore, DOE distinguishes rural and urban households when assigning the water and wastewater sources to the RECS household samples, and using different probability distributions of

owning a well and a septic tank by Census Region based on AHS 2021 data.

Chapter 11 of the direct 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 dishwashers and to estimate the potential impacts of such standards on direct employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects and includes analyses of projected 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 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. To capture the uncertainty relating to manufacturer pricing strategies following amended standards, the GRIM estimates a range of possible impacts under different manufacturer 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 direct final rule TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the dishwasher manufacturing industry based on the market and technology assessment, and publicly available information. This included a top-down analysis of dishwasher manufacturers that DOE used to derive preliminary financial inputs for the GRIM (e.g., revenues; materials, labor, overhead, and depreciation expenses; selling, general, and administrative expenses (“SG&A”); and R&D expenses). DOE also used public sources of information to further calibrate its initial characterization of the dishwasher manufacturing industry, including company filings of form 10-K from the SEC,⁹⁹ corporate annual reports, the U.S. Census Bureau’s *Annual Survey of Manufactures* (“ASM”),¹⁰⁰ and reports from Dun & Bradstreet.¹⁰¹

In Phase 2 of the MIA, 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.

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of dishwashers in order to develop other key GRIM inputs, including product and capital conversion costs, and to gather additional information on the anticipated effects of energy conservation standards on revenues, direct employment, capital assets,

industry competitiveness, and subgroup impacts.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with representative manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. As part of Phase 3, 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 chapter 12 of the direct final rule TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to new or 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 an amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2024 (the base year of the analysis) and continuing to 2056. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of dishwashers, DOE used a real discount rate of 8.5 percent, which was derived from industry financials and then modified according to feedback received during manufacturer interviews.

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 new or amended energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including

publicly available data, results of the engineering and shipments analysis, and information gathered from industry stakeholders during the course of manufacturer interviews conducted in support of the May 2023 NOPR. 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 direct 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.

For this analysis, DOE used a combination of design and efficiency engineering approaches. This approach involved physically disassembling commercially available products, reviewing publicly available cost information, and modeling equipment cost. From this information, DOE estimated the MPCs for a range of products currently available on the market. DOE then considered the incremental steps manufacturers may take to reach higher efficiency levels. In its modeling, DOE started with the baseline MPC and added the expected design options at each higher efficiency level to estimate incremental MPCs. For a complete description of the MPCs, see section IV.C of this document and chapter 5 of the direct final rule TSD.

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 2024 (the base year) to 2056 (the end year of the analysis period). See section IV.G of this document and chapter 9 of the direct final rule TSD for additional details.

c. Capital and Product Conversion Costs

New or amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and dishwasher designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency

⁹⁹ U.S. Securities and Exchange Commission, Electronic Data Gathering, Analysis, and Retrieval (“EDGAR”) system. Available at www.sec.gov/edgar/search/ (last accessed Nov. 18, 2023).

¹⁰⁰ U.S. Census Bureau, Annual Survey of Manufactures. “Statistics for Industry Groups and Industries in the U.S (2021).” Available at www.census.gov/programs-surveys/asm/data/tables.html (last accessed Nov. 14, 2023).

¹⁰¹ The Dun & Bradstreet Hoovers login is available at app.dnbhoovers.com (last accessed Nov. 14, 2023).

level in each product class. For the MIA, DOE classified these conversion costs into two major groups: (1) capital conversion costs; and (2) product conversion costs. 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. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with new or amended energy conservation standards.

DOE relied on information derived from manufacturer interviews, the engineering analysis, and product teardowns to evaluate the level of capital and product conversion costs manufacturers would likely incur at the various efficiency levels. During interviews, DOE asked manufacturers to estimate the capital conversion costs to meet the various efficiency levels. This feedback was compared to findings from the engineering analysis to determine the validity of investment levels. DOE also asked manufacturers to estimate the redesign effort, engineering resources, and marketing expenses required at various efficiency levels to quantify the product conversion costs. Based on manufacturer feedback, DOE also estimated “re-flooring” costs associated with replacing obsolete display models in big-box stores (e.g., Lowe’s, Home Depot, Best Buy) due to more stringent standards. Some manufacturers stated that with a new product release, big-box retailers discount outdated display models and manufacturers share any losses associated with discounting the retail price. The estimated re-flooring costs for each efficiency level were incorporated into the product conversion cost estimates, as DOE modeled the re-flooring costs as a marketing expense. DOE also estimated industry costs associated with the new appendix C2, as finalized in the January 2023 TP Final Rule. Among other updates, appendix C2 contains provisions for a minimum cleaning index threshold to validate the regulated test cycle. See 88 FR 3234, 3271–3272, 3281. At each efficiency level, DOE included the costs associated with re-rating compliant basic models in accordance with appendix C2. 88 FR 3234, 3271–3272. Based on manufacturer feedback, DOE expects some manufacturers may incur one-time costs if their current testing laboratories are at capacity and additional laboratory space or test stations are required. DOE

includes these one-time costs in its capital conversion cost estimates. DOE interviewed manufacturers representing approximately 90 percent of industry shipments. In interviews, multiple manufacturers provided estimates for the expected upfront capital costs associated with implementing the cleaning performance test (e.g., additional test stations, equipment upgrades for existing stations, building modifications, etc.). DOE considered these costs in its conversion cost estimates, as appendix C2 would go into effect at the time when compliance is required for any amended energy conservation standards.

Manufacturer feedback on conversion costs was aggregated to protect confidential information. DOE then scaled up the aggregate capital and product conversion cost feedback from interviews to estimate total industry conversion costs. DOE adjusted the conversion cost estimates developed in support of the May 2023 NOPR to 2022\$ for this direct final rule.

In general, DOE assumes all conversion-related investments occur between the year of publication of the direct final rule and the year by which manufacturers must comply with the new or amended standard. The conversion cost figures at each analyzed TSL can be found in section V.B.2.a of this document. For additional information on the estimated capital and product conversion costs, see chapter 12 of the direct final rule TSD.

d. Manufacturer Markup Scenarios

MSPs include direct manufacturing production costs 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 manufacturer markups to the MPCs estimated in the engineering analysis for each product class and efficiency level. Modifying these manufacturer markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case manufacturer 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 preservation of gross margin percentage scenario; and (2) a tiered scenario. These scenarios lead to different manufacturer markup values that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the preservation of gross margin percentage scenario, DOE applied a single uniform “gross margin percentage” across all efficiency levels,

which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within a product class. As production costs increase with efficiency, this scenario implies that the per-unit dollar profit will increase. Based on publicly available financial information, as well as comments from manufacturer interviews, DOE assumed average gross margin percentages of 19.4 percent for both standard-size and compact-size product classes.¹⁰² Manufacturers noted that this scenario represents the upper bound of the dishwasher industry’s profitability in the standards case because manufacturers can fully pass on additional product costs due to standards to consumers.

The tiered scenario starts with the three tiers of manufacturer markups wherein higher efficiency products have a higher markup than low efficiency products. In the no-new-standards case, the three tiers are baseline efficiency, ENERGY STAR V. 6.0, and ENERGY STAR V. 7.0 (which corresponds to the ENERGY STAR Most Efficient qualification criteria in 2022). In the standards case, DOE models the breadth of manufacturers’ portfolio of products shrinking and amended standards, resulting in higher-tier products moving to lower tiers. As a result, higher efficiency products that previously commanded the ENERGY STAR V. 6.0 and 2022 ENERGY STAR Most Efficient manufacturer markups are assigned the baseline and ENERGY STAR V. 6.0 manufacturer markups, respectively. This scenario reflects a concern about product commoditization at higher efficiency levels as efficiency differentiators are eliminated.

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

3. Discussion of MIA Comments

For this direct final rule, DOE considered comments it had received regarding its MIA presented in the May 2023 NOPR. The approach used for this direct final rule is largely the same approach DOE had used for the May 2023 NOPR analysis.

In response to the May 2023 NOPR, AHAM stated that it cannot comment on the accuracy of DOE’s approach for including how manufacturers might or might not recover potential investments (i.e., the accuracy of DOE’s manufacturer markup scenarios), but that AHAM supports DOE’s intent in the

¹⁰² The gross margin percentage of 19.4 percent is based on a manufacturer markup of 1.24.

microwave ovens SNOPR (“August 2022 SNOPR”) energy conservation standards rulemaking to include those costs and investments in the actual costs of products and retail prices. AHAM urged DOE to apply the same conceptual approach used in the August 2022 SNOPR in this dishwashers rulemaking and all future rulemakings. (AHAM, No. 51 at p. 21)

DOE models different standards-case manufacturer markup scenarios to represent the uncertainty surrounding the potential impacts on prices and profitability for manufacturers following the implementation of amended energy conservation standards (see section IV.J.2.d of this document). The analyzed manufacturer markup scenarios vary by rulemaking as they are meant to reflect the potential range of financial impacts for manufacturers of the specific covered product or equipment. For the May 2023 NOPR, DOE applied the preservation of gross margin percentage scenario to reflect an upper bound of industry profitability and a tiered scenario to reflect a lower bound of industry profitability under amended standards. 88 FR 32514, 32549. DOE used these scenarios to reflect the range of realistic profitability impacts under more stringent standards. Under the preservation of gross margin scenario for dishwashers, the incremental increase in MPCs—at most analyzed efficiency levels—result in an increase in per-unit dollar profit per unit sold. In interviews, multiple manufacturers emphasized the competitive nature of the dishwasher industry and the importance of offering dishwashers at competitive price points. Some manufacturers expressed concern that they would not be able to maintain their current manufacturer markups under more stringent standards. Thus, while manufacturers will likely continue to differentiate products and garner higher manufacturer markups based on consumer features (e.g., Wi-Fi enablement), brand recognition, energy efficiency, etc., DOE believes that maintaining the industry average manufacturer markup, reflected by the preservation of gross margin percentage scenario, represents an appropriate upper bound to industry pricing and profitability. Applying the approach used in the microwave ovens rulemaking (i.e., a conversion-cost-recovery scenario) would reflect a scenario where dishwasher manufacturers would increase manufacturer markups under more stringent standards. Based on information gathered during confidential interviews in support of the May 2023 NOPR and a review of

financial statements of six companies engaged in manufacturing dishwashers, DOE does not expect that the dishwasher industry would increase manufacturer markups under an amended standard. Furthermore, in response to the May 2023 NOPR, DOE did not receive any public or confidential data indicating that industry would increase manufacturer markups in response to more stringent standards. Therefore, DOE maintained the two manufacturer markup scenarios from the May 2023 NOPR for this direct final rule analysis. DOE further notes, that AHAM is a party to the Joint Agreement and is supportive of the recommended standard adopted in this direct final rule.

AHAM urged DOE to consider cumulative regulatory burden in its analysis and decision-making process. AHAM commented that the nature of EPCA’s requirements that energy conservation standards be reviewed every 6 years creates a never-ending cycle in which manufacturers need to constantly update or redesign products to meet new or amended standards. AHAM commented the cumulative regulatory burden is significant for home appliance manufacturers when redesigning products and product lines for consumer clothes dryers, residential clothes washers, conventional cooking products, dishwashers, refrigerators, refrigerator-freezers, and freezers, miscellaneous refrigeration products, room air conditioners, and microwave ovens. AHAM noted that many of these rulemakings are expected to have compliance dates in 2027. (AHAM, No. 51 at p. 22) AHAM asserted that engineers would need to spend all their time redesigning products to meet more stringent energy efficiency standards, pulling resources from other development efforts and business priorities. AHAM asserted that DOE’s analysis does not adequately account for cumulative regulatory burden. AHAM encouraged DOE to acknowledge the cumulative regulatory burden its proposals place on industry and suggested that DOE could reduce cumulative regulatory burden by prioritizing rulemakings, spacing out the timing of final rules, allowing more lead time by delaying the publication of final rules in the **Federal Register** after they have been issued, and reducing the stringency of standards such that fewer products would require redesign. (*Id.* at p. 23) AHAM encouraged DOE to incorporate combined conversion costs across rulemakings into the GRIM in order to quantify cumulative regulatory burden, and to consider the potential

impact of these rulemakings more broadly on the economy and on inflation. AHAM stated that the appropriate approach is to include costs of manufacturers needing to comply with multiple regulations across product categories as well as the same product, noting that the manufacturer impact analysis does not adequately analyze this issue. (*Id.* at p. 24)

Whirlpool commented that manufacturers are facing unprecedented cumulative regulatory burden due to DOE energy conservation standards, citing more stringent proposed standards and tight compliance deadlines for over 10 DOE-covered product categories manufactured and sold by Whirlpool. Whirlpool commented that many of these proposed rules, if finalized, would have compliance dates in 2026 or 2027. Whirlpool, a member of AHAM and party to the Joint Agreement, asserted that manufacturers may be forced to make difficult tradeoffs and potentially stop many projects over a multi-year period focused on cost reduction, quality improvement, or innovation; and instead focus their resources mainly on compliance to these amended standards. (Whirlpool, No. 45, at p. 4)

DOE analyzes cumulative regulatory burden in accordance with section 13(g) of appendix A. As such, DOE details the rulemakings and expected conversion expenses of Federal energy conservation standards that could impact dishwasher original equipment manufacturers (“OEMs”) that take effect approximately 3 years before or after the 2027 compliance date in section V.B.2.e of this document. As shown in Table V.11, DOE considers the rulemakings referenced by AHAM and Whirlpool as potentially contributing to cumulative regulatory burden in this direct final rule analysis. DOE notes that regulations that are not finalized are not considered in its cumulative regulatory burden analysis, as the timing, cost, and impacts of unfinalized rules are speculative. However, to aid stakeholders in identifying potential cumulative regulatory burden, DOE does list rulemakings in Table V.11 that have proposed rules, which have tentative compliance dates, compliance levels, and compliance cost estimates. Regarding AHAM’s suggestion about spacing out the timing of final rules for home appliance rulemakings, DOE has statutory requirements under EPCA on the timing of rulemakings. For dishwashers, refrigerators, refrigerator-freezers, and freezers, consumer cooking products, residential clothes washers, consumer clothes dryers, and room air conditioners, amended standards apply

to covered products manufactured 3 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(m)(4)(A)(i)) For miscellaneous refrigeration products, amended standards apply 5 years after the date on which any new or amended standard is published. (42 U.S.C. 6295(l)(2)) However, DOE notes that the multi-product Joint Agreement recommends alternative compliance dates for refrigerators, refrigerator-freezers, and freezers; consumer conventional cooking products; residential clothes washers; consumer clothes dryers; and miscellaneous refrigeration products.¹⁰³ As a result, the expected compliance dates for many of the home appliance rulemakings AHAM listed will be spread out compared to the estimated compliance dates resulting from EPCA-specified lead times. See section V.B.2.e of this document for additional details. Regarding AHAM's recommendation of combining the product conversion costs from multiple regulations into the GRIM, DOE is concerned that combined results would make it more difficult to discern the direct impact of the amended standard on covered manufacturers. If DOE were to combine the conversion costs from multiple regulations, as requested, it would be appropriate to match the combined conversion costs with the combined revenues of the regulated products. Conversion costs would be spread over a larger revenue base and potentially result in less severe INPV impacts when evaluated on a percent change basis.

In response to the May 2023 NOPR, Gazoobie commented¹⁰⁴ that taking 91 percent of dishwashers off the market will lead to severe supply chain issues and product shortages for minimal savings. Gazoobie asserted that supply chain issues could lead to higher prices than estimated, and facing shortages, more consumers will repair their older and less efficient dishwashers. Further, Gazoobie stated that DOE should not adopt a rule that takes so many units out of existence and recommended DOE adopt a lower TSL that removes less than 33 percent of the units or finalize a no new standards rule to see if supply chain issues becomes resolved over the next few years. (Gazoobie, No. 38 at p. 1)

DOE does not expect that the levels adopted in this direct final rule, which align with the levels proposed in the

May 2023 NOPR, would lead to product shortages. Manufacturers would have until 2027 (3 years after the direct final rule is published in the **Federal Register**) to redesign models to meet the amended standards and/or increase production capacity of compliant models. DOE notes that most OEMs already offer models that meet the adopted TSL. Of the 19 OEMs offering standard-size products, 16 OEMs offer products that meet the efficiency level required. All the compact-size dishwasher OEMs currently offer products that meet the adopted TSL. Furthermore, as discussed in section V.B.2.c of this document, manufacturers did not express any concerns about production capacity at the levels adopted in this direct final rule. Additionally, DOE notes that TSL 3 corresponds to the levels recommended in the Joint Agreement, which includes signatories representing dishwasher manufacturers.

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 CO₂, NO_x, SO₂, and Hg. The second component estimates the impacts of potential standards on emissions of two additional greenhouse gases, CH₄ and N₂O, 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 CO₂, NO_x, SO₂, 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 of the direct final rule TSD. The analysis presented in this notice uses projections from *AEO2023*. Power sector emissions of CH₄ and N₂O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by the EPA.¹⁰⁵

The on-site operation of dishwashers involves combustion of fossil fuels and results in emissions of CO₂, NO_x, SO₂, CH₄, and N₂O where these products are

used. Site emissions of these gases were estimated using Emission Factors for Greenhouse Gas Inventories and, for NO_x and SO₂, emissions intensity factors from an EPA publication.¹⁰⁶

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 CH₄ and CO₂, are estimated based on the methodology described in chapter 15 of the direct 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. *AEO2023* reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the emissions control programs discussed in the following paragraphs the emissions control programs discussed in the following paragraphs, and the Inflation Reduction Act.¹⁰⁷

SO₂ 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 SO₂ for affected EGUs in the 48 contiguous States and the District of Columbia ("DC"). (42 U.S.C. 7651 *et seq.*) SO₂ 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 SO₂ emissions, and went into effect as of

¹⁰⁶ U.S. Environmental Protection Agency. External Combustion Sources. In *Compilation of Air Pollutant Emission Factors*. AP-42. Fifth Edition. Volume I: Stationary Point and Area Sources. Chapter 1. Available at www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors#Proposed/ (last accessed Oct. 24, 2023).

¹⁰⁷ For further information, see the Assumptions to *AEO2023* 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 Oct. 24, 2023).

¹⁰³ The Joint Agreement is available in the docket at www.regulations.gov/comment/EERE-2019-BT-STD-0039-0055.

¹⁰⁴ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0038.

¹⁰⁵ Available at www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf (last accessed Oct. 24, 2023).

January 1, 2015.¹⁰⁸ The AEO incorporates implementation of CSAPR, including the update to the CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). 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 SO₂ emissions limits under CSAPR, any excess SO₂ emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO₂ emissions by another regulated EGU.

However, beginning in 2016, SO₂ emissions began to fall as a result of the Mercury and Air Toxics Standards (“MATS”) for power plants.¹⁰⁹ 77 FR 9304 (Feb. 16, 2012). The final rule establishes power plant emission standards for mercury, acid gases, and non-mercury metallic toxic pollutants. Because of the emissions reductions under the MATS, it is unlikely that excess SO₂ emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO₂ emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation will generally reduce SO₂ emissions. DOE estimated SO₂ emissions reduction using emissions factors based on *AEO2023*.

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. Depending on the configuration of the power sector in the different regions and the need for allowances, however, NO_x emissions might not remain at the limit in the case of lower electricity demand. That would mean that standards might 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 *AEO2023* 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 *AEO2023*, 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 CO₂, CH₄, N₂O, NO_x, and SO₂ 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.

To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

1. Monetization of Greenhouse Gas Emissions

DOE estimates the monetized benefits of the reductions in emissions of CO₂, CH₄, and N₂O by using a measure of the SC of each pollutant (e.g., SC-CO₂). 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 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 IWG on the Social Cost of Greenhouse Gases or by another means, did not affect the rule ultimately adopted by DOE.

DOE estimated the global social benefits of CO₂, CH₄, and N₂O reductions using SC-GHG values that were based on the interim values 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 (“February 2021 SC-GHG TSD”). The SC-GHG 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, the SC-GHG 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-GHG therefore, reflects the societal value of reducing emissions of the gas in question by one metric ton. The SC-GHG is the theoretically appropriate value to use in conducting benefit-cost analyses of policies that affect CO₂, N₂O and CH₄ emissions.

As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agreed that the interim SC-GHG estimates represent the most appropriate estimate of the SC-GHG until revised estimates are developed reflecting the latest, peer-reviewed science. See 87 FR 78382, 78406–78408 for discussion of the development and details of the IWG SC-GHG estimates.

There are a number of limitations and uncertainties associated with the SC-GHG estimates. First, the current scientific and economic understanding of discounting approaches suggests discount rates appropriate for

¹⁰⁸ CSAPR requires States to address annual emissions of SO₂ 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), and EPA issued the CSAPR Update for the 2008 ozone NAAQS. 81 FR 74504 (Oct. 26, 2016).

¹⁰⁹ In order to continue operating, coal power plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce SO₂ emissions.

intergenerational analysis in the context of climate change are likely to be less than 3 percent, near 2 percent or lower.¹¹⁰ 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 and 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 to high temperatures, and 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-CO₂ estimates. However, as discussed in the February 2021 SC-GHG TSD, the IWG has recommended that, taken together, the limitations suggest that the interim SC-GHG estimates used in this direct final rule likely underestimate the damages from GHG emissions. DOE concurs with this assessment.

For this direct final rule, DOE considered comments it had received regarding its approach for monetizing greenhouse gas emissions in the May 2023 NOPR. The approach used for this direct final rule is largely the same approach DOE had used for the May 2023 NOPR analysis.

In response to the May 2023 NOPR, AHAM objected to DOE using the social cost of carbon and other monetization of emissions reductions benefits in its analysis of the factors EPCA requires DOE to balance in determining the

appropriate standard, which AHAM noted are constantly subject to change. (AHAM, No. 51 at p. 25) AHAM commented that DOE’s decision making should not rely on the monetization of reductions benefits and that it is unclear to what extent DOE’s deliberation to propose a TSL rely on the monetization of emissions reduction. (AHAM, No. 51 at pp. 24–25) AHAM stated that based on the extent to which DOE calculates climate and health benefits, it appears that DOE is prepared to rely upon the estimated monetary value of emissions reductions should the consumer NPV and energy savings not appear to justify a more stringent level. (*Id.* at p. 15) AHAM commented that DOE has responded to these objections by indicating 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 EPCA requires DOE to evaluate in determining whether a potential energy conservation standard is economically justified, and AHAM does not object to DOE considering the benefits. AHAM stated that it objects to DOE relying upon those benefits to justify a rule given the uncertain and ever-evolving nature of the estimates. AHAM commented that DOE can consider “other factors” under EPCA, but that does not override the key criteria EPCA requires DOE to balance and DOE must consider EPCA’s factors together and achieve a balance of impacts and benefits—a balance DOE has failed to strike in this rule. (*Id.* at p. 25) AHAM stated 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. (*Id.*)

Zycher commented that the IWG analysis is deeply flawed because it asserts the benefits of GHG reductions on a global scale. (Zycher, No. 49 at pp. 22–23) Zycher stated that the IWG analysis incorporates explicitly in its benefit/cost calculation the purported global climate benefits from reductions in U.S. GHG emissions, presumably on the grounds that the assumed GHG externality is global in nature. Zycher asserted that this argument is fundamentally flawed, in substantial part because the global climate effect of

all U.S. GHG emissions is very close to zero. (Zycher, No. 49 at p. 25)

In response to the AHAM and Zycher’s comments regarding global impacts, DOE reiterates its view that the environmental and public health benefits associated with 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. (*See* 42 U.S.C. 6295(o)(2)(B)(i)(IV)) Additionally, 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.

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 considers the monetized value of emissions reductions in its evaluation of potential standard levels. While the benefits associated with reduction of GHG emissions inform DOE’s evaluation of potential standards, DOE would reach the same conclusion regarding the economic justification of standards presented in this direct final rule without considering the social cost of greenhouse gases. As described in detail in section V.C.1 of this document, at the adopted TSL for dishwashers, the average LCC savings for both product classes are positive, a shipment-weighted 3 percent of consumers would experience a net cost, and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate.

Zycher commented¹¹¹ that the interim IWG estimates are deeply flawed for a number of reasons, they: (1) distort the actual economic growth predictions produced by the integrated assessment models, (2) base predictions of future climate phenomena on climate models that cannot predict the past or the present, (3) incorporate co-benefits in the form of a reduction in the emissions of other criteria and hazardous air pollutants already regulated under different provisions of the Clean Air Act, (4) incorporate the

¹¹⁰Interagency Working Group on Social Cost of Greenhouse Gases. 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/.

¹¹¹ Available at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0049.

asserted benefits of GHG reductions on a global basis, and (5) employ discount rates that are inconsistent and inappropriate. (Zycher, No. 49 at pp. 22–23)

Zycher commented that the artificially low discount rate applied to the asserted climate benefits is incorrect analytically and that the opportunity cost of capital is the appropriate discount rate to be applied to the evaluation of the asserted climate benefits of the proposed rule because the allocation of resources to such endeavors imposes an opportunity cost in the form of forgone investments. (Zycher, No. 49 at p. 26) Zycher commented that the IWG estimates are flawed for a number of reasons, including the use of inconsistent and inappropriate discount rates: (1) “consumption rate of interest” is an incorrect conceptual discount rate for a proposed rule analysis because the use of resources for purposes of reductions in GHG emissions is obviously an investment, the opportunity cost of which is the marginal social return to investment and (2) incorrect identification of future generations’ preferences. (Zycher, No. 49 at pp. 27–28) In regards to the consumption rate of interest, Zycher stated that the use of a low consumption rate of interest for the evaluation of climate benefits only would introduce an important bias in the allocation of resources among government policies and between government and private-sector resource use. Zycher commented that the private sector would not choose to use an artificially-low discount rate for the evaluation of alternative resource uses. (*Id.* at p. 27) In regards to intergenerational preferences, Zycher asserted that future generations prefer to receive a bequest of a bequest of an aggregate capital stock. (*Id.*)

The reasons for using a consumption discount rate rather than a rate based on the social rate of return on capital (estimated to be 7 percent under OMB’s 2003 Circular A–4 guidance) is because 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 reiterates 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.”

CEI *et al.* commented that there are numerous flaws with IWG 2021 that overstate the calculated benefits of avoided emissions. CEI commented that IWG used improperly low discount rates, relied on climate models that have consistently overstated actual warming and on baseline emission scenarios that assume an increasingly coal-centric global energy system through 2100 and beyond, while downplaying the capacity for adaptation to mitigate climate impacts. CEI *et al.* also stated that the inclusion of claimed climate benefits out nearly 300 years into the future and the use of global rather than national benefits, are also skewed toward inflating the end result. (CEI *et al.*, No. 48 at p. 6) CEI *et al.* commented that missing from the agency’s analysis is any estimate of the temperature increase it believes will be averted as a result of the proposed rule, which CEI *et al.* estimated to be 0.0003 °C by 2050. (CEI *et al.*, No. 48 at p. 7)

DOE notes that the IWG’s SC–GHG estimates 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. A number of criticisms raised in the comments were addressed by the IWG in its February 2021 SC–GHG TSD. DOE agrees that the interim SC–GHG values applied for this direct final rule are conservative estimates. In the February 2021 SC–GHG TSD, the IWG stated that the models used to produce the interim estimates do not include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature. For these same impacts, the science underlying their “damage functions” lags behind the most recent research. In the judgment of the IWG, these and other limitations suggest that the range of four interim SC–GHG estimates presented in the TSD likely underestimate societal damages from GHG emissions.

DOE is aware that in December 2023, EPA issued a new set of SC–GHG estimates in connection with a final rulemaking under the Clean Air Act.¹¹²

¹¹² See www.epa.gov/environmental-economics/scghg.

As DOE had used the IWG interim values in proposing this rule and is currently reviewing the updated 2023 SC–GHG values, for this direct final rule, DOE used these updated 2023 SC–GHG values to conduct a sensitivity analysis of the value of GHG emissions reductions associated with alternative standards for dishwashers (see section IV.L.1.c of this document). DOE notes that because EPA’s estimates are considerably higher than the IWG’s interim SC–GHG values applied for this direct final rule, an analysis that uses the EPA’s estimates results in significantly greater climate-related benefits. However, such results would not affect DOE’s decision in this direct final rule. As stated elsewhere in this document, DOE would reach the same conclusion regarding the economic justification of the standards presented in this direct final rule without considering the IWG’s interim SC–GHG values. For the same reason, if DOE were to use EPA’s higher SC–GHG estimates, they would not change DOE’s conclusion that the standards are economically justified.

In response to Zycher’s comment regarding the use of consumption discount rate instead of a rate based on the social rate of return on capital, DOE notes that DOE’s analysis is only using the medium discount rate presented in the IWG TSD as a central estimate of climate benefits. The IWG TSD has provided significant details to justify the choice of discount rate and DOE agrees with the assessment. However, there is no suggested justification to use a 7 percent discount rate in the IWG TSD. DOE also wants to note that while DOE could have used other discount rate values (5 percent or 2.5 percent), as presented by the IWG, it would have only resulted in lower or higher climate benefit, but would not have changed DOE’s conclusion of economic justification. As stated in section V.C.1 of this document, DOE concludes that the rule is economically justified even without factoring in the climate benefit.

DOE’s derivations of the SC–CO₂, SC–N₂O, and SC–CH₄ values used for this direct final 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.

a. Social Cost of Carbon Dioxide

The SC–CO₂ values used for this direct final rule were based on the values developed for the IWG’s February 2021 TSD, which are shown in Table IV.16 in five-year increments from 2020 to 2050. The set of annual values

that DOE used, which was adapted from estimates published by EPA,¹¹³ is presented in appendix 14A of the direct final rule TSD. These estimates are based on methods, assumptions, and

parameters identical to the estimates published by the IWG (which were based on EPA modeling), and include values for 2051 to 2070. DOE expects additional climate benefits to accrue for

products still operating after 2070, but a lack of available SC-CO₂ estimates for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

Table IV.16. Annual SC-CO₂ Values from 2021 Interagency Update, 2020–2050 (2020\$ per Metric Ton CO₂)

Year	Discount Rate and Statistic			
	5%	3%	2.5%	3%
	Average	Average	Average	95 th 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

DOE multiplied the CO₂ emissions reduction estimated for each year by the SC-CO₂ value for that year in each of the four cases. DOE adjusted the values to 2022\$ 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-CO₂ values in each case.

b. Social Cost of Methane and Nitrous Oxide

The SC-CH₄ and SC-N₂O values used for this direct final rule were based on the values developed for the February 2021 SC-GHG TSD. Table IV.17 shows the updated sets of SC-CH₄ and SC-N₂O 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 direct 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-CH₄ and SC-N₂O values, as recommended by the IWG. DOE derived values after 2050 using the approach described above for the SC-CO₂.

Table IV.17. Annual SC-CH₄ and SC-N₂O Values from 2021 Interagency Update, 2020–2050 (2020\$ per Metric Ton)

Year	SC-CH ₄				SC-N ₂ O			
	Discount Rate and Statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5%	3%
	Average	Average	Average	95 th percentile	Average	Average	Average	95 th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2025	800	1700	2200	4500	6800	21000	30000	54000
2030	940	2000	2500	5200	7800	23000	33000	60000
2035	1100	2200	2800	6000	9000	25000	36000	67000
2040	1300	2500	3100	6700	10000	28000	39000	74000
2045	1500	2800	3500	7500	12000	30000	42000	81000
2050	1700	3100	3800	8200	13000	33000	45000	88000

DOE multiplied the CH₄ and N₂O emissions reduction estimated for each year by the SC-CH₄ and SC-N₂O estimates for that year in each of the cases. DOE adjusted the values to 2022\$ 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 cases using the specific discount rate that had been used to obtain the SC-CH₄ and SC-N₂O estimates in each case.

c. Sensitivity Analysis Using EPA’s New SC-GHG Estimates

In December 2023, EPA issued an updated set of SC-GHG estimates (2023

SC-GHG) in connection with a final rulemaking under the Clean Air Act. These estimates incorporate recent research and address recommendations of the National Academies (2017) and comments from a 2023 external peer review of the accompanying technical report.

For this rulemaking, DOE used these updated 2023 SC-GHG values to

¹¹³ 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/Exec/

[ZyPDF.cgi?Dockey=P1013ORN.pdf](#) (last accessed Feb. 21, 2023).

conduct a sensitivity analysis of the value of GHG emissions reductions associated with alternative standards for dishwashers. This sensitivity analysis provides an expanded range of potential climate benefits associated with amended standards. The final year of EPA's new 2023 SC-GHG estimates is 2080; therefore, DOE did not monetize the climate benefits of GHG emissions reductions occurring after 2080.

The overall climate benefits are greater when using the higher, updated 2023 SC-GHG estimates, compared to the climate benefits using the older IWG SC-GHG estimates. The results of the sensitivity analysis are presented in appendix 14C of the direct final rule TSD.

2. Monetization of Other Emissions Impacts

For the direct final rule, DOE estimated the monetized value of NO_x and SO₂ emissions reductions from electricity generation using benefit-per-ton estimates for that sector from the EPA's Benefits Mapping and Analysis Program.¹¹⁴ DOE used EPA's values for PM_{2.5}-related benefits associated with NO_x and SO₂ 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 period; for years beyond 2040, the values are held constant. DOE combined the EPA regional benefit-per-ton estimates with regional information on electricity consumption and emissions from *AEO2023* to define weighted-average national values for NO_x and SO₂ (see appendix 14B of the direct final rule TSD).

DOE also estimated the monetized value of NO_x and SO₂ emissions reductions from site use of natural gas in dishwashers using benefit per ton estimates from the EPA's Benefits Mapping and Analysis Program. Although none of the sectors covered by EPA refers specifically to residential and commercial buildings, the sector called "area sources" would be a reasonable proxy for residential and commercial buildings.¹¹⁵ The EPA

¹¹⁴ U.S. Environmental Protection Agency. Estimating the Benefit per Ton of Reducing Directly Emitted PM_{2.5}, PM_{2.5} Precursors, and Ozone Precursors from 21 Sectors. www.epa.gov/benmap/estimating-benefit-ton-reducing-directly-emitted-pm25-pm25-precursors-and-ozone-precursors.

¹¹⁵ "Area sources" represents all emission sources for which states do not have exact (point) locations in their emissions inventories. Because exact locations would tend to be associated with larger sources, "area sources" would be fairly

document provides high and low estimates for 2025 and 2030 at 3- and 7-percent discount rates.¹¹⁶ DOE used the same linear interpolation and extrapolation as it did with the values for electricity generation.

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 *AEO2023*. 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 *AEO2023* Reference case and various side cases. Details of the methodology are provided in the appendices to chapters 13 and 15 of the direct 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. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment

representative of small dispersed sources like homes and businesses.

¹¹⁶ "Area sources" are a category in the 2018 document from EPA, but are not used in the 2021 document cited above. See www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf.

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 Labor Department's Bureau of Labor Statistics ("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.¹¹⁷ 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 direct final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 ("ImSET").¹¹⁸ ImSET is a special-purpose version of

¹¹⁷ 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 apps.bea.gov/scb/pdf/regional/perinc/meth/rims2.pdf (last accessed July 1, 2021).

¹¹⁸ 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.

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 changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may overestimate actual job impacts over the long run for this rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2027–2031), where these uncertainties are reduced. For more details on the employment impact analysis, see chapter 16 of the direct final rule TSD.

O. Regulatory Impact Analysis

For any regulatory action that the Administrator of the Office of Information and Regulatory Affairs (“OIRA”) within OMB determines is a significant regulatory action under section 3(f)(1) of E.O. 12866, section 6(a)(3)(C) of E.O. 12866 requires Federal agencies to provide an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, identified by the agencies or the public (including improving the current regulation and reasonably viable non-regulatory actions), and an explanation why the planned regulatory action is preferable to the identified potential alternatives. 58 FR 51735, 51741. As discussed further in section VII.A of this document, OIRA has determined that this final regulatory action constitutes a “significant regulatory action” within the scope of section 3(f)(1) of E.O. 12866. Accordingly, DOE conducted a regulatory impact analysis (“RIA”) for this direct final rule.

As part of the RIA, DOE identifies major alternatives to standards that represent feasible policy options to reduce the energy and water consumption of the covered product. DOE evaluates each alternative in terms of its ability to achieve significant energy and water savings at a reasonable cost and compares the effectiveness of each alternative to the effectiveness of the finalized standard. DOE recognizes that voluntary or other non-regulatory

efforts by manufacturers, utilities, and other interested parties can substantially affect energy and water efficiency or reduce energy and water consumption. DOE bases its assessment on the recorded impacts of any such initiatives to date, but also considers information presented by interested parties regarding the impacts current initiatives may have in the future. Further details regarding the RIA are provided in chapter 17 of the direct final rule TSD.

P. Other Comments

As discussed previously, DOE considered relevant comments, data, and information obtained during its own rulemaking process in determining whether the recommended standards from the Joint Agreement are in accordance with 42 U.S.C. 6295(o). And while some of those comments were directed at specific aspects of DOE’s analysis of the Joint Agreement under 42 U.S.C. 6295(o), others were more generally applicable to DOE’s energy conservation standards rulemaking program as a whole. The ensuing discussion focuses on these general comments concerning energy conservation standards issued under EPCA.

1. Non-Regulatory Approaches

AHAM commented that it incorporated by reference its comments on the January 2022 Preliminary TSD regarding AHAM’s position that there is more to be gained from increasing proper dishwasher use and ownership than from increasing energy conservation standards beyond efficiency level (“EL”) 1. (AHAM, No. 51 at p. 7) AHAM stated that the environmental goal for dishwasher cleaning should be to focus on dish cleaning as a process, as continued efficiency improvements for dishwashers themselves have diminishing returns with available technology. AHAM commented that the dishwasher is an important part of that process and increasing ownership and proper use of dishwashers has the potential to drive enormous water and significant energy savings that would dwarf the savings attributable to further amended standards. AHAM commented that in the future, conserving water—rather than energy—will continue to be the defining environmental issue for dishwasher cleaning performance. (*Id.*) AHAM commented that there is a wide range of dish cleaning behavior and from an environmental perspective, the preferred ordering of consumer behaviors is to run a full or partial dishwasher load without pre-rinsing and abstaining from hand-washing

dishes altogether, as the latter tends to use far more water than running a dishwasher. (*Id.* at pp. 7–8) AHAM cited the Energy Information Administration’s (“EIA’s”) 2020 *Residential Energy Consumption Survey* (“RECS”), stating that 14 percent of households have and do not use their dishwasher.

Additionally, according to RECS, dishwasher presence is lower in renter-occupied homes. AHAM recommended that DOE make an effort to increase educational and awareness initiatives on effective dishwasher use. (*Id.* at p. 8) AHAM cited data from EPA and a study from the University of Michigan by Gabriela Porras *et al.* to reiterate that properly using a dishwasher without pre-rinsing is the most economical approach for energy, water, and time usage, and that handwashing using between 6.9 to 22.8 gallons for eight place settings, respectively. (*Id.* at p. 9) AHAM asserted that by increasing dishwasher usage through educational initiatives promoting dishwasher ownership and proper use, DOE can achieve far greater savings that would show on consumers’ utility bills than it can by amending standards. (*Id.* at p. 10)

DOE acknowledges that a percentage of households do not own or own but do not use their dishwashers. DOE also acknowledges that non-regulatory options may exist to promote dishwasher ownership and property use to further push the potential for energy and water savings. However, DOE is required by EPCA to establish or amend standards for a covered product that are designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6295(g), (m), and (o)(2)(A)) DOE has determined that the energy conservation standards for dishwashers adopted in this direct final rule achieve the maximum improvement in energy efficiency which is technologically feasible and economically justified.

2. Test Procedure Usage Factors

The CA IOUs recommended DOE adjust the current load usage factors to reflect changes in consumer pre-treating habits since 2001, the date of the studies DOE relies on in this rulemaking. (CA IOUs, No. 50 at pp. 5–6) The CA IOUs commented that a nationally representative study by Lawrence Berkeley National Laboratory (“LBNL”) in 2021 (“2021 LBNL Study”)¹¹⁹ shows

¹¹⁹ Stratton, H. *et al.*, “Dishwashers in the Residential Sector: A Survey of Product Characteristics, Usage, and Consumer Preferences,”

consumers pre-treat their dishes less often (when compared to 2001) before placing them in a dishwasher, and the CA IOUs recommended DOE capture this change by updating the light, medium, and heavy soil level distribution to 48 percent, 38 percent, and 14 percent, respectively. (*Id.*)

DOE notes that it established the load usage factors in the dishwasher test procedure in August 2003 to account for the varying energy and water performance of units that include soil sensors. 68 FR 51887, 51890. In that rulemaking, DOE relied on survey data gathered and analyzed by Arthur D. Little (“ADL”) ¹²⁰ to characterize the quantity of soils that consumers load into a dishwasher. 68 FR 51887, 51890. Using the soil loads from an earlier version of AHAM DW–1 ¹²¹ as a reference point, the ADL report defined a light soil load as half the quantity of a single soiled place setting as defined in AHAM DW–1. A medium soil load was equivalent to two soiled AHAM DW–1 place settings and a heavy soil load was approximately equal to four soiled AHAM DW–1 place settings. With these load size definitions, ADL found that consumers reported that they most frequently washed lightly soiled loads (62 percent of loads), with medium (33 percent) and heavy (5 percent) soil loads making up the remainder. Therefore, DOE used this as the distribution of soil loads for the heavy, medium, and light soil load cycles in the DOE test procedure. 68 FR 51887, 51890. While the ADL report also presented data on the frequency of different types of pre-treatment, it did not correlate pre-treatment itself to different resulting soil loads and thus load usage factors.

More recently, in the January 2023 TP Final Rule, DOE addressed comments from the CA IOUs and Samsung pertaining to whether consumers’ pre-rinsing habits, including those surveyed in the 2021 LBNL Study, warranted amendments to the soil loads and corresponding usage factors in the dishwasher test procedure. DOE determined in the January 2023 TP

Final Rule that it did not have, nor did commenters submit, any specific information about the types of soils that would be used to reflect pre-rinsing, or lack thereof, or the consumer relevance of such soils. 88 FR 3234, 3246. Accordingly, DOE did not amend the soil load usage factors in the January 2023 TP Final Rule.

DOE also notes that the 2021 LBNL Study focused on consumer priorities with respect to their dishwashers. The requirement for pre-treatment of dishes was identified as the second to last priority of 18 possibilities for the 1201 survey respondents (less important than cutlery tray location). Pre-treatment of dishes reflect consumer habit, rather than dishwasher performance.^{122 123} The 2021 LBNL Study did not address a correlation of pre-treatment of dishes with resulting soil loads on the dishes, which may have changed since the time of the ADL report, so did not provide information with which to evaluate any different load usage factors. Additionally, the LCC employs no load usage factor but relies on the reported number of weekly loads for each household in the RECS 2020 dataset.

3. National Academy of Sciences Report

The National Academies of Sciences, Engineering, and Medicine (“NAS”) periodically appoint a committee to peer review the assumptions, models, and methodologies that DOE uses in setting energy conservation standards for covered products and equipment. The most recent such peer review was conducted in a series of meetings in 2020, and NAS issued the report ¹²⁴ in 2021 detailing its findings and recommendations on how DOE can improve its analyses and align them with best practices for cost-benefit analysis.

AHAM stated that despite previous requests from AHAM and others, DOE has failed to review and incorporate the recommendations of the NAS report, instead indicating that it will conduct a separate rulemaking process without such a process having been initiated. (AHAM, No. 51 at p. 17) AHAM

asserted that DOE seems to be ignoring the recommendations in the NAS Peer Review Report and even conducting analyses that are the opposite of these recommendations. AHAM stated that DOE cannot continue to perpetuate the errors in its analytical approach that have been pointed out by stakeholders and the NAS report, as to do so will lead to arbitrary and capricious rules. (*Id.*)

As discussed, the rulemaking process for establishing new or amended standards for covered products and equipment is specified at appendix A. DOE periodically examines and revises these provisions in separate rulemaking proceedings. The recommendations provided in the 2021 NAS report, which pertain to the processes by which DOE analyzes energy conservation standards, will be considered by DOE in a forthcoming rulemaking process.

V. Analytical Results and Conclusions

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

A. Trial Standard Levels

In general, DOE typically evaluates potential new or 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 dishwasher classes, to the extent that there are such interactions, and price elasticity of consumer purchasing decisions that may change when different standard levels are set.

In the analysis conducted for this direct final rule, DOE analyzed the benefits and burdens of five TSLs for dishwashers. DOE developed TSLs that combine efficiency levels for each analyzed dishwasher class. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the direct 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 dishwashers. TSL 5 represents the max-tech energy efficiency for both product classes and corresponds to EL 4 for standard-size dishwashers and EL

Energy Technologies Area Publications, May 2021 https://eta-publications.lbl.gov/sites/default/files/osg_lbnl_report_dishwashers_final_4.pdf.

¹²⁰ ADL survey data are available at www.regulations.gov/document?D=EERE-2006-TP-0096-0055.

¹²¹ “Household Electric Dishwashers.” AHAM DW–1 was renumbered to AHAM DW–2 when it was updated in 2020. Although not identical to the soil loads in AHAM DW–2–2020, they are substantially similar. This standard provides a uniform method to test and measure cleaning performance of dishwashers, including the soil preparation, soil application, and scoring of test load to calculate cleaning index.

¹²² Richter, Christian Paul, 2011. Use of dishwashers: observation of consumer habits in the domestic environment. (Last accessed January 23, 2024.) <https://pubag.nal.usda.gov/catalog/547534>.

¹²³ Stamminger, et al., 2017. A European Comparison of Cleaning Dishes by Hand. (Last accessed January 23, 2024.) <https://silo.tips/download/a-european-comparison-of-cleaning-dishes-by-hand>.

¹²⁴ National Academies of Sciences, Engineering, and Medicine. 2021. *Review of Methods for Setting Building and Equipment Performance Standards*. Available at www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards (last accessed Nov. 20, 2023).

2 for compact-size dishwashers. TSL 4 is the TSL that maximizes net benefits at a 3-percent discount rate; this TSL represents the highest efficiency levels providing positive LCC savings, which comprises the gap-fill efficiency level between ENERGY STAR V. 6.0 and ENERGY STAR V. 7.0 (EL 2) for standard-size dishwashers and max-tech efficiency level (EL 2) for compact-size dishwashers. TSL 3 is the

Recommended TSL detailed in the Joint Agreement. TSL 3 maximizes net benefits at a 7-percent discount rate; this TSL comprises the gap-fill efficiency level between the ENERGY STAR V. 6.0 level and ENERGY STAR V. 7.0 level (EL 2) for standard-size dishwashers and the ENERGY STAR V. 6.0 level (EL 1) for compact-size dishwashers. TSL 2 comprises the ENERGY STAR V. 6.0 level (EL 1) for standard-size

dishwashers and the max-tech efficiency level (EL 2) for compact-size dishwashers. TSL 1 represents EL 1 across both product classes and the ENERGY STAR V. 6.0 level. While representative ELs were included in the TSLs, DOE considered all efficiency levels as part of its analysis and included the efficiency levels with positive LCC savings in the TSLs.¹²⁵

Table V.1 Trial Standard Levels for Dishwashers

TSL	PC 1: Standard-Size Dishwasher			PC 2: Compact-Size Dishwasher		
	Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Per-Cycle Water Consumption (gal/cycle)	Efficiency Level	Estimated Annual Energy Use (kWh/year)*	Per-Cycle Water Consumption (gal/cycle)
1	1	232	3.5	1	174	3.1
2	1	232	3.5	2	124	1.6
3**	2	223	3.3	1	174	3.1
4	2	223	3.3	2	124	1.6
5	4	193	2.4	2	124	1.6

* Based on appendix C2.

** Recommended TSL from the Joint Agreement.

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on dishwasher 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. Because the technologies to improve energy

efficiency may also reduce water usage (as discussed in IV.C.1.b), annual operating costs include both energy and water consumption. 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 and water use, energy prices, energy and water price trends, repair costs, and maintenance costs). The LCC calculation also uses product lifetime and a discount rate. Chapter 8 of the direct 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 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.

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¹²⁵ Efficiency levels that were analyzed for this final rule are discussed in section IV.C.4 of this

document. Results by efficiency level are presented in TSD chapters 8, 10, and 12.

Table V.2 Average LCC and PBP Results for PC 1: Standard-Size Dishwashers

TSL	EL	Average Costs (2022\$)				Simple Payback (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	\$470	\$45	\$625	\$1,095	--	15.2
1,2	1	\$496	\$40	\$592	\$1,088	4.9	15.2
3,4	2	\$496	\$39	\$576	\$1,072	3.9	15.2
5	4	\$649	\$34	\$585	\$1,234	15.9	15.2

* Based on the test procedure assumption of 184 cycles per year.

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.3 Average LCC Savings Relative to the No-New-Standards Case for PC 1: Standard-Size Dishwashers

TSL	EL	Life-Cycle Cost Savings	
		Average LCC Savings* (2022\$)	Percent of Consumers that Experience Net Cost
1,2	1	\$5	4%
3,4	2	\$17	3%
5	4	(\$145)	97%

Table V.4 Average LCC and PBP Results for PC 2: Compact-Size Dishwashers

TSL	EL	Average Costs (2022\$)				Simple Payback (years)	Average Lifetime (years)
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	Baseline	\$508	\$33	\$491	\$999	--	15.2
1,3	1	\$508	\$31	\$460	\$968	0.0	15.2
2,4,5	2	\$566	\$23	\$398	\$964	5.5	15.2

* Based on the test procedure assumption of 184 cycles per year.

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: Compact-Size Dishwashers

TSL	EL	Life-Cycle Cost Savings	
		Average LCC Savings* (2022\$)	Percent of Consumers that Experience Net Cost
1,3	1	\$32	0%
2,4,5	2	\$4	54%

* 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, senior-only households, and well-water 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 standard-size dishwashers. In most cases, the average LCC savings and PBP for low-income households, senior-only households, and well-water households

at the considered efficiency levels are not substantially different from the average for all households. The well-users have reduced water operating costs and therefore receive less operating cost savings (and lower LCC savings). The senior subgroup has

slightly lower dishwasher usage frequency compared to the national sample and therefore also experience

lower operating cost savings (and lower LCC savings).

Chapter 11 of the direct 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: Standard-Size Dishwashers

	Low-Income Households**	Senior-Only Households†	Well-water Households‡	All Households
Average LCC Savings* (2022\$)				
TSL 1-2	\$45	(\$7)	(\$18)	\$5
TSL 3-4	\$21	\$13	\$12	\$17
TSL 5	(\$29)	(\$159)	(\$162)	(\$145)
Payback Period (years)				
TSL 1-2	2.0	6.2	7.2	4.9
TSL 3-4	1.6	4.9	5.5	3.9
TSL 5	6.6	19.8	21.4	15.9
Consumers with Net Benefit (%)				
TSL 1-2	4%	2%	2%	2%
TSL 3-4	81%	87%	86%	87%
TSL 5	45%	2%	2%	3%
Consumers with Net Cost (%)				
TSL 1-2	2%	5%	5%	4%
TSL 3-4	2%	4%	4%	3%
TSL 5	46%	98%	98%	97%

* The savings represent the average LCC for affected consumers.

** Low-income households represent 5.7 percent of all households for this product class. To perform the cost-benefit analysis, DOE drew 10,000 consumer samples from the low-income sample pool and distinguished the assumption on low-income owners and renters depending on if they were paying the energy bills. More details can be found in Table IV.15. The statistics of the 10,000 low-income consumer samples were shown in the table.

† Senior-only households represent 23.2 percent of all households for this product class.

‡ Well-water households represent 10.5 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: Compact-Size Dishwashers

	Low-Income Households**	Senior-Only Households†	Well water Households‡	All Households
Average LCC Savings* (2022\$)				
TSL 1,3	\$39	\$26	\$23	\$32
TSL 2,4,5	\$62	(\$14)	(\$19)	\$4
Payback Period (years)				
TSL 1,3	0.0	0.0	0.0	0.0
TSL 2,4,5	2.3	6.8	6.9	5.5
Consumers with Net Benefit (%)				
TSL 1,3	2%	2%	2%	2%
TSL 2,4,5	52%	23%	22%	31%
Consumers with Net Cost (%)				
TSL 1,3	0%	0%	0%	0%
TSL 2,4,5	26%	62%	63%	54%

* The savings represent the average LCC for affected consumers.

** Low-income households represent 5.7 percent of all households for this product class.

† Senior-only households represent 23.2 percent of all households for this product class.

‡ Well-water households represent 10.5 percent of all households for this product class.

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c. Rebuttable Presumption Payback

As discussed in section III.D.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. (42 U.S.C. 6295(o)(2)(B)(iii)) 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 dishwashers. 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 dishwashers. 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	TSL				
	1	2	3	4	5
	years				
PC 1: Standard-Size	3.7	3.7	3.0	3.0	12.6
PC 2: Compact-Size	0.0	4.6	0.0	4.6	4.6

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of amended energy conservation standards on manufacturers of dishwashers. The following section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the direct 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 illustrate the estimated financial impacts (represented by changes in INPV) of potential amended energy conservation standards on manufacturers of dishwashers, as well as the conversion costs that DOE estimates manufacturers of dishwashers would incur at each TSL.

To evaluate the range of cash-flow impacts on the dishwasher industry, DOE modeled two scenarios using different assumptions that correspond to the range of anticipated market responses to amended energy conservation standards: (1) a preservation of gross margin percentage scenario; (2) a tiered scenario, as discussed in section IV.J.2.d of this

document. The preservation of gross margin percentage applies a “gross margin percentage” of 19.4 percent for both standard-size and compact-size product classes.¹²⁶ This scenario assumes that a manufacturer’s per-unit dollar profit would increase as MPCs increase in the standards cases and represents the upper-bound to industry profitability under potential amended energy conservation standards.

The tiered scenario starts with the three different product manufacturer markups in the no-new-standards case (baseline, ENERGY STAR V. 6.0, and ENERGY STAR V. 7.0¹²⁷). This scenario reflects a concern about product commoditization at higher efficiency levels as efficiency differentiators are eliminated and manufacturer markups are reduced. The tiered scenario results in the lower (or larger in magnitude) bound to impacts of potential amended standards on industry.

Each of the modeled scenarios results in a unique set of cash flows and corresponding INPV for each TSL. INPV is the sum of the discounted cash flows to the industry from the direct final rule publication year through the end of the analysis period (2024–2056). The “change in INPV” results refer to the difference in industry value between the no-new-standards case and standards

case at each TSL. To provide perspective on the short-run cash flow impact, DOE includes a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before amended standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry in the no-new-standards case.

Conversion costs are one-time investments for manufacturers to bring their manufacturing facilities and product designs into compliance with potential amended standards. As described in section IV.J.2.c of this document, conversion cost investments occur between the year of publication of the direct final rule and the year by which manufacturers must comply with the new standard. The conversion costs can have a significant impact on the short-term cash flow of the industry and generally result in lower free cash flow in the period between the publication of the direct final rule and the compliance date of potential amended standards. Conversion costs are independent of the manufacturer markup scenarios and are not presented as a range in this analysis.

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¹²⁶ The gross margin percentage of 19.4 percent is based on a manufacturer markup of 1.24.

¹²⁷ ENERGY STAR V. 7.0 corresponds to the 2022 ENERGY STAR Most Efficient qualification criteria.

Table V.9 Manufacturer Impact Analysis Results for Dishwashers

	Unit	No-new-standards case	TSL 1	TSL 2	TSL 3**	TSL 4	TSL 5
INPV	2022\$ Million	735.8	680.8 to 729.7	673.7 to 723.3	587.1 to 639.1	579.9 to 632.8	334.4 to 414.6
Change in INPV*	%	-	(7.5) to (0.8)	(8.4) to (1.7)	(20.2) to (13.1)	(21.2) to (14.0)	(54.5) to (43.7)
Free Cash Flow (2026)*	2022\$ Million	52.3	47.9	43.8	1.5	(2.5)	(236.4)
Change in Free Cash Flow (2026)*	%	-	(8.5)	(16.3)	(97.1)	(104.8)	(552.0)
Product Conversion Costs	2022\$ Million	-	11.8	17.0	58.3	63.5	249.0
Capital Conversion Costs	2022\$ Million	-	1.0	6.0	68.7	73.7	432.0
Total Conversion Costs	2022\$ Million	-	12.7	23.0	126.9	137.2	681.0

* Parentheses indicates negative (-) values.

**The Recommended TSL

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At TSL 1, the standard represents EL 1 across both standard-size and compact-size dishwashers and the ENERGY STAR V. 6.0 level. The change in INPV is expected to range from -7.5 percent to -0.8 percent. At this level, free cash flow is estimated to decrease by 8.5 percent compared to the no-new-standards case value of \$52.3 million in the year 2026, the year before the standards year. Currently, approximately 93 percent of domestic dishwasher shipments meet the efficiencies required at TSL 1. For standard-size dishwashers, which account for approximately 98 percent of annual shipments, 93 percent of shipments meet the efficiencies required. For compact-size dishwashers, which account for the remaining 2 percent of annual shipments, 87 percent of shipments meet the efficiencies required.

The design options DOE analyzed for standard-size dishwashers include implementing electronic controls, soil sensing, multiple spray arms, improved water filters, a separate drain pump, and tub insulation. The design options DOE analyzed for compact-size dishwashers include implementing improved controls. At this level, capital conversion costs are minimal since the majority of products already meet the efficiency levels required. As with all

the analyzed TSLs, conversion costs incorporate industry testing costs as manufacturers implement the cleaning performance test and re-rate all their existing, compliant models in accordance with the new appendix C2. 10 CFR appendix C2 to subpart of part 430. DOE expects industry to incur some re-flooring costs associated with standard-size dishwashers as manufacturers redesign baseline products to meet the efficiency levels required by TSL 1. In interviews, manufacturers stated that there are not re-flooring costs associated with compact-size dishwashers as those are typically not on display at big-box stores. DOE estimates capital conversion costs of \$1.0 million and product conversion costs of \$11.8 million. Conversion costs total \$12.7 million.

Under the tiered manufacturer markup scenario, which is discussed in IV.J.2.d of this document, the key driver of impacts to INPV at TSL 1 is the result of margin compression for both standard-size and compact-size dishwashers as manufacturers forfeit premiums and cut into margins as they try to maintain a competitively priced baseline product. Although only a small fraction of products (approximately 7 percent of shipments) would need to be redesigned at this level, the margin compression under the tiered scenario has a disproportionately large impact on

INPV, since most of the market (approximately 84 percent of standard-size and compact-size dishwasher shipments) is at EL 1 (*i.e.*, the ENERGY STAR V. 6.0 level) in the no-new-standards case.

At TSL 2, the standard represents the ENERGY STAR V. 6.0 level (EL 1) for standard-size dishwashers and the max-tech efficiency level (EL 2) for compact-size dishwashers. The change in INPV is expected to range from -8.4 percent to -1.7 percent. At this level, free cash flow is estimated to decrease by 16.3 percent compared to the no-new-standards case value of \$52.3 million in the year 2026, the year before the standards year. Currently, approximately 92 percent of domestic dishwasher shipments meet the efficiencies required at TSL 2. As with TSL 1, 93 percent of standard-size dishwasher shipments meet the efficiencies required. For compact-size dishwashers, 21 percent of shipments currently meet the efficiencies required.

The design options DOE analyzed for standard-size dishwashers are the same as at TSL 1. The design options analyzed for compact-size dishwashers include implementing the design options at TSL 1 as well as permanent magnet motors, improved filters, hydraulic system optimization, heater incorporated into base of tub, and reduced sump volume. The increase in

conversion costs from the prior TSL is entirely due to the higher efficiency level required for compact-size dishwashers. At TSL 2, all manufacturers of compact-size countertop dishwashers with four or more place settings and in-sink dishwashers with less than four place settings would need to redesign their products to meet the efficiencies required, as DOE is not aware of any currently available products in these two configurations that meet TSL 2. Manufacturer feedback and the engineering analysis indicate that redesigning these compact-size configurations to meet max-tech would require significant investment, both in terms of engineering resources and new tooling, relative to the size of the domestic compact-size dishwasher market. While it is technologically feasible for compact-size countertop dishwashers with four or more place settings and in-sink dishwashers with less than four place settings to meet TSL 2 (max-tech for compact-size dishwashers), manufacturers would need to determine whether the shipments volumes justify the level of investment required. DOE expects industry to incur the same re-flooring costs as at TSL 1. DOE estimates capital conversion costs of \$6.0 million and product conversion costs of \$17.0 million. Conversion costs total \$23.0 million.

Under the tiered manufacturer markup scenario, the key driver of impacts to INPV at TSL 2 is the result of margin compression for both standard-size and compact-size dishwashers as manufacturers forfeit premiums and cut into margins in an attempt to maintain a competitively priced baseline product. In particular, because TSL 2 sets standards for compact-size dishwashers at max-tech, manufacturers lose their premium markup for high-efficiency compact-size products, contributing to a reduction in future revenues and INPV.

At TSL 3, the standard represents the gap-fill efficiency level between the ENERGY STAR V. 6.0 level and ENERGY STAR V. 7.0 level (EL 2) for standard-size dishwashers and the ENERGY STAR V. 6.0 level (EL 1) for compact-size dishwashers. The change in INPV is expected to range from –20.2 percent to –13.1 percent. At this level, free cash flow is estimated to decrease by 97.1 percent compared to the no-new-standards case value of \$52.3 million in the year 2026, the year before the standards year. Currently, approximately 11 percent of domestic dishwasher shipments meet the efficiencies required at TSL 3. For

standard-size dishwashers, 9 percent of current shipments meet the efficiencies required. As with TSL 1, 87 percent of compact-size dishwasher shipments meet the efficiencies required.

The design options DOE analyzed for standard-size dishwashers include implementing the design options at TSL 1 and TSL 2 as well as improved control strategies, which could necessitate product redesign to more closely control water temperature, water fill volumes, *etc.* The design options analyzed for compact-size dishwashers are the same as for TSL 1. The increase in conversion costs from the prior TSL is entirely due to the increased efficiency level required for standard-size dishwashers. In interviews, some manufacturers stated that meeting TSL 3 would involve physical improvements to system elements to enable tighter controls and better design tolerances, while maintaining certain product attributes valued by their consumers. Although manufacturers tended to agree that the key product attributes (in addition to energy use, water use, and cleaning performance) included drying performance, cycle duration, and noise levels, manufacturers identified different priorities and internal targets for those metrics. One manufacturer noted that maintaining the same normal cycle time across its dishwasher portfolio was a key design parameter, as this feature was part of its value proposition and marketing material. A different manufacturer emphasized that maintaining drying performance, particularly of plastic dishware, was a key concern for its consumer base. These manufacturers stated that they may need new tooling and some modifications to the assembly line to improve the system elements to meet TSL 3 efficiencies while maintaining these product attributes. DOE notes that since the May 2023 NOPR published, more manufacturers now offer standard-size dishwasher models that meet the TSL 3 efficiencies. DOE believes that the recent introduction of more high-efficiency standard-size dishwashers is largely in response to ENERGY STAR V. 7.0, which went into effect in July 2023. Of the 19 OEMs offering standard-size products, 16 OEMs offer products that meet the efficiency level required. DOE expects industry to incur more re-flooring costs compared to TSL 2. DOE estimates capital conversion costs of \$68.7 million and product conversion costs of \$58.3 million. Conversion costs total \$126.9 million.

TSL 3 brings standards for standard-size dishwashers above ENERGY STAR V. 6.0 levels. Under the tiered scenario, the fraction of products that are eligible

for any additional premium markups above baseline is further reduced as manufacturers sacrifice margins while seeking to maintain a low-price-point baseline model.

At TSL 4, the standard represents the highest efficiency levels providing positive LCC savings, which comprise the gap-fill efficiency level between the ENERGY STAR V. 6.0 level and ENERGY STAR V. 7.0 level (EL 2) for standard-size dishwashers and max-tech efficiency level (EL 2) for compact-size dishwashers. The change in INPV is expected to range from –21.2 percent to –14.0 percent. At this level, free cash flow is estimated to decrease by 104.8 percent compared to the no-new-standards case value of \$52.3 million in the year 2026, the year before the standards year. Currently, approximately 10 percent of domestic dishwasher shipments meet the efficiencies required at TSL 4. As with TSL 3, 9 percent of standard-size dishwasher shipments meet the efficiencies required. As with TSL 2, 21 percent of compact-size dishwasher shipments meet the efficiencies required.

The design options DOE analyzed for standard-size dishwashers are the same as at TSL 3. The design options analyzed for compact-size dishwashers are the same as at TSL 2 and include implementing permanent magnet motors, improved filters, hydraulic system optimization, heater incorporated into base of tub, and reduced sump volume. The increase in conversion costs from the prior TSL is entirely due to the increased efficiency level required for compact-size dishwashers. As discussed previously, all manufacturers of compact-size countertop dishwashers with four or more place settings and in-sink dishwashers with less than four place settings would need to redesign their products to meet the efficiencies required, as DOE is not aware of any currently available products in these two configurations that meet TSL 4 (max-tech for compact-size dishwashers). Manufacturer feedback and the engineering analysis indicate that redesigning these compact-size dishwasher configurations to meet TSL 4 would require significant investment, both in terms of engineering resources and new tooling, relative to the size of the domestic compact-size dishwasher market. DOE expects industry to incur similar re-flooring costs compared to TSL 3. DOE estimates capital conversion costs of \$73.7 million and product conversion costs of \$63.5 million. Conversion costs total \$137.2 million.

At TSL 4, the large conversion costs result in free cash flow dropping below zero in the years before the standards year. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

Under the tiered manufacturer markup scenario, one of the key drivers of impacts to INPV at TSL 4 is the result of margin compression for both standard-size and compact-size dishwashers as manufacturers forfeit premiums and cut into margins in an attempt to maintain a competitively priced baseline product. In particular, because TSL 4 sets standards for compact-size dishwashers at max-tech, manufacturers lose their premium markups for high-efficiency compact-size products, contributing to a reduction in future revenues and INPV.

At TSL 5, the standard represents the max-tech energy efficiency for both product classes and corresponds to EL 4 for standard-size dishwashers and EL 2 for compact-size dishwashers. The change in INPV is expected to range from -54.5 percent to -43.7 percent. At this level, free cash flow is estimated to decrease by 552.0 percent compared to the no-new-standards case value of \$52.3 million in the year 2026, the year before the standards year. Currently, less than 1 percent of domestic dishwasher shipments meet the efficiencies required at TSL 5. For standard-size dishwashers, DOE estimates that no shipments currently meet the efficiencies required. As with TSL 4, 21 percent of compact-size dishwasher shipments meet the efficiencies required.

The design options DOE analyzed for standard-size dishwashers include design options considered at the lower efficiency levels (*i.e.*, electronic controls, soil sensors, multiple spray arms, improved water filters and control strategies, separate drain pump, tub insulation, hydraulic system optimization, water diverter assembly, temperature sensor, 3-phase variable-speed motor, and flow meter) and include additional design options such as condensation drying, including use of a stainless steel tub; flow-through heating implemented as an in-sump integrated heater; and control strategies. The design options analyzed for compact-size dishwashers are the same as at TSL 4. The increase in conversion costs from the prior TSL is entirely due to the increased efficiencies required for standard-size dishwashers.

All manufacturers interviewed stated that meeting max-tech would necessitate significant platform redesign in order to meet the required

efficiencies and maintain the product attributes that consumers desire. Manufacturers noted that investments in new tooling, equipment, and production line modifications may be necessary to implement a range of design options. Specifically, manufacturers discussed tooling for additional spray arms, new sump tooling, new stamping equipment, door opening systems, improved filtration systems, and new dish racks. Manufacturers would likely need to convert all existing plastic tub designs to stainless steel tubs, which would necessitate expanding existing stainless steel tub production capacity and retiring plastic injection equipment used for plastic tubs. None of the manufacturers interviewed, which together account for approximately 90 percent of dishwasher shipments, currently offer standard-size dishwashers that meet max-tech. Therefore, most manufacturers expressed technical uncertainty about the extent of the design changes and production line updates that would be needed to meet max-tech and satisfy their consumer base. Some manufacturers suggested they would explore new water purification technology systems for water reuse. Other manufacturers noted that meeting max-tech may necessitate new tub architectures, which would require significant capital investment. These manufacturers noted that if new technology was necessary (*e.g.*, water purification systems) or if new tub architectures were required, the 3-year compliance period may be insufficient to complete the necessary product redesign and production facility updates. DOE estimates capital conversion costs of \$432.0 million and product conversion costs of \$249.0 million. Conversion costs total \$681.0 million.

At TSL 5, the large conversion costs result in free cash flow dropping below zero in the years before the standards year. The negative free cash flow calculation indicates manufacturers may need to access cash reserves or outside capital to finance conversion efforts.

TSL 5 sets the standard for all products as high as technologically feasible, leaving manufacturers no ability to differentiate products by efficiency under the tiered manufacturer markup scenario. Thus, all margins collapse to the baseline levels.

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the dishwasher industry, DOE used the GRIM to

estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period. For this direct final rule, DOE used the most up-to-date information available. DOE calculated these values using statistical data from the U.S. Census Bureau's 2021 ASM,¹²⁸ BLS employee compensation data,¹²⁹ results of the engineering analysis, and manufacturer interviews.

Labor expenditures related to product manufacturing depend on the labor intensity of the product, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the total MPCs by the labor percentage of MPCs. The total labor expenditures in the GRIM were then converted to total production employment levels by dividing production labor expenditures by the average fully burdened wage multiplied by the average number of hours worked per year per production worker. To do this, DOE relied on the ASM inputs: Production Workers Annual Wages, Production Workers Annual Hours, Production Workers for Pay Period, and Number of Employees. DOE also relied on the BLS employee compensation data to determine the fully burdened wage ratio. The fully burdened wage ratio factors in paid leave, supplemental pay, insurance, retirement and savings, and legally required benefits.

The total of production employees is then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered product. This value is derived from manufacturer interviews, product database analysis, and publicly available information. DOE estimates that approximately 78 percent of standard-size dishwashers are produced domestically. DOE estimates that no compact-size dishwashers are produced domestically. Therefore, overall, DOE estimates that approximately 76 percent of all covered dishwashers sold in the

¹²⁸ U.S. Census Bureau, *Annual Survey of Manufactures*. "Summary Statistics for Industry Groups and Industries in the U.S. (2021)." Available at www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html (last accessed Nov. 22, 2023).

¹²⁹ U.S. Bureau of Labor Statistics, *Employer Costs for Employee Compensation*. September 12, 2023. Available at www.bls.gov/news.release/archives/ecec_12152023.pdf (last accessed Nov. 22, 2023).

United States are produced domestically.

The domestic production employees estimate covers production line workers, including line supervisors, who are directly involved in fabricating and assembling products within the OEM facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor. DOE's estimates only account for production workers who manufacture the specific products covered by this direct final rule.

Non-production workers account for the remainder of the direct employment figure. The number of non-production employees covers domestic workers who are not directly involved in the production process, such as sales, engineering, human resources, management, *etc.* Using the number of domestic production workers calculated above, non-production domestic employees are extrapolated by multiplying the ratio of non-production workers in the industry compared to production employees. DOE assumes that this employee distribution ratio remains constant between the no-new-standards case and standards cases.

Using the GRIM, DOE estimates in the absence of new energy conservation standards there would be 3,950 domestic production and non-production workers for standard-size dishwashers in 2027 (the analyzed compliance year). To evaluate the range of cash-flow impacts on the dishwasher industry, DOE modeled two scenarios using different assumptions that

correspond to the range of anticipated market responses to amended energy conservation standards: (1) a preservation of gross margin percentage scenario; (2) a tiered scenario, as discussed in section IV.J.2.d of this document. The preservation of gross margin percentage applies a "gross margin percentage" of 19.4 percent for both standard-size and compact-size product classes. This scenario assumes that a manufacturer's per-unit dollar profit would increase as MPCs increase in the standards cases and represents the upper-bound to industry profitability under potential amended energy conservation standards.

The tiered scenario starts with the three different product manufacturer markups in the no-new-standards case (baseline, ENERGY STAR V. 6.0, and ENERGY STAR V. 7.0). This scenario reflects a concern about product commoditization at higher efficiency levels as efficiency differentiators are eliminated and manufacturer markups are reduced. The tiered scenario results in the lower (or larger in magnitude) bound to impacts of potential amended standards on industry.

Each of the modeled scenarios results in a unique set of cash flows and corresponding INPV for each TSL. INPV is the sum of the discounted cash flows to the industry from the direct final rule publication year through the end of the analysis period (2024–2056). The "change in INPV" results refer to the difference in industry value between the no-new-standards case and standards case at each TSL. To provide perspective on the short-run cash flow impact, DOE includes a comparison of

free cash flow between the no-new-standards case and the standards case at each TSL in the year before amended standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry in the no-new-standards case.

Conversion costs are one-time investments for manufacturers to bring their manufacturing facilities and product designs into compliance with potential amended standards. As described in section IV.J.2.c of this document, conversion cost investments occur between the year of publication of the direct final rule and the year by which manufacturers must comply with the new standard. The conversion costs can have a significant impact on the short-term cash flow of the industry and generally result in lower free cash flow in the period between the publication of the direct final rule and the compliance date of potential amended standards. Conversion costs are independent of the manufacturer markup scenarios and are not presented as a range in this analysis.

Table V.9 Table V.10 shows the range of the impacts of energy conservation standards on U.S. manufacturing employment in the standard-size dishwasher industry. As previously noted, DOE did not identify any U.S. manufacturing facilities producing compact-size dishwashers for the domestic market, and therefore does not present a range of direct employment impacts. The following discussion provides a qualitative evaluation of the range of potential impacts presented in Table V.10.

Table V.10 Direct Employment Impacts for Domestic Standard-Size Dishwasher Manufacturers in 2027*

	No-Standards Case	Trial Standard Level				
		1	2	3**	4	5
Direct Employment in 2027 (Production Workers + Non-Production Workers)	3,950	3,981	3,981	3,981	3,981	4,583
Potential Changes in Direct Employment in 2027*	-	(3,526) to 31	(3,526) to 31	(3,526) to 31	(3,526) to 31	(3,526) to 633

* DOE presents a range of potential employment impacts. Numbers in parentheses indicate negative numbers.

**The Recommended TSL

The direct employment impacts shown in Table V.10 represent the potential domestic employment changes that could result following the compliance date for the standard-size

dishwashers in this direct final rule. The upper bound estimate corresponds to an increase in the number of domestic workers that would result from amended energy conservation

standards if manufacturers continue to produce the same scope of covered products within the United States after compliance takes effect.

To establish a conservative lower bound, DOE assumes all manufacturers would shift production to foreign countries or would shift to importing finished goods (versus manufacturing in-house). As previously discussed, the majority of standard-size dishwashers sold in the United States are manufactured in domestic production facilities. However, many major dishwasher OEMs with U.S. production facilities also have dishwasher manufacturing facilities located outside the United States. At lower TSLs (*i.e.*, TSL 1 through TSL 4), DOE believes the likelihood of changes in production location due to amended standards are low due to the relatively minor production line updates required. However, at max-tech, both the complexity and cost of production facility updates increases, manufacturers are more likely to revisit their production location decisions. At max-tech, one manufacturer representing a large portion of the U.S. dishwasher market noted concerns about the level of investment and indicated the potential need to relocate production lines in order to remain competitive. In this direct final rule, DOE is adopting the Recommended TSL, which corresponds to the standard levels recommended in the Joint Agreement. As discussed in section III.B of this document, the Joint Agreement included a trade association, AHAM, which represents 16 manufacturers of dishwashers. Additionally, DOE notes that the Recommended TSL for standard-size dishwashers corresponds to EL 2 and not max-tech (EL 4). Furthermore, most OEMs already make standard-size dishwashers that meet the Recommended TSL. Of the 19 OEMs offering standard-size products, 16 OEMs already offer standard-size dishwashers that meet the efficiency level required. Since most manufacturers with U.S. production facilities already manufacture standard-size dishwashers that meet the adopted levels, DOE expects that the likelihood of shifts in domestic production locations as a direct result of amended standards for standard-size dishwashers are relatively low.

Additional detail on the analysis of direct employment can be found in chapter 12 of the direct final rule TSD. Additionally, the employment impacts discussed in this section are independent of the employment impacts

from the broader U.S. economy, which are documented in chapter 16 of the direct final rule TSD.

c. Impacts on Manufacturing Capacity

As discussed in section V.B.2.a of this document, implementing the different design options analyzed for this direct final rule would require varying levels of resources and investment. At higher efficiency levels, manufacturers noted that balancing more stringent energy and water use requirements while maintaining the product attributes their consumers value becomes increasingly challenging. All manufacturers interviewed, which together account for approximately 90 percent of industry shipments, noted that meeting the standard-size dishwasher max-tech efficiencies and cleaning performance requirement while maintaining internal targets for other product attributes such as drying performance, cycle duration, and noise levels, would require significant investment. None of the manufacturers interviewed currently offer a max-tech product, and they expressed technical uncertainty about the exact technologies and production line changes that would be needed to meet both the required efficiencies and the manufacturers' internal design standards. In interviews, several manufacturers expressed concerns that the 3-year time period between the announcement of the direct final rule and the compliance date of the amended energy conservation standard might be insufficient to design, test, and manufacture the necessary number of products to meet consumer demand. These manufacturers noted that the 3-year time period would be particularly problematic if the standard necessitated completely new tub architectures. However, because TSL 3 (*i.e.*, the Recommended TSL, which corresponds to the levels recommended in the Joint Agreement) would not require max-tech efficiencies, DOE does not expect manufacturers to face long-term capacity constraints due to the standard levels detailed in this direct final rule.

d. Impacts on Subgroups of Manufacturers

Using average cost assumptions to develop industry cash-flow estimates may not capture the differential impacts among subgroups of manufacturers. Small manufacturers, niche players, or manufacturers exhibiting a cost

structure that differs substantially from the industry average could be affected disproportionately. DOE investigated small businesses as a manufacturer subgroup that could be disproportionately impacted by energy conservation standards and could merit additional analysis. DOE did not identify any other adversely impacted manufacturer subgroups for this rulemaking based on the results of the industry characterization.

DOE analyzes the impacts on small businesses in a separate analysis for the standards proposed in the NOPR published elsewhere in this issue of the **Federal Register** and in chapter 12 of the direct final rule TSD. In summary, the Small Business Administration ("SBA") defines a "small business" as having 1,500 employees or less for NAICS 335220, "Major Household Appliance Manufacturing."¹³⁰ Based on this classification, DOE did not identify any domestic OEM that qualifies as a small business. For a discussion of the impacts on the small business manufacturer subgroup, *see* chapter 12 of the direct 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.

For the cumulative regulatory burden analysis, DOE examines Federal, product-specific regulations that could affect dishwasher manufacturers that take effect approximately 3 years before or after the 2027 compliance date (2024 to 2030). This information is presented in Table V.11.

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¹³⁰ U.S. Small Business Administration. "Table of Small Business Size Standards." (Effective March

17, 2023). Available at www.sba.gov/document/

[support-table-size-standards](#) (last accessed Nov. 18, 2023).

Table V.11 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Dishwasher Original Equipment Manufacturers

Federal Energy Conservation Standard	Number of OEMs*	Number of OEMs Affected by Today's Rule**	Approx. Standards Compliance Year	Industry Conversion Costs (Millions)	Industry Conversion Costs / Equipment Revenue***
Portable Air Conditioners 85 FR 1378 (January 10, 2020)	9	2	2025	\$320.9 (2015\$)	6.7%
Miscellaneous Refrigeration Products† 88 FR 19382 (March 31, 2023)	38	8	2029	\$126.9 (2021\$)	3.1%
Automatic Commercial Ice Makers† 88 FR 30508 (May 11, 2023)	23	3	2027	\$15.9 (2022\$)	0.6%
Refrigerated Bottled or Canned Beverage Vending Machines† 88 FR 33968 (May 25, 2023)	5	1	2028	\$1.5 (2022\$)	0.2%
Room Air Conditioners 88 FR 34298 (May 26, 2023)	8	4	2026	\$24.8 (2021\$)	0.4%
Microwave Ovens 88 FR 39912 (June 20, 2023)	18	10	2026	\$46.1 (2021\$)	0.7%
Consumer Water Heaters† 88 FR 49058 (July 27, 2023)	22	3	2030	\$228.1 (2022\$)	1.1%
Consumer Boilers† 88 FR 55128 (August 14, 2023)	24	1	2030	\$98.0 (2022\$)	3.6%
Commercial Water Heating Equipment 88 FR 69686 (October 6, 2023)	15	1	2026	\$42.7 (2022\$)	3.8%
Commercial Refrigerators, Refrigerator-Freezers, and Freezers† 88 FR 70196 (October 10, 2023)	83	4	2028	\$226.4 (2022\$)	1.6%
Dehumidifiers† 88 FR 76510 (November 6, 2023)	20	4	2028	\$6.9 (2022\$)	0.4%
Consumer Furnaces 88 FR 87502 (December 18, 2023)	15	1	2029	\$162.0 (2022\$)	1.8%

Refrigerators, Refrigerator-Freezers, and Freezers 89 FR 3026 (January 17, 2024)	63	9	2029 and 2030‡	\$830.3 (2022\$)	1.3%
Consumer Conventional Cooking Products 89 FR 11434 (February 14, 2024)	35	12	2028	\$66.7 (2022\$)	0.3%
Consumer Clothes Dryers 89 FR 18164 (March 12, 2024)	19	11	2028	\$180.7 (2022\$)	1.4%
Residential Clothes Washers 89 FR 19026 (March 15, 2024)	22	12	2028	\$320.0 (2022\$)	1.8%

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

** This column presents the number of OEMs producing dishwashers that are also listed as OEMs in the identified energy conservation standard that is contributing to cumulative regulatory burden.

*** This column presents industry conversion costs as a percentage of equipment 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 direct 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.

† These rulemakings are at the NOPR stage, and all values are subject to change until finalized through publication of a final rule.

‡ For the refrigerators, refrigerator-freezers, and freezers energy conservation standards direct final rule, the compliance year (2029 or 2030) varies by product class.

As shown in Table V.11, the rulemakings with the largest overlap of dishwasher OEMs include refrigerators, refrigerator-freezers, and freezers, consumer conventional cooking products, residential clothes washers, consumer clothes dryers, and miscellaneous refrigeration products, which are all part of the multi-product Joint Agreement submitted by interested parties.¹³¹ As detailed in the multi-product Joint Agreement, the signatories indicated that their recommendations should be considered a “complete package.” The signatories further stated

that “each part of this agreement is contingent upon the other parts being implemented.” (Joint Agreement, No. 55 at p. 3)

The multi-product Joint Agreement states the “jointly recommended compliance dates will achieve the overall energy and economic benefits of this agreement while allowing necessary lead-times for manufacturers to redesign products and retool manufacturing plants to meet the recommended standards across product categories.” (Joint Agreement, No. 55 at p. 2) The staggered compliance dates help

mitigate manufacturers’ concerns about their ability to allocate sufficient resources to comply with multiple concurrent amended standards and about the need to align compliance dates for products that are typically designed or sold as matched pairs. See section IV.J.3 of this document for stakeholder comments about cumulative regulatory burden. See Table V.12 for a comparison of the estimated compliance dates based on EPCA-specified timelines and the compliance dates detailed in the Joint Agreement.

¹³¹ The microwave ovens energy conservation standards final rule (88 FR 39912), which has 10

overlapping OEMs, was published prior to the joint submission of the multi-product Joint Agreement.

Table V.12 Expected Compliance Dates for Multi-Product Joint Agreement

Rulemaking	Estimated Compliance Year based on EPCA Requirements	Compliance Year in the Joint Agreement
Consumer Clothes Dryers	2027	2028
Residential Clothes Washers	2027	2028
Consumer Conventional Cooking Products	2027	2028
Dishwashers	2027	2027*
Refrigerators, Refrigerator-Freezers, and Freezers	2027	2029 or 2030 depending on the product class
Miscellaneous Refrigeration Products	2029	2029

*Estimated compliance year. The Joint Agreement states, “3 years after the publication of a final rule in the *Federal Register*.” (Joint Agreement, No. 55 at p. 2)

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3. National Impact Analysis

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

a. Significance of Energy and Water Savings

To estimate the energy and water savings attributable to potential amended standards for dishwashers, DOE compared their energy and water consumption under the no-new-standards case to their anticipated energy and water 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 (2027–2056). Table V.13 and Table V.14 present DOE’s projections of the national energy and water savings for each TSL considered for dishwashers. The savings were calculated using the approach described in section IV.H.2 of this document.

Table V.13 Cumulative National Energy Savings for Dishwashers; 30 Years of Shipments (2027–2056)

	Trial Standard Level				
	1	2	3	4	5
	<i>quads</i>				
Primary energy	0.05	0.07	0.30	0.32	1.21
FFC energy	0.05	0.08	0.31	0.34	1.28

Table V.14 Cumulative National Water Savings for Dishwashers; 30 Years of Shipments (2027–2056)

	Trial Standard Level				
	1	2	3	4	5
	<i>trillion gallons</i>				
Water Savings	0.09	0.11	0.24	0.26	0.92

OMB Circular A–4¹³² requires agencies to present analytical results,

¹³² U.S. Office of Management and Budget. Circular A–4: Regulatory Analysis. Available at www.whitehouse.gov/omb/information-for-agencies/circulars (last accessed April 10, 2024). DOE used the prior version of Circular A–4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version. Available at www.whitehouse.gov/wp-content/

including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A–4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking,

[uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf](https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf) (last accessed March 11, 2024).

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.¹³³ The review timeframe established in EPCA is generally not synchronized with the product lifetime, product manufacturing cycles, or other factors specific to dishwashers. Thus, such results are

presented for informational purposes only and are not indicative of any change in DOE’s analytical methodology. The NES and NWS sensitivity analysis results based on a 9-year analytical period are presented in

Table V.15 and Table V.16. The impacts are counted over the lifetime of dishwashers purchased during the period 2027–2035.

Table V.15 Cumulative National Energy Savings for Dishwashers; 9 Years of Shipments (2027–2035)

	Trial Standard Level				
	1	2	3	4	5
	<i>quads</i>				
Source energy	0.01	0.02	0.08	0.09	0.33
FFC energy	0.01	0.02	0.09	0.09	0.35

Table V.16 Cumulative National Water Savings for Dishwashers; 9 Years of Shipments (2027–2035)

	Trial Standard Level				
	1	2	3	4	5
	<i>trillion gallons</i>				
Water Savings	0.02	0.03	0.07	0.07	0.25

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 dishwashers. In accordance with OMB’s guidelines on regulatory analysis,¹³⁴ DOE calculated NPV using both a 7-percent and a 3-

percent real discount rate. Table V.17 shows the consumer NPV results with impacts counted over the lifetime of products purchased during the period 2027–2056.

Table V.17 Cumulative Net Present Value of Consumer Benefits for Dishwashers; 30 Years of Shipments (2027–2056)

Discount Rate	Trial Standard Level				
	1	2	3	4	5
	<i>billion 2022\$</i>				
3 percent	0.17	0.22	2.90	2.95	(20.12)
7 percent	0.03	0.03	1.23	1.23	(12.18)

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.18. The impacts are counted over the lifetime of

products purchased during the period 2027–2035. 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.18 Cumulative Net Present Value of Consumer Benefits for Dishwashers; 9 Years of Shipments (2027–2035)

Discount Rate	Trial Standard Level				
	1	2	3	4	5
	<i>billion 2022\$</i>				
3 percent	0.04	0.05	1.01	1.02	(8.30)
7 percent	0.02	(0.03)	0.58	0.57	(6.52)

¹³³ 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. (42 U.S.C. 6295(m)) 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.

¹³⁴ U.S. Office of Management and Budget. Circular A-4: Regulatory Analysis. Available at

www.whitehouse.gov/omb/information-for-agencies/circulars (last accessed April 10, 2024). DOE used the prior version of Circular A-4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version. Available at www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf (last accessed March 11, 2024).

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The previous results reflect the use of a default trend to estimate the change in price for dishwashers 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 direct 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 dishwashers 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 (2027–2056), 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 direct final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Products

As stated, EPCA, as codified, contains the provision that 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))

As discussed in this section, DOE has concluded that the standards adopted in this direct final rule will not lessen the utility or performance of the dishwashers under consideration in this rulemaking. Manufacturers of these products currently offer units that meet or exceed the adopted standards.

In making this determination for this direct final rule, DOE considered comments it had received in response to the May 2023 NOPR.

a. Cleaning Performance

EPCA authorizes DOE to design test procedures that measure energy efficiency, energy use, water use, or estimated annual operating cost of a covered product during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(3)) Representative average use of a dishwasher reflects, in part, a consumer using the dishwasher to achieve an acceptable level of cleaning performance. As discussed, the amended standards adopted in this direct final rule require the use of the test procedure at appendix C2, which includes a minimum cleaning performance threshold as a condition for a valid test cycle to determine if a dishwasher, when tested according to the DOE test procedure, “completely washes a normally soiled load of dishes,” so as to better represent consumer use of the product. *See* section 1 of appendix C2 for definition of “normal cycle” and section 4 of appendix C2 for the cleaning index threshold.

In response to the May 2023 NOPR, ASAP *et al.* asserted that analyses from DOE and EPA demonstrate that dishwashers meeting the proposed standards meet consumer expectations in various performance areas. (ASAP *et al.* No. 46 at pp. 2–3) ASAP *et al.* commented that as part of the development of ENERGY STAR V. 7.0, EPA used web-scraped and Consumer Reports data to understand how dishwashers meeting the proposed requirements perform across a range of metrics that impact consumer satisfaction and found standard-size dishwashers on the market that could meet the ENERGY STAR Most Efficient 2022 criteria¹³⁵ while achieving the cleaning performance threshold. (*Id.*) ASAP *et al.* additionally commented that EPA’s analysis indicated that standard-size dishwashers are able to meet EL 3, while providing high consumer satisfaction across various

areas of performance such as drying time, cycle time, and noise performance. (*Id.*)

Samsung supported DOE’s revised cleaning index threshold value of 70 and commented that the minimum cleaning index would help incentivize dishwasher designs that do not require multiple runs to perform basic functionality, thereby avoiding increased energy use from running multiple cycles. (Samsung, No. 52 at p. 3) NEEA also commented in support of DOE’s requirement of a certain cleaning performance level for the normal cycle to ensure dishwasher cleaning performance is maintained. NEEA noted that NEEA’s dishwasher market research, previously shared confidentially with DOE, shows no correlation between cleaning performance and efficiency for current models. (NEEA, No. 53 at p. 2)

AHAM commented that DOE must further evaluate the impact of amended standards on performance despite the newly finalized cleaning performance metric in the test procedure. AHAM stated that the test procedure requirement alone is not sufficient to satisfy EPCA’s requirement that standards not result in the unavailability of products with performance characteristics substantially the same as those currently available. AHAM commented that DOE has not presented any consumer data to demonstrate that its test and/or threshold are relevant to consumers nor has it produced sufficient data to demonstrate that its proposed standards will not result in a degradation of performance. (AHAM, No. 51 at p. 10).

Sub-Zero asserted that the degradation in dishwasher performance that will result from the proposed standards will affect consumer opinions of Sub-Zero’s products and disproportionately harm the segment of the market in which Sub-Zero operates. (Sub-Zero, No. 47 at pp. 1–2)

CEI *et al.* stated that adverse impacts of the agency’s past dishwasher rules have necessitated compensating behaviors that are not only costly and inconvenient, but also undercut any climate benefits. (CEI *et al.*, No. 48 at p. 7) CEI *et al.* commented that the reduced useful life of compliance models is also environmentally detrimental, as it results in greater energy and other resources going into the manufacturing and disposal of dishwashers. (CEI *et al.*, No. 48 at p. 7)

Zycher commented that DOE claims the proposed standard would not reduce the utility or performance of the products under consideration in this rulemaking, but Zycher asserted that the

¹³⁵ 2022 ENERGY STAR Most Efficient Requirement for Dishwashers: www.energystar.gov/sites/default/files/ENERGY%20STAR%20Most%20Efficient%202022%20Dishwasher%20Final%20Criteria%20Memo_0.pdf.

only analytical support for this statement provided by DOE is that manufacturers of these products currently offer units that meet or exceed the proposed standards. (Zycher, No. 49 at pp. 2, 4, 28) Zycher stated that this argument does not provide any information about the relative “utility or performance” of such options. (*Id.*)

In response to comments from stakeholders over concerns about product cleaning performance for standard-size dishwashers at EL 2, DOE reiterates that the amended standards adopted in this direct final rule require the use of the test procedure at appendix C2, which includes a minimum cleaning performance threshold to determine if a dishwasher, when tested according to the DOE test procedure, “completely washes a normally soiled load of dishes,” so as to better represent consumer use of the product. That is, the new test procedure at appendix C2 ensures that the rated energy and water consumption of dishwashers are representative of a consumer-acceptable level of cleaning performance.

DOE further references its investigatory testing data that was presented in the January 2022 Preliminary Analysis, which demonstrated that standard-size dishwashers within the test sample could achieve the threshold cleaning performance finalized in the January 2023 TP Final Rule at all soil levels for efficiency levels up to EL 3. DOE also notes that feedback from some manufacturers during confidential interviews indicates that the adopted standards are achievable without impacting consumer utility. Additionally, DOE identified dishwasher models that are certified as 2024 ENERGY STAR Most Efficient,¹³⁶ which specifies equivalent cleaning performance requirements as appendix C2 but has more stringent water and energy use criteria than the standards adopted in this document. Some of these models met or exceeded EL 4, indicating that max-tech efficiency dishwashers that can achieve the threshold cleaning performance on the normal cycle currently exist on the market. In fact, DOE’s investigatory testing data shows that the best performing unit at all soil levels is a unit that meets the adopted standard level. DOE also did not observe any correlation between cleaning indices

and efficiency level in its test sample and units that would meet the amended standard have the same average cleaning index across all soil levels as units that would not meet the amended standard.

Furthermore, as previously discussed, on February 14, 2024, DOE received a second joint statement from the same group of stakeholders that submitted the Joint Agreement in which the signatories reaffirmed the standards recommended in the Joint Agreement.¹³⁷ In particular, the letter states that there are more than 400 dishwasher models that are certified to the current ENERGY STAR V. 7.0 level, which is more stringent than the standards recommended in the Joint Agreement, that are also required to meet a minimum cleaning index threshold of 65. The signatories stated that the prevalence of these ENERGY STAR certified dishwashers indicated that dishwashers meeting the recommended standard levels can provide cleaning performance at levels consistent with those on the market today.

Accordingly, DOE has concluded, based not only on its newly adopted test procedure, but also on confirmatory testing data, confidential interviews, and ENERGY STAR’s performance requirements, that the standards adopted here will not negatively impact dishwasher performance.

CEI *et al.* commented that the previous rulemakings affecting existing energy and water efficiency measures for dishwashers have already led to widespread and well-documented consumer dissatisfaction and that the proposed rulemaking would exacerbate the issues. (CEI *et al.*, No. 48 at p. 2)

Whirlpool commented that it was concerned with any amended dishwashers energy conservation standards beyond EL 1. Whirlpool commented that the proposed rule would lessen the utility and performance of dishwashers, especially as compared to consumer expectations of dishwashers today, and the experiences from past dishwashers that consumers may have owned. (Whirlpool, No. 45 at pp. 3, 4) Whirlpool also commented that DOE should not take any action that would potentially degrade the performance or lower the utility of dishwashers, especially because dishwashers have among the lowest household penetration rates of any major appliance in U.S. households. (*Id.* at p. 4) Whirlpool also asserted that the new

cleaning index requirement does not adequately correlate to real-world consumer satisfaction and that consumers will perform compensatory behaviors to make up for the loss in cleaning performance. (*Id.* at p. 5) Whirlpool stated that lowering the energy and water consumption of a dishwasher further will degrade cleaning and drying performance for consumers, and create negative rebound effects, thus making it less attractive for many consumers to own and use their dishwashers. (Whirlpool, No. 45 at p. 6) Whirlpool commented that DOE should work collaboratively to increase overall penetration of the already energy and water efficient appliances but the proposed rule may disincentivize increased penetration and utilization as dishwashers offer consumers lower utility and performance benefits. (*Id.* at p. 3)

AHAM asserted that further cost-effective efficiency gains may threaten performance and product functionality as opportunities for additional energy and water savings beyond those already achieved are severely diminished as products are near maximum efficiency under available technology. (AHAM, No. 51 at pp. 1–2) AHAM noted that while DOE does account for the cleaning performance outcome, DOE does not account for the relationship of cleaning performance to other performance elements in the dishwasher system including washing temperatures, length of washing cycles, types and amounts of detergent applied, and mechanics (power). (*Id.* at pp. 10–11) AHAM commented that reducing one aspect of wash performance, such as energy or water, can lead to an impact on these other performance elements. (*Id.* at p. 11) AHAM commented that the test procedure’s cleaning performance metric ignores all performance aspects other than cleaning performance. AHAM stated that AHAM DW–2–2020, which DOE proposed to use in appendix C2 for the determination of cleaning performance was primarily designed to address performance in terms of redeposition of soils and the soils were selected with that in mind. AHAM stated that AHAM DW–2–2020 does not assess greasy or detergent buildup over time, which it stated is an issue for the majority of dishwasher users who pre-rinse their dishes. AHAM also commented that the test procedure does not address other elements of performance such as drying performance, cycle length, and noise. (*Id.*) AHAM stated that some of these performance factors, such as wash temperature, cannot be lowered

¹³⁶ ENERGY STAR Most Efficient 2024. “Recognition Criteria Residential Dishwashers.” 2024. Available online at www.energystar.gov/sites/default/files/asset/document/Dishwasher%20ENERGY%20STAR%20Most%20Efficient%202024%20Final%20Criteria.pdf.

¹³⁷ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

indefinitely because the wash temperature must be warm enough to activate the detergent and remove fatty soils, otherwise the dishwasher would lose its utility. AHAM stated that water heating is the biggest contributor to energy use and once water heating energy is reduced as much as possible, it leaves fewer options for manufacturers to consider other than lengthening cycles, reducing drying performance or eliminating drying altogether, or increasing the noise level of the dishwasher to allow for greater power, in order to maintain cleaning performance while also meeting more stringent standards. (*Id.*) AHAM asserted that by requiring energy and water levels and a cleaning performance level, DOE could force manufacturers to design dishwashers that satisfy DOE's test procedure requirements but do not satisfy consumers on all factors, including cleaning performance. Therefore, AHAM stated that DOE must assess the impact of its proposed standards from a more holistic perspective. (*Id.*) AHAM recommended that DOE issue a NODA or other notice that would provide data on the impact of these standards on performance and provide interested parties with an opportunity to comment. (*Id.*)

Sub-Zero asserted that any standard beyond ENERGY STAR V. 6.0 (*i.e.*, EL 1) will force manufacturers to make significant design changes that lower a dishwasher's cleaning performance scores. Sub-Zero also asserted that the levers of performance and energy consumption have already been working against each other for years via serial rulemakings on dishwashers, but with the proposed standards, its consumers would be the most disappointed based on the consumer purchase price versus consumer expectations correlation. (Sub-Zero, No. 47 at p. 1)

CEI *et al.* stated that DOE has violated the "features provision" of EPCA, which prohibits setting an efficiency standard so stringent that it would sacrifice any desired product characteristics. CEI *et al.* asserted that by DOE's own admission, DOE has imposed standards on dishwashers that increase cycle times. (CEI *et al.*, No. 48 at p. 3) CEI *et al.* also asserted that previous efficiency standards have led to other drawbacks by negatively affecting dishwasher reliability and durability, adversely impact cleaning performance, and undermining drying performance. (*Id.* at p. 4) CEI *et al.* additionally asserted that DOE's proposed rulemaking would exacerbate these issues and therefore would violate EPCA's features provision. (*Id.* at p. 5)

DOE does not anticipate that significant design changes will be necessary for standard-size dishwashers to reach EL 2 because DOE's teardown analysis, described in chapter 5 of the direct final rule TSD, showed that existing products at EL 2 utilize the same design options as those at EL 1 with improved control strategies. Improved control strategies would allow manufacturers to more closely control water temperature and water fill volumes, thereby optimizing the wash cycle and minimizing losses. For these reasons, DOE does not expect any impact to utility or performance at the standards adopted in this direct final rule. As such, DOE's analysis indicates that it is possible to meet the adopted standards in this direct final rule without making significant design changes and without impacting a dishwasher's cleaning performance or other performance attributes, as discussed further in this section (regarding cleaning performance) and sections IV.H.2 (regarding impact on non-dishwasher cleaning patterns), V.B.4.b (regarding drying performance), and V.B.4.c (regarding cycle length) of this document.

Furthermore, in this direct final rule, DOE is adopting standards for dishwashers that are consistent with the standards recommended in the Joint Agreement. Additionally, as previously discussed, on February 14, 2024, DOE received a second joint statement from the same group of stakeholders that submitted the Joint Agreement in which the signatories reaffirmed the standards recommended in the Joint Agreement, and stated that they would not negatively affect features or performance, including cycle times.¹³⁸

b. Drying Performance

Whirlpool asserted that DOE's proposed standards for dishwashers will be difficult for manufacturers to meet while meeting consumer demand for dishwashers capable of drying dishes thoroughly. (Whirlpool, No. 45 at p. 5) Whirlpool stated that the low final rinse temperatures and shorter heated drying durations that would be required to meet stringent energy conservation standards beyond EL 1 would make it increasingly difficult to completely dry all items in the dishwasher. Whirlpool stated that DOE must not set standards beyond EL 1, which would further reduce the total allowable energy usage that manufacturers can dedicate to effective drying performance and further

reduce consumer satisfaction with drying performance. (*Id.*)

In response to concerns over drying performance, DOE expects existing drying options would continue to be available on dishwashers regardless of amended standards up to at least EL 3 because there are no unique drying technologies at EL2 and EL3. In the May 2023 NOPR TSD as well as in this final rule, DOE noted that dishwasher models could reach EL 2 or EL 3 with the same drying technology options on the regulated cycle as at EL 1 (*see* chapter 5 of this final rule TSD). DOE expects that any amended standards up to at least EL 3 would not stifle innovation around drying options and other features that could be implemented on dishwashers outside the regulated cycle.

Furthermore, as previously discussed, on February 14, 2024, DOE received a second joint statement from the same group of stakeholders that submitted the Joint Agreement (including AHAM, of which Whirlpool is a member) in which the signatories reaffirmed the standards recommended in the Joint Agreement.¹³⁹ In particular, the letter states that the stakeholders do not anticipate the recommended standards will negatively affect features, which DOE assumes would also include drying performance.

c. Cycle Length

CEI *et al.* stated that given the long cycle times and other issues with dishwashers traceable to current standards, this is the proper regulatory avenue that DOE should be pursuing. CEI *et al.* commented that DOE should be fixing the problems with existing dishwasher standards rather than making them worse with the proposed rule. CEI *et al.* stated DOE has previously taken steps to address longer cycle times, but the efforts were reversed. CEI *et al.* commented that corrective rulemakings should be revived and expanded to include all performance-related features that have been impacted by past dishwasher regulations. (CEI *et al.*, No. 48 at pp. 7–8) CEI *et al.* commented that compliance with EPCA is best served by DOE regulations that address the consumer problems with dishwashers, not ones that exacerbate these problems. (*Id.*)

In this rulemaking, DOE considered dishwasher performance, including comments raised about cycle times. In the January 2022 Preliminary TSD, DOE provided data from its investigatory testing sample that determined cycle

¹³⁸ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

¹³⁹ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

time is not substantively correlated with energy and water consumption of the normal cycle. (See section 5.9 of the January 2022 Preliminary TSD). Additionally, the adopted standards are applicable to the regulated cycle type (*i.e.*, normal cycle); manufacturers can continue to provide additional, non-regulated cycle types (*e.g.*, quick cycles, pots and pans, heavy, delicates, *etc.*) for consumers that choose to utilize them. Specifically, DOE expects quick cycles, many of which clean a load within 1 hour or less would still be available on dishwasher models that currently offer such cycle types. DOE has determined that the adopted standards in this direct final rule are compliant with the applicable provisions of EPCA. Additionally, in this direct final rule, DOE is adopting standards for dishwashers that are consistent with the standards recommended in the Joint Agreement, which do not apply to any short-cycle product classes. Further, as previously discussed, on February 14, 2024, DOE received a second joint statement from the same group of stakeholders that submitted the Joint Agreement in which the signatories reaffirmed the standards recommended in the Joint Agreement.¹⁴⁰ In particular, the signatories acknowledge that DOE's investigative testing shows that cycle times at the recommended levels for dishwashers are the same as dishwashers on the market today.

Finally, as noted previously, the Fifth Circuit Court of Appeals recently remanded to DOE the January 2022 Rule for further consideration. As noted elsewhere in this document, DOE has published an RFI regarding short-cycle products. 89 FR 17338.

d. Water Dilution

Whirlpool commented that water dilution and soil and detergent redeposition remain an issue under amended standards beyond EL 1, and that DOE does not cite new technology in its supporting analysis to indicate that this problem will be resolved. (Whirlpool, No. 45 at p. 5) As a result, Whirlpool asserted that according to its own test data, dishwasher cleaning performance will degrade under the proposed standards. (*Id.*)

As noted in the May 2023 NOPR, while DOE recognizes that poor water dilution can impact cleaning performance, as mentioned elsewhere in this document (as well as the May 2023 NOPR and January 2022 Preliminary TSD), DOE's testing and analysis

indicates that satisfactory cleaning performance is achievable at all efficiencies. (See 88 FR 32514, 32533–32534 and chapter 5 of the May 2023 NOPR TSD and January 2022 Preliminary TSD). Additionally, the minimum cleaning index threshold requirement specified in the new appendix C2 ensures that cleaning performance will be maintained after the compliance date of any new standards.

e. Equipment Lifetime and Energy Savings

CEI *et al.* commented that the reduced useful life of compliance models is also environmentally detrimental, as it results in greater energy and other resources going into the manufacturing and disposal of dishwashers. (CEI *et al.*, No. 48 at p. 7)

DOE determines the lifetime of dishwashers from an analysis of historical shipments, AHS and RECS data. See section IV.F.6 of this document for more information. No publicly available data show that the lifetime of a dishwasher is correlated with its efficiency level.

Zycher asserted that energy savings *per se* are not relevant analytically because the economic benefits of energy savings are captured fully by purchasers of such appliances. Further, Zycher commented that there is no externality attendant upon energy consumption *per se*, and if energy savings are to be considered relevant for purpose of benefit/cost analysis, then the adverse effects or costs of reduction in energy consumption in terms of the quality of dishwasher performance in the context of this proposed rule must be included in the analysis. (Zycher, No. 49 at p. 3) Zycher also asserted that DOE's estimates of the annual cost savings are subject to uncertainty and the asserted benefits are so small that that from an analytical standpoint they cannot be regarded as benefits at all. Zycher further asserted that the proposed rule would force consumers to change their purchase choices in ways that have not and would not be observed in the absence of the proposed rule. Zycher commented that this demonstrates that the energy cost savings, even if the underlying calculations are accepted, must be accompanied by some explicit or implicit costs in terms of forgone quality dimensions of dishwasher performance, the value of which must be greater than the value of the purported energy cost savings. (*Id.* at p. 4)

In regard to the purported adverse effects of reduction in energy consumption in terms of the quality of

dishwasher performance, DOE does not expect any rebound effect due to reduced energy and water consumption in the standards case. More detailed discussion can be found in section IV.H.2 of this document regarding the rebound effect and in section V.B.4.a of this document regarding the standards' impact on the cleaning performance.

In response to comments regarding the significance of annualized LCC savings, as described in section IV.E of this document, DOE's LCC analysis captures the variability of consumer's life cycle costs. For example, DOE's energy and water use analysis relied on RECS 2020, which provides sample household's dishwasher usage frequency information ranging from one to 21 cycles per week. DOE also considered the variability of energy and water costs based on the sample household's geographic location, as well as the range of product lifetime. Taking into account the variability of those inputs allows DOE to observe the full range of LCC savings and to understand the distribution of results, enabling a more informed evaluation of the potential impact of the adopted standards. DOE presents all statistic results of LCC savings in chapter 8 of the direct final rule TSD. Based on the LCC savings estimates of 10,000 household samples, 97 percent of the sample households would either not be affected (11 percent) or experience a positive savings (86 percent). The weighted average LCC savings are \$17 for the selected TSL which is significantly different from zero. In addition, DOE's decision on amended standards is not solely determined by LCC savings. While they play an important role, they may be considered alongside other critical factors, including the percentage of negatively impacted consumers, the simple payback period, and the overall impact on the manufacturers.

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.d 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

¹⁴⁰ This document is available in the docket at: www.regulations.gov/comment/EERE-2019-BT-STD-0039-0059.

determination, DOE is providing DOJ with copies of the direct final rule and the TSD for review.

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 direct 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 dishwashers is expected to yield environmental benefits in the form of

reduced emissions of certain air pollutants and greenhouse gases. Table V.19 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 III.C of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the direct final rule TSD.

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Table V.19 Cumulative Emissions Reduction for Dishwashers Shipped During the Period 2027–2056

	Trial Standard Level				
	1	2	3	4	5
Electric Power Sector Emissions					
CO ₂ (million metric tons)	2.06	2.80	8.43	9.17	34.54
CH ₄ (thousand tons)	0.06	0.09	0.36	0.40	1.48
N ₂ O (thousand tons)	0.01	0.01	0.05	0.06	0.22
SO ₂ (thousand tons)	0.16	0.27	1.37	1.49	5.59
NO _x (thousand tons)	1.72	2.26	6.01	6.55	24.70
Hg (tons)	0.00	0.00	0.01	0.01	0.03
Upstream Emissions					
CO ₂ (million metric tons)	0.28	0.38	1.06	1.15	4.35
CH ₄ (thousand tons)	26.65	35.44	98.60	107.40	404.81
N ₂ O (thousand tons)	0.00	0.00	0.00	0.00	0.01
SO ₂ (thousand tons)	0.01	0.01	0.04	0.04	0.15
NO _x (thousand tons)	4.37	5.83	16.36	17.82	67.16
Hg (tons)	0.00	0.00	0.00	0.00	0.00
Total FFC Emissions					
CO ₂ (million metric tons)	2.34	3.18	9.48	10.33	38.89
CH ₄ (thousand tons)	26.70	35.53	98.97	107.80	406.30
N ₂ O (thousand tons)	0.01	0.01	0.06	0.06	0.23
SO ₂ (thousand tons)	0.16	0.28	1.41	1.53	5.73
NO _x (thousand tons)	6.09	8.09	22.37	24.37	91.86
Hg (tons)	0.00	0.00	0.01	0.01	0.03

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO₂ that DOE estimated for each of the considered TSLs for dishwashers.

Section IV.L of this document discusses the estimated SC–CO₂ values that DOE used. Table V19 presents the value of CO₂ emissions reduction at each TSL for each of the SC–CO₂ cases. The time-

series of annual values is presented for the Recommended TSL in chapter 14 of the direct final rule TSD.

Table V.20 Present Value of CO₂ Emissions Reduction for Dishwashers Shipped During the Period 2027–2056

TSL	SC-CO ₂ Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95 th percentile
	<i>Million 2022\$</i>			
1	23.0	98.2	153.5	297.9
2	31.3	133.7	209.0	405.7
3	94.1	400.3	625.1	1,214.6
4	102.4	435.9	680.6	1,322.4
5	385.7	1,641.3	2,563.1	4,979.8

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 N₂O that DOE estimated for each of the

considered TSLs for dishwashers. Table V.21 presents the value of the CH₄ emissions reduction at each TSL, and Table V.22 presents the value of the N₂O emissions reduction at each TSL. The

time-series of annual values is presented for the Recommended TSL in chapter 14 of the direct final rule TSD.

Table V.21 Present Value of Methane Emissions Reduction for Dishwashers Shipped During the Period 2027–2056

TSL	SC-CH ₄ Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95 th percentile
	<i>Million 2022\$</i>			
1	12.2	36.3	50.6	96.0
2	16.3	48.3	67.3	127.8
3	45.4	134.6	187.6	356.2
4	49.4	146.6	204.3	387.9
5	186.2	552.7	770.0	1,462.2

Table V.22 Present Value of Nitrous Oxide Emissions Reduction for Dishwashers Shipped During the Period 2027–2056

TSL	SC-N ₂ O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95 th percentile
	<i>Million 2022\$</i>			
1	0.0	0.1	0.2	0.4
2	0.1	0.2	0.3	0.6
3	0.2	0.9	1.3	2.3
4	0.2	0.9	1.4	2.5
5	0.9	3.5	5.4	9.3

DOE is well aware that scientific and economic knowledge about the contribution of CO₂ 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 CO₂ 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 SO₂ emissions reductions anticipated to result from the considered TSLs for dishwashers. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.23 presents the

present value for NO_x emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.24 presents similar results

for SO₂ 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 Recommended TSL in chapter 14 of the direct final rule TSD.

Table V.23 Present Value of NO_x Emissions Reduction for Dishwashers Shipped During the Period 2027–2056

TSL	7% Discount Rate	3% Discount Rate
	<i>million 2022\$</i>	
1	83.6	214.1
2	113.5	290.0
3	336.5	853.5
4	366.3	929.3
5	1,379.9	3,500.2

Table V.24 Present Value of SO₂ Emissions Reduction for Dishwashers Shipped During the Period 2027–2056

TSL	7% Discount Rate	3% Discount Rate
	<i>million 2022\$</i>	
1	3.4	8.3
2	6.4	15.7
3	35.1	85.9
4	38.1	93.3
5	142.7	349.2

Not all the public health and environmental benefits from the reduction of greenhouse gases, NO_x, and SO₂ 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.25 presents the NPV values that result from adding the estimates of the economic benefits resulting from reduced GHG and NO_x and SO₂

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 dishwashers, and are measured for the lifetime of products shipped during the period 2027–2056. 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 dishwashers shipped during the period 2027–2056.

Table V.25 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
<i>Using 3% discount rate for Consumer NPV and Health Benefits (billion 2022\$)</i>					
5% Average SC-GHG case	0.4	0.6	4.0	4.1	(15.7)
3% Average SC-GHG case	0.5	0.7	4.4	4.6	(14.1)
2.5% Average SC-GHG case	0.6	0.8	4.7	4.9	(12.9)
3% 95th percentile SC-GHG case	0.8	1.1	5.4	5.7	(9.8)
<i>Using 7% discount rate for Consumer NPV and Health Benefits (billion 2022\$)</i>					
5% Average SC-GHG case	0.2	0.2	1.7	1.8	(10.1)
3% Average SC-GHG case	0.3	0.3	2.1	2.2	(8.5)
2.5% Average SC-GHG case	0.3	0.4	2.4	2.5	(7.3)
3% 95th percentile SC-GHG case	0.5	0.7	3.2	3.3	(4.2)

BILLING CODE 6450-01-C**C. Conclusion**

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

For this direct final rule, DOE considered the impacts of amended standards for dishwashers 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 and water 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 and water savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of product purchases in chapter 9 of the direct 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.¹⁴¹

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

¹⁴¹ 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.

estimated in the regulatory process.¹⁴² 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. General considerations for consumer welfare and preferences as well as the special cases of complementary goods are areas DOE plans to explore in a forthcoming RFI related to the agency's updates to its overall analytic framework.

1. Benefits and Burdens of TSLs Considered for Dishwashers Standards

Table V.26 and Table V.27 summarize the quantitative impacts estimated for

¹⁴² 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).

each TSL for dishwashers. The national impacts are measured over the lifetime of dishwashers purchased in the 30-year period that begins in the anticipated year of compliance with amended standards (2027–2056). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. The consumer operating savings are inclusive of energy and water. DOE is presenting monetized benefits of GHG emissions reductions 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 IWG. The efficiency levels contained in each TSL are described in section V.A of this document.

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Table V.26 Summary of Analytical Results for Dishwashers TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings					
Quads	0.05	0.08	0.31	0.34	1.28
Cumulative Water Savings					
Trillion gallons	0.09	0.11	0.24	0.26	0.92
Cumulative FFC Emissions Reduction					
CO ₂ (million metric tons)	2.34	3.18	9.48	10.33	38.89
CH ₄ (thousand tons)	26.70	35.53	98.97	107.80	406.30
N ₂ O (thousand tons)	0.01	0.01	0.06	0.06	0.23
NO _x (thousand tons)	6.09	8.09	22.37	24.37	91.86
SO ₂ (thousand tons)	0.16	0.28	1.41	1.53	5.73
Hg (tons)	0.00	0.00	0.01	0.01	0.03
Present Value of Monetized Benefits and Costs (3% discount rate, billion 2022\$)					
Consumer Operating Cost Savings	0.43	0.63	3.16	3.36	1.75
Climate Benefits*	0.13	0.18	0.54	0.58	2.20
Health Benefits**	0.22	0.31	0.94	1.02	3.85
Total Benefits†	0.79	1.12	4.64	4.97	7.80
Consumer Incremental Product Costs‡	0.26	0.41	0.26	0.41	21.87
Consumer Net Benefits	0.17	0.22	2.90	2.95	(20.12)
Total Net Benefits	0.53	0.71	4.38	4.56	(14.08)
Present Value of Monetized Benefits and Costs (7% discount rate, billion 2022\$)					
Consumer Operating Cost Savings	0.18	0.27	1.38	1.46	0.68
Climate Benefits*	0.13	0.18	0.54	0.58	2.20
Health Benefits**	0.09	0.12	0.37	0.40	1.52
Total Benefits†	0.41	0.57	2.29	2.45	4.40
Consumer Incremental Product Costs‡	0.15	0.24	0.15	0.24	12.86
Consumer Net Benefits	0.03	0.03	1.23	1.23	(12.18)
Total Net Benefits	0.25	0.33	2.13	2.21	(8.46)

Note: This table presents the costs and benefits associated with dishwashers shipped during the period 2027–2056. These results include benefits to consumers which accrue after 2056 from the products shipped during the period 2027–2056.

* Climate benefits are calculated using four different estimates of the SC-CO₂, SC-CH₄ and SC-N₂O. 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** Health benefits are calculated using benefit-per-ton values for NO_x and SO₂. DOE is currently only monetizing (for NO_x and SO₂) 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.27 Summary of Analytical Results for Dishwashers TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Manufacturer Impacts					
Industry NPV (million 2022\$) (No-new-standards case INPV = 735.8)	680.8 to 729.7	673.7 to 723.3	587.1 to 639.1	579.9 to 632.8	334.4 to 414.6
Industry NPV (% change)	(7.5) to (0.8)	(8.4) to (1.7)	(20.2) to (13.1)	(21.2) to (14.0)	(54.5) to (43.7)
Consumer Average LCC Savings (2022\$)					
PC 1: Standard-size dishwashers	\$5	\$5	\$17	\$17	(\$145)
PC 2: Compact-size dishwashers	\$32	\$4	\$32	\$4	\$4
Shipment-Weighted Average*	\$5	\$4	\$17	\$16	(\$142)
Consumer Simple PBP (years)					
PC 1: Standard-size dishwashers	4.9	4.9	3.9	3.9	15.9
PC 2: Compact-size dishwashers	0.0	5.5	0.0	5.5	5.5
Shipment-Weighted Average*	4.8	4.9	3.8	3.9	15.7
Percent of Consumers that Experience a Net Cost					
PC 1: Standard-size dishwashers	4%	4%	3%	3%	97%
PC 2: Compact-size dishwashers	0%	54%	0%	54%	54%
Shipment-Weighted Average*	4%	5%	3%	4%	96%

Parentheses indicate negative (-) values. The entry “n.a.” means not applicable because there is no change in the standard at certain TSLs.

* Weighted by shares of each product class in total projected shipments in 2027.

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DOE first considered TSL 5, which represents the max-tech efficiency levels for both product classes. Specifically, for a standard-size dishwasher, this efficiency level includes design options considered at the lower efficiency levels (*i.e.*, electronic controls, soil sensors, multiple spray arms, improved water filters and control strategies, separate drain pump, tub insulation, hydraulic system optimization, water diverter assembly, temperature sensor, 3-phase variable-speed motor, and flow meter) and condensation drying, including use of a stainless steel tub; flow-through heating implemented as an in-sump integrated heater; and control strategies. The majority of these design options reduce both energy and water use together.¹⁴³ For a compact-size

dishwasher, this efficiency level includes the design options considered at the lower efficiency levels (*i.e.*, improved control strategies) and additionally includes the use of permanent magnet motor, improved filters, hydraulic system optimization, heater incorporated into base of tub, and reduced sump volume. Similar to standard-size dishwashers, the majority of these design options reduce both energy and water use together. TSL 5 would save an estimated 1.28 quads of energy and 0.92 trillion gallons of water, an amount DOE considers significant. Under TSL 5, the NPV of consumer benefit (inclusive of both energy and water) would be –\$12.18 billion using a discount rate of 7 percent, and –\$20.12 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 5 are 38.89 Mt of CO₂, 5.73 thousand tons of SO₂, 91.86 thousand tons of NO_x, 0.03 tons of Hg, 406.30 thousand tons of CH₄, and 0.23 thousand tons of N₂O. 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 5 is \$2.20 billion. The estimated monetary value of the health benefits from reduced SO₂ and NO_x emissions at TSL 5 is \$1.52 billion using a 7-percent discount rate and \$3.85 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO₂ and NO_x emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 5 is –\$8.46 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total

¹⁴³ As discussed previously in section IV.A.2 of this document, because the energy used to heat the water consumed by the dishwasher is included as part of the EAEU energy use metric, technologies

that decrease water use also inherently decrease energy use.

NPV at TSL 5 is –\$14.08 billion. The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether an amended standard level is economically justified.

At TSL 5, the average LCC impact is a loss of \$145 for standard-size dishwashers and a \$4 savings for compact-size dishwashers. The simple payback period is 15.9 years for standard-size dishwashers and 5.5 years for compact-size dishwashers. The fraction of consumers experiencing a net LCC cost is 97 percent for standard-size dishwashers and 54 percent for compact-size dishwashers. Notably, for the standard-size product class, which as discussed represents 98 percent of the market, TSL 5 (which includes EL 4 for this product class) would increase the first cost by \$178. This associated increase in first cost at TSL 5 for standard-size dishwashers could impact the number of new shipments by approximately less than 2 percent annually due to consumers shifting to extending the lives of their existing dishwashers beyond their useful life, repairing instead of replacing, or handwashing their dishes. In the national impact analysis, DOE modeled a scenario where part of this 2-percent of consumers forgoing the purchase of a new dishwasher due to price increases will substitute to handwashing. This results in a small increase in energy and water use, which is then subtracted from the energy and water savings projected to result from the amended standards at TSL5.

For the low-income consumer group, the average LCC impact is a loss of \$29 for standard-size dishwashers and a savings of \$62 for compact-size dishwashers. The simple payback period is 6.6 years for standard-size dishwashers and 2.3 years for compact-size dishwashers. The fraction of low-income consumers experiencing a net LCC cost is 46 percent for standard-size dishwashers and 26 percent for compact-size dishwashers. For the senior-only households consumer group, the average LCC impact is a loss of \$159 for standard-size dishwashers and a loss of \$14 for compact-size dishwashers. The simple payback period is 19.8 years for standard-size dishwashers and 6.8 years for compact-size dishwashers. The fraction of senior-only consumers experiencing a net LCC cost is 98 percent for standard-size dishwashers and 62 percent for compact-size dishwashers. For the consumer sub-group of well-water households, the average LCC impact is a loss of \$162 for standard-size

dishwashers and a loss of \$19 for compact-size dishwashers. The simple payback period is 21.4 years for standard-size dishwashers and 6.9 years for compact-size dishwashers. The fraction of well-water consumers experiencing a net LCC cost is 98 percent for standard-size dishwashers and 63 percent for compact-size dishwashers.

At TSL 5, the projected change in INPV ranges from a decrease of \$334.4 million to a decrease of \$414.6 million, which corresponds to decreases of 54.5 percent and 43.7 percent, respectively. Industry conversion costs could reach \$681.0 million at this TSL, as manufacturers work to redesign their portfolios of model offerings, transition their standard-size dishwasher platforms entirely to stainless steel tubs, and renovate manufacturing facilities to accommodate changes to the production line and manufacturing processes.

DOE estimates that less than 1 percent of dishwasher shipments currently meet the max-tech levels. Standard-size dishwashers account for approximately 98 percent of annual shipments. Of the 19 standard-size dishwasher OEMs, only one OEM, which accounts for approximately 2 percent of basic models in the CCD, currently offers products that meet the max-tech efficiencies required. All manufacturers interviewed, which together account for approximately 90 percent of the industry shipments, expressed uncertainty as to whether they could reliably meet the standard-size dishwasher max-tech efficiencies and the cleaning performance threshold and noted meeting max-tech would require a platform redesign and significant investment in tooling, equipment, and production line modifications. Many manufacturers would need to increase production capacity of stainless steel tub designs. Some manufacturers noted that a max-tech standard could necessitate new tub architectures.

For compact-size dishwashers, which account for the remaining 2 percent of annual shipments, DOE estimates that 14 percent of shipments currently meet the required max-tech efficiencies. Of the five compact-size dishwasher OEMs, two OEMs currently offer compact-size products that meet max-tech. At TSL 5, compact-size countertop dishwashers with four or more place settings and in-sink dishwashers with less than four place settings are not currently available in the market. Meeting TSL 5 is technologically feasible for those products; however, DOE expects that it would take significant investment relative to the size of the compact-size

dishwasher market to redesign products to meet the max-tech efficiencies.

Based on the above considerations, the Secretary concludes that at TSL 5 for dishwashers, the benefits of energy and water savings, emissions reductions, and the estimated monetary value of the health benefits and climate benefits from emissions reductions would be outweighed by the negative NPV of consumer benefits and the impacts on manufacturers, including the large potential reduction in INPV. At TSL 5, a majority of standard-size dishwasher consumers (97 percent) would experience a net cost and the average LCC loss is \$145 for this product class. Additionally, at TSL 5, manufacturers would need to make significant upfront investments to redesign product platforms and update manufacturing facilities. Some manufacturers expressed concern that they would not be able to complete product and production line updates within the 3-year conversion period. Consequently, the Secretary has concluded that TSL 5 is not economically justified.

DOE next considered TSL 4, which represents the highest efficiency levels providing positive LCC savings. TSL 4 comprises the gap-fill efficiency level between the ENERGY STAR V. 7.0 level and the ENERGY STAR V. 6.0 level (EL 2) for standard-size dishwashers and the max-tech efficiency level for compact-size dishwashers. Specifically, for a standard-size dishwasher, this efficiency level includes design options considered at the lower efficiency levels (*i.e.*, electronic controls, soil sensors, multiple spray arms, improved water filters, separate drain pump, and tub insulation) and additionally includes the use of improved control strategies. For a compact-size dishwasher, this efficiency level includes the design options considered at the lower efficiency levels (*i.e.*, improved control strategies) and additionally includes the use of a permanent magnet motor, improved filters, hydraulic system optimization, heater incorporated into base of tub, and reduced sump volume. The majority of these design options for both standard-size and compact-size dishwashers reduce both energy and water use together. TSL 4 would save an estimated 0.34 quads of energy and 0.26 trillion gallons of water, an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit (inclusive of energy and water) would be \$1.23 billion using a discount rate of 7 percent, and \$2.95 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 10.33 Mt of CO₂, 1.53 thousand tons of SO₂, 24.37 thousand

tons of NO_x, 0.01 tons of Hg, 107.80 thousand tons of CH₄, and 0.06 thousand tons of N₂O. 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 4 is \$0.58 billion. The estimated monetary value of the health benefits from reduced SO₂ and NO_x emissions at TSL 4 is \$0.40 billion using a 7-percent discount rate and \$1.02 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO₂ and NO_x emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 4 is \$2.21 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at TSL 4 is \$4.56 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 4, the average LCC impact is a savings of \$17 for standard-size dishwashers and \$4 for compact-size dishwashers. The simple payback period is 3.9 years for standard-size dishwashers and 5.5 years for compact-size dishwashers. The fraction of consumers experiencing a net LCC cost is 3 percent for standard-size dishwashers and 54 percent for compact-size dishwashers.

For the low-income consumer group, the average LCC impact is a savings of \$21 for standard-size dishwashers and \$62 for compact-size dishwashers. The simple payback period is 1.6 years for standard-size dishwashers and 2.3 years for compact-size dishwashers. The fraction of low-income consumers experiencing a net LCC cost is 2 percent for standard-size dishwashers and 26 percent for compact-size dishwashers. For the senior-only households consumer group, the average LCC impact is a savings of \$13 for standard-size dishwashers and a loss of \$14 for compact-size dishwashers. The simple payback period is 4.9 years for standard-size dishwashers and 6.8 years for compact-size dishwashers. The fraction of senior-only consumers experiencing a net LCC cost is 4 percent for standard-size dishwashers and 62 percent for compact-size dishwashers. For the consumer sub-group of well-water households, the average LCC impact is a savings of \$12 for standard-size dishwashers and a loss of \$19 for compact-size dishwashers. The simple payback period is 5.5 years for standard-

size dishwashers and 6.9 years for compact-size dishwashers. The fraction of well-water consumers experiencing a net LCC cost is 4 percent for standard-size dishwashers and 63 percent for compact-size dishwashers.

At TSL 4, the projected change in INPV ranges from a decrease of \$155.9 million to a decrease of \$103.1 million, which corresponds to decreases of 21.2 percent and 14.0 percent, respectively. Industry conversion costs could reach \$137.2 million at this TSL as some manufacturers of standard-size dishwashers redesign products to enable improved controls and better design tolerances and manufacturers of certain compact-size dishwashers redesign products to meet max-tech.

DOE estimates that approximately 10 percent of dishwasher shipments currently meet the TSL 4 efficiencies, of which approximately 9 percent of standard-size dishwasher shipments and 14 percent of compact-size dishwasher shipments meet the required efficiencies. Compared to max-tech, more manufacturers offer standard-size dishwashers that meet the required efficiencies. Furthermore, since the May 2023 NOPR, more manufacturers now offer standard-size dishwasher models that meet the TSL 4 efficiencies. DOE believes that the recent introduction of more high-efficiency standard-size dishwashers is largely in response to ENERGY STAR V. 7.0, which went into effect in July 2023. Of the 19 OEMs offering standard-size products, 16 OEMs offer products that meet the efficiency level required. For compact-size dishwashers, TSL 4 represents the same efficiency level as for TSL 5. Just as with TSL 5, compact-size countertop dishwashers with four or more place settings and in-sink dishwashers with less than four place settings are not currently available in the market at TSL 4 levels. Meeting TSL 4 is technologically feasible for those products; however, DOE expects that it would take significant investment (nearly \$11 million) relative to the size of the compact-size dishwasher market (no-new-standards case INPV of \$15.4 million) for them to meet the max-tech efficiencies.

Based upon the above considerations, the Secretary concludes that at TSL 4 for dishwashers, the benefits of energy and water savings, positive NPV of consumer benefits, emission reductions, and the estimated monetary value of the health benefits and climate benefits from emissions reductions would be outweighed by negative LCC savings for the senior-only households for the compact-size dishwasher product class and the high percentage of consumers

with net costs for the compact-size dishwasher product class. Consequently, the Secretary has concluded that TSL 4 is not economically justified.

DOE then considered the Recommended TSL (*i.e.*, TSL 3), which comprises the gap-fill efficiency level between the ENERGY STAR V. 7.0 level and the ENERGY STAR V. 6.0 level (EL 2) for standard-size dishwashers and the ENERGY STAR V. 6.0 level (EL 1) for compact-size dishwashers. Specifically, for a standard-size dishwasher, this efficiency level includes design options considered at the lower efficiency levels (*i.e.*, electronic controls, soil sensors, multiple spray arms, improved water filters, separate drain pump, and tub insulation) and additionally includes the use of improved control strategies. For a compact-size dishwasher, this efficiency level represents the use of improved controls. The majority of these design options for both standard-size and compact-size dishwashers reduce both energy and water use together. The Recommended TSL would save an estimated 0.31 quads of energy and 0.24 trillion gallons of water, an amount DOE considers significant. Under the Recommended TSL, the NPV of consumer benefit (inclusive of energy and water) would be \$1.23 billion using a discount rate of 7 percent, and \$2.90 billion using a discount rate of 3 percent.

The cumulative emissions reductions at the Recommended TSL are 9.48 Mt of CO₂, 1.41 thousand tons of SO₂, 22.37 thousand tons of NO_x, 0.01 tons of Hg, 98.97 thousand tons of CH₄, and 0.06 thousand tons of N₂O. 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 the Recommended TSL is \$0.54 billion. The estimated monetary value of the health benefits from reduced SO₂ and NO_x emissions at the Recommended TSL is \$0.37 billion using a 7-percent discount rate and \$0.94 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO₂ and NO_x emissions, and the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at the Recommended TSL is \$2.13 billion. Using a 3-percent discount rate for all benefits and costs, the estimated total NPV at the Recommended TSL is \$4.38 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 the Recommended TSL, the average LCC impact is a savings of \$17 for standard-size dishwashers and \$32 for compact-size dishwashers. The simple payback period is 3.9 years for standard-size dishwashers and 0.0 years for compact-size dishwashers. The fraction of consumers experiencing a net LCC cost is 3 percent for standard-size dishwashers and 0 percent for compact-size dishwashers.

For the low-income consumer group, the average LCC impact is a savings of \$21 for standard-size dishwashers and \$39 for compact-size dishwashers. The simple payback period is 1.6 years for standard-size dishwashers and 0.0 years for compact-size dishwashers. The fraction of low-income consumers experiencing a net LCC cost is 2 percent for standard-size dishwashers and 0 percent for compact-size dishwashers. For the senior-only households consumer group, the average LCC impact is a savings of \$13 for standard-size dishwashers and \$26 for compact-size dishwashers. The simple payback period is 4.9 years for standard-size dishwashers and 0.0 years for compact-size dishwashers. The fraction of senior-only consumers experiencing a net LCC cost is 4 percent for standard-size dishwashers and 0 percent for compact-size dishwashers. For the consumer sub-group of well water households, the average LCC impact is a savings of \$12 for standard-size dishwashers and \$23 for compact-size dishwashers. The simple payback period is 5.5 years for standard-size dishwashers and 0.0 years for compact-size dishwashers. The fraction of well water consumers experiencing a net LCC cost is 4 percent for standard-size dishwashers and 0 percent for compact-size dishwashers.

At the Recommended TSL, the projected change in INPV ranges from a decrease of \$148.8 million to a decrease of \$96.7 million, which corresponds to decreases of 20.2 percent and 13.1 percent, respectively. Industry conversion costs could reach \$126.9 million at this TSL as some manufacturers redesign standard-size products to enable improved controls and better design tolerances.

DOE estimates that approximately 11 percent of dishwasher shipments currently meet the Recommended TSL efficiencies, of which approximately 9 percent of standard-size dishwasher shipments and 87 percent of compact-size dishwasher shipments meet the required efficiencies. At this level, the decrease in conversion costs compared to TSL 4 is entirely due to the lower efficiency level required for compact-

size dishwashers, as the efficiency level required for standard-size dishwashers is the same as for TSL 4 (EL 2). All the compact-size dishwasher OEMs currently offer products that meet the Recommended TSL. At this level, DOE expects manufacturers of compact-size dishwashers would implement improved controls, which would likely require minimal upfront investment.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that a standard set at the Recommended TSL for dishwashers would be economically justified. At this TSL, the shipments weighted-average LCC savings for both product classes is \$17. The shipments weighted-average share of consumers with a net LCC cost for both product classes is 3 percent. For all consumer sub-groups, the LCC savings are positive and the net share of consumers with a net LCC cost is below 5 percent for both product classes. The FFC national energy and water savings are significant and the NPV of consumer benefits is \$2.90 billion and \$1.23 billion using both a 3-percent and 7-percent discount rate respectively. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At the Recommended TSL, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent, is over eight times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at the Recommended TSL are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing \$0.54 billion in climate benefits (associated with the average SC-GHG at a 3-percent discount rate), and \$0.94 billion (using a 3-percent discount rate) or \$0.37 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

The adopted standards are applicable to the regulated cycle type (*i.e.*, normal cycle) as specified by the DOE test procedures; manufacturers can continue to provide additional, non-regulated cycle types (*e.g.*, quick cycles, pots and pans, heavy, delicates, *etc.*). Specifically, DOE expects quick cycles, many of which clean a load within 1 hour or less, and existing drying options would still be available on dishwasher models that currently offer such cycle types. DOE has no information suggesting that any aspect of this direct final rule would limit the other cycle options, especially quick cycles. Additionally, in the January 2022 Preliminary TSD, DOE provided data from its investigatory testing sample

that determined cycle time is not substantially correlated with energy and water consumption of the normal cycle.¹⁴⁴ Based on these results, DOE has determined that this direct final rule would not have any substantive impact to normal cycle durations.

The test procedure in appendix C2, which includes provisions for a minimum cleaning index threshold of 70 to validate the selected test cycle, will go into effect at such time as compliance is required with any amended energy conservation standards. At the Recommended TSL, both standard-size and compact-size dishwasher models achieving the efficiencies, as measured by appendix C2, including the cleaning performance threshold, are readily available on the market.

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. Although DOE has not conducted a comparative analysis to select the amended energy conservation standards, DOE considers amended standard levels for dishwashers by grouping the efficiency levels for each product class into TSLs and evaluates all analyzed efficiency levels in its LCC analysis and all efficiency levels with positive LCC savings for the NIA and MIA. For both standard-size and compact-size dishwashers, the adopted standard level represents the maximum energy savings that do not result in a large percentage of consumers experiencing a net LCC cost. The efficiency levels at the adopted standard level result in positive LCC savings for both product classes, significantly 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 the Recommended TSL in the preceding paragraphs.

At the Recommended standard level for the standard-size product class, the average LCC savings are \$17, the percentage of consumers experiencing a net cost is 3 percent (*see* Table V.3), and

¹⁴⁴ See section 5.5.1 of the January 2022 Preliminary TSD. Available at www.energy.gov/sites/default/files/2022-01/dw-tds.pdf.

the FFC energy savings are 0.3 quads. At the Recommended standard level for compact-size product class, the average LCC savings are \$32 and there are no consumers that would experience a net cost. DOE concludes that there is economic justification to adopt the standards for standard-size and compact size dishwashers independent of each other.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for dishwashers at the Recommended TSL.

While DOE considered each potential TSL under the criteria laid out in 42 U.S.C. 6295(o) as discussed in the preceding paragraphs, DOE notes that the Recommended TSL for dishwashers adopted in this direct final rule is part of a multi-product Joint Agreement covering six rulemakings (refrigerators, refrigerator-freezers, and freezers; miscellaneous refrigeration products; consumer conventional cooking products; residential clothes washers; consumer clothes dryers; and dishwashers). The signatories indicate that the Joint Agreement for the six rulemakings should be considered as a

joint statement of recommended standards, to be adopted in its entirety. As discussed in section V.B.2.e of this document, many dishwasher OEMs also manufacture refrigerators, refrigerator-freezers, and freezers, miscellaneous refrigeration products, consumer conventional cooking products, residential clothes washers, and consumer clothes dryers. Rather than requiring compliance with five amended standards in a single year (2027),¹⁴⁵ the negotiated multi-product Joint Agreement staggers the compliance dates for the five amended standards over a 4-year period (2027–2030). In response to the May 2023 NOPR, AHAM expressed concerns about the timing of ongoing home appliance rulemakings. Specifically, AHAM commented that the combination of the stringency of DOE’s proposals, the short lead-in time required under EPCA to comply with standards, and the overlapping timeframe of multiple standards affecting the same manufacturers represents significant cumulative regulatory burden for the home appliance industry. (AHAM, No. 51 at pp. 21–24) AHAM has submitted similar

comments to other ongoing consumer product rulemakings.¹⁴⁶ As AHAM is a key signatory of the Joint Agreement, DOE understands that the compliance dates recommended in the Joint Agreement would help reduce cumulative regulatory burden. These compliance dates help relieve concern on the part of some manufacturers about their ability to allocate sufficient resources to comply with multiple concurrent amended standards, about the need to align compliance dates for products that are typically designed or sold as matched pairs, and about the ability of their suppliers to ramp up production of key components. The Joint Agreement also provides additional years of regulatory certainty for manufacturers and their suppliers while still achieving the maximum improvement in energy efficiency that is technologically feasible and economically justified.

The amended energy conservation standards for dishwashers, which are expressed in EAEU and per-cycle water consumption, shall not exceed the values shown in Table V.28.

Table V.28 Amended Energy Conservation Standards for Dishwashers

Product Class	Estimated Annual Energy Use (kWh/year)*	Per-Cycle Water Consumption (gal/cycle)
PC 1: Standard-size Dishwashers (≥ 8 place settings plus 6 serving pieces)	223	3.3
PC 2: Compact-size Dishwashers (< 8 place settings plus 6 serving pieces)	174	3.1

* Based on appendix C2.

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 2022\$) of the benefits from operating products that meet the adopted standards (consisting primarily of operating cost savings from using less energy and water), minus increases in product purchase costs, and 2) the annualized

monetary value of the climate and health benefits.

Table V.29 shows the annualized values for dishwashers under the Recommended TSL, expressed in 2022\$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NO_x and SO₂ reductions, and the 3-percent discount rate case for GHG social costs, the estimated cost of the adopted standards for dishwashers is \$14.0 million per year in increased equipment

installed costs, while the estimated annual benefits are \$127.2 million from reduced equipment operating costs, \$29.0 million in GHG reductions, and \$34.3 million from reduced NO_x and SO₂ emissions. In this case, the net benefit amounts to \$176.4 million per year.

Using a 3-percent discount rate for all benefits and costs, the estimated cost of the adopted standards for dishwashers is \$14.0 million per year in increased equipment costs, while the estimated

¹⁴⁵ The refrigerators, refrigerator-freezers, and freezers (88 FR 12452); consumer conventional cooking products (88 FR 6818); residential clothes washers (88 FR 13520); consumer clothes dryers (87 FR 51734); and dishwashers (88 FR 32514) utilized a 2027 compliance year for analysis at the proposed rule stage. Miscellaneous refrigeration products (88 FR 12452) utilized a 2029 compliance year for the NOPR analysis.

¹⁴⁶ AHAM has submitted written comments regarding cumulative regulatory burden for the other five rulemakings included in the multi-product Joint Agreement. AHAM’s written comments on cumulative regulatory burden are available at: www.regulations.gov/comment/EERE-2017-BT-STD-0003-0069 (pp. 20–21) for refrigerators, refrigerator-freezers, and freezers; [\[STD-0039-0031\]\(http://www.regulations.gov/comment/EERE-2014-BT-STD-0039-0031\) \(pp. 12–15\) for miscellaneous refrigeration products; \[www.regulations.gov/comment/EERE-2014-BT-STD-0005-2285\]\(http://www.regulations.gov/comment/EERE-2014-BT-STD-0005-2285\) \(pp. 44–47\) for consumer conventional cooking products; \[www.regulations.gov/comment/EERE-2017-BT-STD-0014-0464\]\(http://www.regulations.gov/comment/EERE-2017-BT-STD-0014-0464\) \(pp. 40–44\) for residential clothes washers; and \[www.regulations.gov/comment/EERE-2014-BT-STD-0058-0046\]\(http://www.regulations.gov/comment/EERE-2014-BT-STD-0058-0046\) \(pp. 12–13\) for consumer clothes dryers.](http://www.regulations.gov/comment/EERE-2020-BT-</p>
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annual benefits are \$171.2 million in reduced operating costs, \$29.0 million from GHG reductions, and \$50.8 million

from reduced NO_x and SO₂ emissions.

In this case, the net benefit amounts to \$237.0 million per year.

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Table V.29 Annualized Benefits and Costs of Adopted Standards (the Recommended TSL) for Dishwashers

Category	Million 2022\$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
3% discount rate			
Consumer Operating Cost Savings	171.2	164.1	175.8
Climate Benefits*	29.0	28.3	29.3
Health Benefit**	50.8	49.6	51.3
Total Benefits†	251.0	242.0	256.4
Consumer Incremental Product Costs‡	14.0	17.0	13.2
Net Monetized Benefits	237.0	224.9	243.1
Change in Producer Cashflow (INPV‡‡)	(14) - (9)	(14) - (9)	(14) - (9)
7% discount rate			
Consumer Operating Cost Savings	127.2	122.5	130.5
Climate Benefits*	29.0	28.3	29.3
Health Benefit**	34.3	33.5	34.5
Total Benefits†	190.5	184.3	194.3
Consumer Incremental Product Costs‡	14.0	16.7	13.3
Net Monetized Benefits	176.4	167.6	181.0
Change in Producer Cashflow (INPV‡‡)	(14) - (9)	(14) - (9)	(14) - (9)

Note: This table presents the costs and benefits associated with dishwashers shipped during the period 2027–2056. These results include consumer, climate, and health benefits that accrue after 2056 from the products shipped during the period 2027–2056. The Primary, Low Net Benefits, and High Net Benefits Estimates utilize projections of energy prices from the *AEO2023* 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 and IV.H 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; however, DOE emphasizes the importance and value of considering the benefits calculated using all four sets of SC-GHG estimates. To monetize the benefits of reducing GHG emissions, this analysis uses the interim 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.

** Health benefits are calculated using benefit-per-ton values for NO_x and SO₂. DOE is currently only monetizing (for SO₂ 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.

‡‡ Operating Cost Savings are calculated based on the life-cycle cost analysis and national impact analysis as discussed in detail below. *See* sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, MIA). *See* section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cashflow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted-average cost of capital value of 8.5 percent that is estimated in the MIA (*see* chapter 12 of the direct final rule TSD for a complete description of the industry weighted-average cost of capital). For dishwashers, the change in INPV ranges from -\$14 million to -\$9 million. DOE accounts for that range of likely impacts in analyzing whether a trial standard level is economically justified. *See* section

V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the Preservation of Gross Margin scenario, which is the manufacturer markup scenario used in the calculation of Consumer Operating Cost Savings in this table; and the Tiered scenario, which models a reduction of manufacturer markups due to reduced product differentiation as a result of amended standards. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this direct final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation for this direct final rule, the annualized net benefits would range from \$223 million to \$228 million at 3-percent discount rate and would range from \$163 million to \$168 million at 7-percent discount rate. Parentheses () indicate negative values.

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VI. Severability

DOE added a new paragraph (3) into section 10 CFR 430.32(f) to provide that each energy and water conservation for each dishwasher category is separate and severable from one another, and that if any energy or water conservation standard is stayed or determined to be invalid by a court of competent jurisdiction, the remaining standards shall continue in effect. This severability clause is intended to clearly express the Department's intent that should an energy or water conservation standard for any product class be stayed or invalidated, the other conservation standards shall continue in effect. In the event a court were to stay or invalidate one or more energy or water conservation standards for any product class as finalized, the Department would want the remaining energy or conservation standards as finalized to remain in full force and legal effect.

VII. Procedural Issues and Regulatory Review

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

Executive Order ("E.O.") 12866, "Regulatory Planning and Review," as supplemented and reaffirmed by E.O. 13563, "Improving Regulation and Regulatory Review," 76 FR 3821 (Jan. 21, 2011) and amended by E.O. 14094, "Modernizing Regulatory Review," 88 FR 21879 (Apr. 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, OIRA in the 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 regulatory action constitutes a "significant regulatory action" within the scope of section 3(f) of E.O. 12866. DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the final regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments are summarized in this preamble and further detail can be found in the technical support document for this rulemaking.

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 and a final regulatory flexibility analysis 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 is not obligated to prepare a regulatory flexibility analysis for this rulemaking because there is not a requirement to publish a general notice of proposed rulemaking under the Administrative Procedure Act. *See* 5 U.S.C. 601(2), 603(a). As discussed previously, DOE has determined that the Joint Agreement meets the necessary requirements under EPCA to issue this direct final rule for energy conservation standards for dishwashers under the procedures in 42 U.S.C. 6295(p)(4). DOE notes that the NOPR for energy conservation standards for dishwashers published elsewhere in this issue of the **Federal Register** contains a regulatory flexibility analysis.

C. Review Under the Paperwork Reduction Act

Manufacturers of dishwashers 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 dishwashers, 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 dishwashers. (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

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), 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 direct 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 direct 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 dishwashers manufacturers in the years between the direct final rule and the compliance date for the new standards and (2) incremental additional expenditures by consumers to purchase higher-efficiency dishwashers, 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 direct final rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this document and the TSD for this

direct final rule respond to those requirements.

Under section 205 of UMRA, DOE is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(m), this direct final rule establishes amended energy conservation standards for dishwashers 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 direct 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. Although this direct final rule would not have any impact on the autonomy or integrity of the family as an institution as defined, this rule could impact a family's well-being. When developing a Family Policymaking Assessment, agencies must assess whether: (1) the action strengthens or erodes the stability or safety of the family and, particularly, the marital commitment; (2) the action strengthens or erodes the authority and rights of parents in the education, nurture, and supervision of their children; (3) the action helps the family perform its functions, or substitutes governmental

activity for the function; (4) the action increases or decreases disposable income or poverty of families and children; (5) the proposed benefits of the action justify the financial impact on the family; (6) the action may be carried out by State or local government or by the family; and whether (7) the action establishes an implicit or explicit policy concerning the relationship between the behavior and personal responsibility of youth, and the norms of society.

DOE has considered how the proposed benefits of this rule compare to the possible financial impact on a family (the only factor listed that is relevant to this rule). As part of its rulemaking process, DOE must determine whether the energy conservation standards contained in this final rule are economically justified. As discussed in section V.C.1 of this document, DOE has determined that the standards are economically justified because the benefits to consumers far outweigh the costs to manufacturers. Families will also see LCC savings as a result of this rule. Moreover, as discussed further in section V.B.1 of this document, DOE has determined that for the for low-income households, average LCC savings and PBP at the considered efficiency levels are improved (*i.e.*, higher LCC savings and lower payback period) as compared to the average for all households. Further, the standards will also result in climate and health benefits for families.

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 direct 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 dishwashers, 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 direct 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.¹⁴⁷ 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

¹⁴⁷ The 2007 “Energy Conservation Standards Rulemaking Peer Review Report” is available at the following website: energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0 (last accessed Nov. 15, 2023).

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.¹⁴⁸

M. Materials Incorporated by Reference

The following standard appears in the amendatory text of this document and was previously approved for the locations in which it appears: AHAM DW–1–2020.

N. 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 the Office of Information and Regulatory Affairs has determined that this rule meets the criteria set forth in 5 U.S.C. 804(2).

VIII. Approval of the Office of the Secretary

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

List of Subjects in 10 CFR Part 430

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

Signing Authority

This document of the Department of Energy was signed on April 12, 2024 by Jeffrey Marootian, Principal Deputy 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

¹⁴⁸ The report is available at www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards.

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 April 12, 2024.

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. Amend § 430.32 by revising paragraph (f) to read as follows:

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

* * * * *

(f) *Dishwashers*. (1) All dishwashers manufactured on or after May 30, 2013, shall meet the following standard—

(i) Standard size dishwashers shall not exceed 307 kwh/year and 5.0 gallons per cycle. Standard size dishwashers have a capacity equal to or greater than eight place settings plus six serving pieces as specified in AHAM DW–1–2020 (incorporated by reference, see § 430.3) using the test load specified in section 2.3 of appendix C1 or section 2.4 of appendix C2 to subpart B of this part, as applicable.

(ii) Compact size dishwashers shall not exceed 222 kwh/year and 3.5 gallons per cycle. Compact size dishwashers have a capacity less than eight place settings plus six serving pieces as specified in AHAM DW–1–2020 (incorporated by reference, see § 430.3) using the test load specified in section 2.3 of appendix C1 or section 2.4 of appendix C2 to subpart B of this part, as applicable.

(2) All dishwashers manufactured on or after April 23, 2027, shall not exceed the following standard—

Product class	Estimated annual energy use (kWh/year)	Maximum per-cycle water consumption (gal/cycle)
(i) Standard-size ¹ (≥8 place settings plus 6 serving pieces) ²	223	3.3
(ii) Compact-size (<8 place settings plus 6 serving pieces) ²	174	3.1

¹ The energy conservation standards in this table do not apply to standard-size dishwashers with a cycle time for the normal cycle of 60 minutes or less.

² Place settings are as specified in AHAM DW-1-2020 (incorporated by reference, see § 430.3) and the test load is as specified in section 2.4 of appendix C2 to subpart B of this part.

(3) The provisions of paragraph (f)(2) of this section are separate and severable from one another. Should a

court of competent jurisdiction hold any provision(s) of this section to be stayed

or invalid, such action shall not affect any other provision of this section.

* * * * *

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